MECHANICAL DESIGN CRITERIA
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FORMS

MECHANICAL DESIGN CRITERIA

I. GENERAL

A. The Design Professional shall use this document in conjunction with the Educational Specifications and District Master Specifications (DMS) to develop the design and contract documents.

B. The Design Professional is encouraged to specify and select high efficiency equipment and systems, as well as peak demand shifting and energy storage systems that can qualify for energy rebate incentive programs offered by Florida Power & Light Company (FPL).

   1. Exercise caution to maintain competitive bidding and avoid single-source supply of such equipment and systems.

C. Goals:

   1. Design the project to USGBC LEED for Schools Silver requirements see USGBC LEED for Schools Recommendation List in the Architectural Criteria for point recommendations.
      a. Coordinate with Architect– see Architectural Design Criteria for additional goals and documentation requirements.
      b. All Energy and Atmosphere Prerequisites and Credits
      c. Indoor Environmental Quality Prerequisite 1 Minimum Indoor Air Quality Performance
      d. Indoor Environmental Quality Prerequisite 3 Minimum Acoustical Performance
      e. Indoor Environmental Quality Credit 1 Outdoor Air Delivery Monitoring
      f. Indoor Environmental Quality Credit 5 Indoor Chemical and Pollution Source Control
      g. Indoor Environmental Quality Credit 6.1 Controllability of Systems - Lighting
      h. Indoor Environmental Quality Credit 6.2 Controllability of Systems – Thermal Control
      i. Indoor Environmental Quality Credit 7.1 Thermal Comfort – Design
      j. Indoor Environmental Quality Credit 7.2 Thermal Comfort - Verification
      k. Indoor Environmental Quality Credit 8.1 Daylight and Views – Daylight
      l. Indoor Environmental Quality Credit 9 Enhanced Acoustical Performance
      m. Indoor Environmental Quality Credit 10 Mold Prevention
   2. Design HVAC systems to create safe and comfortable environmental indoor conditions conducive to learning.
   3. HVAC systems must control and maintain indoor temperatures, humidity levels, provide required outdoor ventilation rates and not exceed noise levels as specified in this document or as required by applicable codes, standards, and regulations.
      a. Indoor air must be clean and odor free.
   4. Design HVAC systems and building envelope to maintain positive building pressurization and eliminate infiltration of unconditioned humid air to the building interior.
      a. This will prevent Indoor Air Quality (IAQ) or sick building syndrome problems manifested by the intrusion of moisture and/or presence of mold, mildew, and musty smells.
   5. Design the HVAC systems and building envelope to meet applicable Energy Efficiency Code requirements.
   6. Design of HVAC systems must be coordinated with the architect to be accessible and compatible with all components of the life safety systems.

D. This division contains requirements for the following sections:

   1. HVAC Design Criteria
   2. HVAC System Load Calculation
   3. Static Pressure Calculations (Variable Air Volume)
   4. Static Pressure Calculations (Single Zone)
   5. Static Pressure Calculations (Multi Zone)
   6. Room-By-Room Air Balance Analysis
   7. VAV Box Selection Procedure
   8. Index of Abbreviations and Acronyms

E. In this document the term “Engineer” represents the professionally qualified Design Engineer of Record and/or Engineering Consultant, duly licensed in the State of Florida, that signs and seals project design documents.
F. The Engineer is the person “responsible in charge” for the design and development of all project documents.
G. Project documents shall conform to and incorporate all requirements included in this document (Mechanical Design Criteria) and in Permit Documentation Requirements listed in procedure BD-001.
H. The Engineer must request, in advance and in writing, the approval for deviations from the requirements in Mechanical Design Criteria and in Permit Documentation Requirements.
   1. The SDPBC shall review the requested deviations, and based on good engineering practices and/or economics, either approve or deny the request in writing.
   2. Any approved deviations are valid only for the specific request and for the specific project.
I. Project documents shall be in compliance with the following code requirements as adopted, updated and in effect on permit application date:
   1. Florida Building Code, FBC
   2. National Fire Protection Association, NFPA
      a. Florida Administrative Code, specifically FAC Chapter 69A-58 "Fire Safety in Educational Facilities", and FAC Chapter 69A-60 "Florida Fire Prevention Code"
   3. American Association of Heating Refrigerating and Air Conditioning Engineers, ASHRAE standards
   4. ASHRAE Advanced Energy Design Guidelines for K12 School Buildings
J. Submittal requirements as listed in procedure BD-001 – Submission for Project Documents
K. Section “I” provides Index of Abbreviations and Acronyms that may not be spelled out in the text of this document.

II. CRITERIA

A. HVAC DESIGN - GENERAL
   1. Design Documents
      a. The project shall comply with all codes and the requirements of this section.
   2. General Design Conditions:
      a. The LEED Team shall present to the SDPBC PM evidence that the project was computer modeled in keeping with the LEED for Schools Energy and Atmosphere Prerequisite and Credit requirements.
      b. Use data from section "H" HVAC Calculations in addition to the requirements of this section.
         1) The LEED Team shall verify to the SDPBC PM that the Design Guideline parameters are in keeping with LEED requirements.
   3. Cooling Load Calculations:
      a. The LEED PA shall present to the SDPBC PM evidence that the project was computer modeled in keeping with the LEED for Schools Energy and Atmosphere Prerequisite and Credit requirements.
      b. Follow the procedure listed in section "H" HVAC Calculations.
         1) The LEED AP shall verify to the SDPBC PM that the Design Guideline parameters are in keeping with LEED requirements.
   4. Site Plan and Building Plans:
      a. For requirements, refer to procedure BD-001, Permit Documentation Requirements, Phase III – Complete Building Permit, HVAC Requirements.
   5. Building Envelope:
      a. Provide permanent vapor barriers that prevent air infiltration and vapor transmission through the walls and the roof/ceiling assembly, and that maintains their integrity for the life of the building.
      b. The proper location of the vapor barrier in humid climates is on the exterior.
      c. DO NOT use batt insulation on top of a lay-in ceiling with a ventilated attic.

d. Coordinate with Architect.

6. Floor Plans and Sections:
   a. For requirements, refer to procedure BD-001, Permit Documentation Requirements, Phase-III – Complete Building Permit, HVAC Requirements.
7. Roof Plans:
   a. For requirements, refer to procedure BD-001, Permit Documentation Requirements, Phase III – Complete Building Permit, HVAC Requirements.
8. Energy Rebates
   a. For schools served by Florida Power and Light (FPL), contact FPL to determine their latest requirements regarding rebates for Thermal Energy Storage (TES) systems, chillers, DX and other HVAC systems, equipment with adjustable speed drives (ASD), high efficiency motors, etc.
      1) Determine if the equipment from the major manufacturers can qualify for the FPL rebates.
   b. Identify any and all other possible sources for rebates, Federal, State, Local, etc.
   c. The District prefers the equipment with highest efficiency, and requires competitive bidding for the equipment; therefore, equipment specifications should avoid single-source supply.
      1) In case of conflicts, the District's Mechanical Engineer shall review available options, to determine the minimum specifications for acceptable equipment.
9. Design for Test and Balance (TAB) Work
   a. Complete all testing and balancing in a comprehensive commissioning plan issued by the SDPBC in keeping with EQ Prerequisite 1 Fundamental Commissioning of Building Energy Systems.
      1) Design HVAC systems to allow TAB work to be properly completed, refer to SDPBC details.
      2) Include SDPBC DMS Section 23 08 00 (15990), Commissioning of HVAC Systems and Section 23 05 93 (15991), Testing, Adjusting, and Balancing in the project manual.
      3) These sections define the requirements for the District's TAB contract with one or more TAB contractors DO NOT edit these sections.
   b. Show all CFMs on floor plans in accordance with requirements in procedure BD-001, Permit Documentation Requirements, Phase-III – Complete Building Permit, HVAC Requirements.
   c. Show collars and manual VDs for flexible duct run-outs to CDs and from RGs.
   d. Locate manual VDs at branch ducts that serve three or more CDs, RGs and EGs.
   e. For OA systems with motorized 2-position (open closed) OADs, provide a manual VD in addition to the motorized OAD. Do not use the motorized OAD for balancing.
      1) Locate manual VD in the main RA duct upstream of the OA duct connection.
   f. Multi-zone systems, locate a manual zone VD in each zone.
      1) With the multi-zone F&BPD dampers 100% open to coil, use the zone VDs to balance total CFM to each zone.
   g. If a system cannot be balanced using a flow hood, show locations for duct traverse test ports.
      1) Dimension the minimum upstream length (of two duct equivalent diameters) and minimum downstream length (of one duct equivalent diameter) of straight duct that are required for proper airflow measurement.
      2) For rectangular duct the equivalent diameter is defined as D=square root of (4xAxB/pi).
      3) Normally, fan powered relief air systems and outdoor air systems require duct traverse test ports for TAB work.
      4) For more accurate and/or continuous airflow monitoring or control, provide airflow-measuring station installed per manufacturer's recommendations.

B. HVAC DESIGN – ROOM SPECIFIC

1. Media Center
   a. The central AHU serving all spaces in Media Center operates between the hours of 800 and 1600.
   b. Provide a separate small DX system only in the Reading Room/Stacks areas to operate during AHU Off-hours (for humidity control).
      1) The EMCS shall control the DX unit when AHU is off during the unoccupied mode.

2) The central system's (relative humidity) RH-sensor (located in the Reading Room/Stacks area) shall also control the DX system.
   a) The EMCS shall activate the DX system when the space's (RH) exceeds 60%.
   b) The EMCS shall turn the DX system off when the space's RH decreases below 55%.
3) Size the DX unit for approximately 50% of the Reading Room/Stacks area, envelope transmission load in order to ensure adequate running time.
4) Duct smoke detectors for the DX systems (usually, with design capacity smaller than 2000 CFM) are not required.
   a) The EMCS has a 24-hour monitoring capability of the temperature, humidity, and smoke conditions in all Media Center spaces via space temperature & humidity sensors, and smoke detectors provided for the central AHU.

2. Dining Room and Kitchen
   a. Provide separate systems for Kitchen and Dining that function together in accordance with the Detail for Cafeteria HVAC System Schematic.
   b. Refer to District's EMCS control schematics for Kitchen Chilled Water Single Zone AHU and for Dining Chilled Water Single Zone AHU.
   c. Transfer the conditioned relief air from the Dining Room to the Kitchen to decrease the required make-up air when the kitchen's AHU, hood supply, and exhaust fans are operational.
   d. Provide air curtains (fly fans) at all doors from Dining or Kitchen to the exterior.
      1) Exception, air curtain are not required on emergency doors from dinning to the exterior, if the main entry to the Dining space is through an interior corridor system.
   e. For other spaces in Dining and Kitchen areas, refer to items 9, 10, and 11 below.
3. Staff Dining
   a. Provide a separate constant volume system serving Staff Dining from the system that serves Student Dining.
   b. Provide motorized control damper and T-sensor.
   c. Design the Staff Dining system for 150% of the staff dining design CFM.
   d. This design will compensate for a 50% variation in supply air temperature due to the modulation of the face and bypass dampers (CHW systems) or staging of compressors (DX systems).
   e. Provide tab note on floor plan that reads "BALANCE AIRFLOW IN STAFF DINING WITH MOTORIZED CONTROL DAMPER IN FULL OPEN POSITION."
4. Kitchen Manager’s Office
   a. Provide a dedicated DX or similar system.
   b. Size cooling equipment capacity based on 75°F indoor space temperature.
   c. Provide electric thermostat with sensor connected to the door into the space; provide a timer to the door sensor to shut off the DX system if door is open more than 15 minutes.
   d. DX unit will cycle to maintain thermostat's set point.
   e. Monitoring of this space is not required; therefore, do not provide EMCS T-sensor or RH-sensor.
5. Dry Food Storage, Walk-In Cooler and Freezer in Kitchen Area
   a. Dry Food Storage: Provide a dedicated DX system to operate continuously.
      1) Size equipment capacity based on 70°F indoor space temperature
      2) Provide electric thermostat.
      3) Provide a T-sensor for monitoring via EMCS. Do not provide RH-sensor.
   b. Walk-in cooler and freezer: Provide T-sensor for monitoring via EMCS.
6. PE Coach’s Office / Planning Room
   a. Provide small-dedicated DX or similar system.
   b. Size cooling equipment capacity based on 75°F indoor space temperature.
   c. Provide electric thermostat with sensor connected to the door into the space; provide a timer to the door sensor to shut off the DX system if door is open more than 15 minutes.
   d. DX unit will cycle to maintain thermostat's set point.

e. Monitoring of this space is not required; therefore, do not provide EMCS T-sensor or RH-sensor.

7. Kiln Room Exhaust System
   a. Coordinate with the Architect the location of the Kiln Room, preferably on exterior wall.
   b. During normal school, hours provide cooling from central HVAC system in the Kiln Room.
   c. Design the Kiln Room exhaust system to operate independently from the central air conditioning systems, using outdoor unconditioned make-up air.
      1) Exhaust Air System: Provide ceiling exhaust fan with a gravity back draft damper, volume damper, and wall discharge cap (preferred) or roof vent with bird screen.
      2) Make-up Air System: Provide intake wall louver (preferred) or roof intake hood with bird screen, motorized two-position (open/closed) damper, and duct that terminates 12" AFF with a grille.
         a) Separate air discharge and air intake with a minimum distance of 10'
      3) Electrically interlock (Division 26) the exhaust fan and motorized damper.
      4) Provide 0-12 hour manual timer switch.
      5) When the timer switch is activated, the exhaust fan is on and the make-up air damper is open.
      6) Provide heat detector for fixed temperature only (200°F, no rate of rise feature) and connect to the school fire alarm system, coordinate with electrical.
   d. An exhaust hood over the kiln is not required.
   e. Insulate common walls between the kiln room and adjacent air-conditioned areas to prevent condensation and mildew growth on the kiln room walls.
      1) Provide vapor barrier on the kiln room wall coordinate with Architect.
8. Custodial Room / Janitor Closet Exhaust Systems
   a. Provide independent exhaust system(s) for custodial rooms.
      1) To maintain custodial rooms at negative pressure provide make-up air or transfer air systems.
   b. When conditioned make-up air is used, exhaust custodial rooms located within the AHU zone at 2 CFM/SF.
   c. In non-conditioned areas, or where non-conditioned make-up air is used, exhaust custodial rooms at 3 CFM/SF.
   d. For make-up air equal to 150 CFM or less, use a 3/4" door undercut, if fire rating allows coordinate with Architect.
      1) For make-up air greater than 150 CFM, use a door grille or transfer duct/grilles.
   e. Provide ceiling exhaust fan with back draft damper.
      1) Provide exhaust ductwork with volume damper for balancing, and at the duct discharge provide roof or wall cap with bird screen.
      2) Layout the exhaust ductwork so the volume damper is above an accessible ceiling
      3) If that is not possible, provide ceiling access panel.
   f. Custodial exhaust system is part of the relief air system that provides proper pressurization and air balance for the AHU zone.
      1) Within the AHU zone, interlock the start/stop of the custodial exhaust fan with the open/close of OA damper or start/stop of the OA fan via the EMCS.
9. Toilet Exhaust Systems
   a. To maintain toilets at negative pressure provide exhaust systems with make-up air or transfer air systems. Do not provide supply air.
   b. When conditioned make-up air is used, exhaust toilets located within the AHU zone at 2 CFM/SF but not less than 50 CFM per water closet or urinal (FBC-M, Table M403.3).
   c. In non-conditioned areas, or where non-conditioned make-up air is used, exhaust toilets at 3 CFM/SF but not less than 50 CFM per water closet or urinal (FBC-M, Table M403.3).
   d. Toilet exhaust system is part of the relief air system that provides proper pressurization and air balance for the AHU zone.

1) Within the AHU zone, interlock the start/stop of the toilet exhaust fan with the open/close of OA damper or start/stop of OA fan via the EMCS; refer to item E.7.d.
2) When combining multiple toilet exhaust systems, do not locate fan or motors in ceiling above classroom.

e. Within the AHU zone, combine individual toilet exhausts to minimize the number of exhaust fans, and EMCS points for fan start/stop and fan status.
f. When toilet exhausts cannot be combined per item e, provide individual ceiling exhaust fans.
1) Control each fan from toilet light switch (or occupancy sensor) with 5-minute delay timer.
2) Coordinate with Electrical Engineer.
3) Although individual toilet exhaust fans are not controlled or monitored by the EMCS, they are included in the air balance analysis for the AHU.

g. Provide combined toilet exhaust fans or individual toilet exhaust fans with back draft dampers.
h. Design the exhaust ductwork to include separate (duct mounted) volume damper for balancing each exhaust grille and/or exhaust fan, and at the duct discharge provide roof or wall cap with bird screen.
1) Layout the exhaust ductwork so that the fan and volume damper are within 2' above an accessible ceiling
2) If that is not possible, provide ceiling access panel(s).

i. To control noise from single toilets (without vestibule) adjacent to occupied spaces in Administration area refer to C.8.l.
1) For single toilets in other locations with make-up air equal to 150 CFM or less, use a 3/4" door undercut if fire rating allows coordinate with Architect.
2) For make-up air greater than 150 CFM, either use a door grille or transfer duct/grilles.

10. School Police Office/Surveillance Room
a. During normal business hours, provide cooling and outdoor air via the Administration's AHU.
b. After normal business hours, to offset computer equipment and security monitor loads, provide a dedicated DX system.
1) Provide programmable thermostat.
2) Provide T-sensor for monitoring via EMCS.
3) Do not provide RH-sensor, unit will cycle to maintain the thermostat set point.

c. To avoid potential damage to computer hardware caused by condensate, locate DX unit in (ceiling) space near the doorway.
1) Do not route DX condensate drain line over electronic equipment area.

11. Electrical Rooms
a. Review the heat load of electrical equipment rooms with transformers and provide a DX unit or another ventilation system to keep the room temperature below 90°F 24 hours a day 7 days per week.
b. Mechanical Engineer to coordinate with the Electrical Engineer and Architect
c. If using DX unit, locate equipment so as not to cause damage from the condensate of the refrigeration lines or drain lines to the electrical equipment in the room.

12. Golf Cart Storage/Charging Area
a. Provide ventilation at the rate of five air changes per hour, this may be mechanical or natural.
b. All fans shall have explosion proof motors
c. The HVAC documents shall include a requirement for a permanent sign "No spark or flame producing equipment and materials are allowed in this space"
d. Coordinate with the Architect.

13. ILS Communication Closet Room (CCR)
a. Provide air conditioning for CCR from the AHU that serves the area.
1) There is usually one CCR per building.

14. ILS Communication Equipment Room (CER)

a. During normal business hours, provide cooling and outdoor air via the area's AHU.
b. After normal business hours, to offset communication equipment loads, provide a dedicated DX system.
    1) Provide programmable thermostat.
    2) Provide T-sensor for monitoring via EMCS.
    3) Do not provide RH-sensor, DX unit will cycle to maintain the thermostat set point.
c. There is only one CER and it is usually located in the administration building.
d. To avoid potential damage to communication equipment caused by condensate, locate DX unit in (ceiling) space directly adjacent to the CER.
    1) Do not route DX condensate drain line over CER.

15. Chemical Storage Room
    a. Provide continuously operating mechanical exhaust system connected directly to exterior of the building.
    b. Monitor the fan operation using the building's EMS, which creates an alarm when the electrical current stops on the exhaust fans.
    c. Exhaust system shall consist of dual exhaust fans with one single exhaust discharge (Primary and secondary fans).
        1) Normal operating conditions (During occupancy), both exhaust fans exhaust a minimum of 110% of the supply CFM to the room, approximately 15 air changes per hour.
        2) Off hours (Non-occupied times), the smaller of the two fans shall exhaust approximately 1/3 the occupied CFM rate.
    d. Provide connection for vented flammable storage cabinet directly to the mechanical exhaust system for the room.
        1) Provide vapor proof exhaust fan.
16. Mechanical Equipment Rooms (MERs)
    a. The Engineer, not the contractor, shall provide detailed plans and sections of MERs including Air Handler Units (AHUs). There are no exceptions.
    b. During Phase II, size MERs for proper service access, and properly locate MER doors to provide service access (e.g. for coil removal), coordinate with Architect.
    c. Locate MERs on exterior walls with solid exterior doors with weather stripping and center overlapping astragal to minimize infiltration and to reduce condensation on AHUs and ductwork.
        1) Provide conditioned air to MER coordinate with Architect.
        2) To eliminate the creation of plenum space in MER, door grilles and open (un-ducted) wall grilles are not allowed.
    d. For noise attenuation generated in MERs refer to C.8.n.
    e. Show all ductwork double-line.
    f. Show pipes, fittings, valves, specialties, etc. (2" and larger) double-line
        1) Plans must show locations of main CHW shut-off valves, y-strainers, control valve in CHWR line with actuator in vertical orientation, and Venturi flow meter with proper straight pipe upstream and downstream lengths. In section show, flexible coil piping connections to allow clearance for coil pull space.
        2) When access is to the backside of the AHU, locate the coil connections on the backside with the coil pull from the front side, refer to item "i" below.
    g. Using shaded areas, show service areas per manufacturer's recommendations for maintenance, removal or replacement of the following:
        1) Coil
        2) Fan motor and drive
        3) Fan shaft and bearings
        4) Filters
        5) Control actuators

h. For multi-zone units provide 30" clearance at the AHU discharge end (SA) and locate the control actuators for the zone dampers in front of the AHU.
    1) Do not locate control actuators for the zone dampers on top of the AHU.
i. Provide a minimum of 30" of clearance on all sides of the AHU.
    1) The Engineer, with approval may reduce the 30" clearance in tight rooms, in this order: (1) inlet end (RA), (2) back side, and (3) discharge end (SA) except for multi-zone unit.
j. Show locations of starters, disconnects, EMCS panels, electric duct heater control panels, variable frequency drives, etc., and their working clearances per latest applicable revision of NEC.
    1) Coordinate with Electrical Engineer and EMCS Representative.
k. Provide housekeeping pad 6" larger than the AHU footprint and minimum 6" thick.
    1) The Engineer must verify that the 6" pad height will allow the proper size of condensate p-trap for the equipment selected as the basis of design.
l. For condensate, provide an open hub drain with a p-trap, and the lip at 1" AFF with a recessed dome strainer located next to the AHU housekeeping pad near the cooling coil condenser drain connection for continuation coordinate with plumbing design.
    1) The LEED Team shall evaluate condensate capture for the purpose of reuse on site has been evaluated in all applicable Water Efficiency Credits.
    2) Drain line shall have 1" air-gap above hub lip.
    3) Trap vent and trap primer are not required.
    4) Drain to nearest catch basin, if via roof drain system, provide an accessible backwater valve; coordinate with plumbing design.
m. Provide 3" floor drain with trap primer connected to sanitary system.
    1) Offset the floor drain vent below the roof to obtain a minimum of 10' separation from the outdoor air intakes.
    2) Slope MER floor to a floor drain; coordinate with Architect.
n. Provide hose bibb with tamperproof anti-siphon vacuum breaker.
o. Provide duplex power receptacle; coordinate with Electrical Engineer.

C. HVAC DESIGN – EQUIPMENT/CONTROLS
1. HVAC Design and Controls
    a. Shall reflect the HVAC system optimization in the computer modeling generated to meet the LEED for Schools Energy and Atmosphere Prerequisites and Credit requirements.
2. Equipment Identification Marks
    a. Define HVAC equipment using building number and equipment number. For example the first AHU and its associated systems in building 8 are identified as follows:
        1) AHU: AHU 8-1
        2) VAV Terminal Boxes : VAV 8-1-1, VAV 8-1-2, VAV 8-1-3, etc.
        3) Outdoor Air Fan: OAF 8-1
        4) Outdoor Air Damper: OAD 8-1
        5) Relief Air Damper: RAD 8-1
        6) Toilet, Custodial and General Exhaust Fans: EF 8-1, EF 8-2, EF 8-3, etc
3. Equipment Schedules:
    a. Provide schedules on drawings, not in the project manual.
    b. Schedules shall include all data as defined in specific equipment sections in this document.
    c. The equipment data in the Design Notebook, computer selection program printouts and in the Equipment Schedules must be consistent.
4. Installation Details:
    a. Provide details on drawings, not in the project manual.
    b. The engineer, not the contractor, shall provide proper detail design.
5. Control Schematics

a. Provide Control Schematics on drawings and not in the project manual refer to DMS sections 15900 and 16650.
b. Provide HVAC systems with individual classroom temperature control.
c. Consider resource rooms as classrooms.
d. Consider each side of a classroom with a moveable partition as two separate classrooms and provide independent temperature control for each.
e. Serve adjacent auxiliary spaces from the classroom zone.
   1) Examples of auxiliary spaces are material storage, project storage, textbook storage, administrative storage, classroom toilets, mechanical equipment rooms (MERs), electrical equipment rooms (EERs), communication closet rooms (CCR), corridors, etc.
f. The Vendor for EMCS equipment will be Automated Logic Corporation (ALC).
g. The design of the EMCS will be a joint effort between the Engineer, the EMCS Vendor, and the District's Mechanical Engineer.
h. The EMCS Vendor and/or the District's Mechanical Engineer will provide standard control schematics and specifications.
i. The Engineer must edit and/or revise the standard control schematics, control sequences, and specifications to address the specific design requirements for each project.
j. Provide EMCS conduits between buildings and the chiller plant as part of the electrical systems.
   1) Contact the EMCS Vendor for the number and size of conduits.
   2) Label EMCS conduits coordinate with Electrical Engineer.

6. Temperature Sensors, Relative Humidity Sensors and Thermostats
   a. For student areas, locate sensors away from primary exit doors to reduce damage.
   b. Locate sensors on interior walls and away from windows to eliminate solar influence.
      1) Sensors shall not be located on walls that have the other side exposed to the outdoors.
   c. Coordinate locations of sensors with Architect.
      1) Architect must show locations of sensors on architectural floor plans, to prevent locating sensors on HVAC floor plans behind chalk boards, tack boards, bulletin boards, etc. and inside of case work.
   d. H-Sensor:
      1) Provide one RH-sensor per AHU.
         a) For multi-zone and VAV systems, locate RH-sensor in a typical exterior zone.
      2) Gymnasium Locker/Dressing Rooms: Provide only T-sensor (no RH-sensor).
      3) Kitchen: Provide only T-sensor (no RH-sensor).
   e. Provide a T-sensor for monitoring via EMCS, with temperature control by a dedicated DX unit with thermostat in the following areas:
      1) Kitchen's Dry Food Storage
      2) Kitchen's walk-in cooler and walk-in freezer
      3) Administration's Data Processing Computer
      4) ILS Communication Equipment Room (CER) – Electric Thermostat
   f. Thermostats usually provided to control indoor design conditions in spaces served by dedicated DX systems.
7. Liquid & Air Flow Meters, Pressure Gauges and Thermometers
   a. Provide required instruments in per HVAC Design Details and/or DMS Section 23 05 19 (15135).
8. Noise Attenuation of Mechanical Equipment
   a. Noise attenuation must meet LEED for Schools Indoor Environmental Quality Prerequisite 3 Minimum Acoustical Performance.
      1) Evaluate all other requirements against the noise attenuation requirements in this requirement.
   b. Attenuate noise at the school's property line in accordance with city/county noise ordinance.

1) If the city does not have a noise ordinance, apply the county noise ordinance of 55 dBA.

c. Attenuate noise at physical education play courts and ball fields not to exceed 60 dBA.
   1) The noise level is a maximum value at any location -- not an average value.

d. LEED for Schools projects shall comply with IEQ Prerequisite 3 Minimum Acoustical Performance.

e. LEED teams may pursue IEQ Credit 9 Enhanced Acoustical Performance if site conditions warrant and the approach is cost effective.
   1) The bases for the acoustic performance criterion in LEED for Schools is on ANSI Standard S12.60-2002, Acoustic Performance Criteria, Design requirements, and Guidelines for Schools.
   2) LFS acoustic compliance is based on the following:
      a) Designing to the ANSI 12.60-2002 Standard
      b) Achieve a maximum background noise level from HVAC systems in classrooms and other core learning spaces of 45 dBA AND:
         (1) Case 1 - Classrooms and Core Learning Spaces < 20,000 cubic feet
            (a) Option 1 – Confirm that 100% of all ceiling areas (excluding lights, diffusers and grills) in all classrooms and core learning spaces are finished with a material that has a Noise Reduction Coefficient (NRC) of 0.70 or higher or
            (b) Option 2 – Confirm that the total area of acoustical wall panels, ceiling finishes, and other sound absorbent finishes equals or exceeds the total ceiling area of the room excluding lights, diffusers, and grills, materials must have an NRC of 0.70 or higher to be included in the calculation.
         (2) Case 2 – Classrooms and Core Learning Spaces equal to or > than 20,000 cubic feet.
            (a) Confirm through calculations described in ANSI Standard S12.60-2002 that all classrooms and core learning spaces greater than or equal to 20,000 cubic feet are designed to have a reverberation time of 1.5 seconds or less

f. Design the classroom spaces for a maximum noise criterion level of NC35, with Music Band, Chorus Rooms, and Auditoriums of NC20 to NC25.
   1) Size ductwork and select air distribution devices (CDs, RGs, and EGs) to satisfy above maximum room noise criteria.
   2) Assume a room attenuation of 5 dB:
   3) Caution: To obtain the room noise level the dBs of multiple outlets in a room add them logarithmically.

g. For attenuation, at the inlet to and the discharge from the AHU, provide the following minimum lengths of double-wall ducts with a perforated inner wall and 1" thick insulation encapsulated in a Mylar sleeve.
   1) Duct liner exposed to the air stream is prohibited.
   2) For additional details on electric duct heater installation in double wall ducts Refer to E.6.a.
   3) Multizone : 20' RA duct, 0' SA ducts
   4) Single Zone : 20' RA duct, 20' SA duct
   5) VAV : 20' RA duct, 20' SA duct
   6) If branch duct take-offs are necessary in the double-wall main duct, provide double-wall take-offs and double-wall branch ducts to obtain the minimum double wall lengths.
   7) Show locations of double-wall ducts on floor plans. Note referring to "X feet of double wall duct" is not acceptable.
   8) For quality control, double-wall ductwork must be factory made.
      a) Field fabricated double-wall ducts and fittings are not acceptable.

h. Noise attenuation; provide non-metallic flexible duct run outs from branch SA ducts to CDs and from RGs to RA ducts.
   1) The length of flexible duct must be 6' minimum to 10' maximum laying length.

2) For insulation requirements refer to item F.6.

i. Route the main VAV high velocity supply air duct over non-sensitive noise areas (corridors, storage rooms, toilets, etc.).

1) If no other alternative route is possible except over a noise sensitive area, then take measures during design to prevent potential noise problems

a) Two possible options:

(1) Using double-wall duct with a solid inner wall

(2) Using a low frequency band silencer within the MER

j. The main low velocity return air ducts may cause a low frequency rumble, in noise sensitive areas, therefore, during the design phase take measures to prevent this problem with one of the following options:

1) Single wall round duct or flat-oval duct

2) Double-wall duct with a solid inner wall

3) A low frequency band silencer within the MER

k. To attenuate noise from VAV boxes, select boxes in accordance with the VAV Box Selection Procedure for the SDPBC.

l. To control noise from single toilets (without vestibule) adjacent to occupied spaces in Administration area use U-shaped transfer air duct with two 90° mitered elbows for make-up air.

m. To attenuate noise from MERs provide walls of CMU or concrete construction extended to the roof or to the floor deck above.

1) Fire-rate the walls if required by the Life Safety Plan, coordinate with Architect.

n. Coordinate with Architect the location of the outdoor chiller yard and the design of chiller yard equipment and enclosure, to maintain maximum 55-dBA-noise level at the school property line.

1) To attenuate noise, the top of chiller yard enclosure wall shall be approximately 24" higher than the highest point of the chiller assembly when mounted on the concrete support pads.

2) The design of chiller yard enclosure will affect the selection of chiller equipment; see D.5.d.

3) If not feasible (in urban sites with close proximity of residential properties), with the District's Mechanical Engineer written approval, the Engineer may consider indoor water cooled chiller plant with outdoor cooling towers as an alternative; refer to item l below.

o. Coordinate with Architect the location of indoor chiller plant with outdoor cooling towers, and the design of cooling tower equipment and enclosure, to maintain maximum 55-dB-noise level at the school property line.

p. To prevent mechanical transmission of vibrations to the building structure, and vibrations that could cause excessive noise levels, provide vibration isolation systems, isolators, and/or supports for all rotating and reciprocating equipment.

1) Provide vibration isolators between vibrating equipment and connected piping and ductwork.

2) Refer to applicable HVAC Details and DMS Section 23 05 48 (15242).

D. CHILLERS

1. Chiller Plant (Indoor and Outdoor Type Chiller Plants)

a. The Engineer -- not by the Contractor, shall provide detailed plans and sections in minimum ¼” scale. There are no exceptions.

b. During Phase II, size chiller plant for proper service access and minimum operating clearances, refer to item e below. Chiller plant designs that do not provide proper service access and clearances are not acceptable, coordinate work with the Architect.

c. Show CHW and CW pipes, fittings, valves, specialties, etc. (2” and larger) double line

d. Provide two spare CHW flanged connections; see item D.8.k for details.

e. Show locations of starters, disconnects, EMCS panels, chiller control panels, variable frequency drives, etc.

f. Using shaded areas show working clearances for all electrical equipment per latest applicable revision of NEC, Coordinate with Electrical Engineer and EMCS Representative.

g. For other than electrical equipment show clearances per manufacturer's recommendations, using shaded areas.
h. Provide equipment housekeeping pads and/or supports. Coordinate with Structural Engineer.
i. Show locations of pipe supports and provide pipe support details.
j. Provide hose bibb(s) with tamperproof anti-siphon vacuum breaker(s) coordinate with plumbing.
k. Provide duplex receptacle(s), coordinate with Electrical Engineer

2. Indoor Chiller Plant (Water Cooled Chillers) in addition to D.1
   a. In Chiller Room, provide cooling from the central HVAC system.
   b. Provide roll-up door in front of each chiller.
      1) Size door to allow chiller replacement as a single unit, coordinate work with Architect
   c. Provide a rolling trolley and hoist system, attached to the building structure, and sized for the largest and heaviest chiller component, coordinate with Structural Engineer.
   d. In accordance with ASHRAE 15, provide refrigerant monitor and alarm control panel with horn and strobe, refrigerant sensors, remote alarm panels with horn and strobe outside of each personnel entrance door, and two (2) SCBAs within locked cabinets in a nearby locked room.
      1) Next to each remote alarm panel, provide sign that reads "SELF-CONTAINED BREATHING APPARATUS IS LOCATED IN ROOM #X".
   e. Provide emergency exhaust and ventilation system with wall intakes and roof discharges and with non-conditioned outdoor air make-up system.
      1) Exhaust air from the floor and the ceiling level to the outdoors, refer to ASHRAE 15
      2) Provide wall mounted electric thermostat.
      3) Exhaust fan will cycle to maintain thermostat's set point.
      4) Provide a refrigerant monitor and alarm control panel that overrides the thermostat and starts the fan in the emergency exhaust mode, in case of a refrigerant leak.
   f. Provide 4" floor drain(s) with trap primer(s) connected to sanitary system.
      1) Slope floor to the floor drain(s) coordinate work with plumbing and architectural design.
3. Outdoor Chiller Yard (Air Cooled Chillers) in addition to D.1
   a. Show required clearances.
      1) Minimum 6' clearance between air-cooled chiller and solid wall of chiller yard enclosure or adjacent building wall
      2) Minimum 10' clearances between multiple air cooled chillers
      3) Clearances recommended by chiller manufacturer shall apply if they are greater than those required by the District
   b. Provide concrete support piers for chillers per SDPBC Detail #39.
   c. Provide concrete slab on grade inside the chiller yard enclosure.
   d. Provide chiller yard enclosure designed for easy authorized access, proper air circulation and for sound attenuation; refer to item C.8.a, coordinate with the Architect and Structural Engineer.
   e. Provide paved access and 8 foot wide concrete landing with access doors.
   f. Coordinate with architectural and landscape design to prevent any overhangs (trees, structures, etc.) from intruding into the outdoor chiller yard enclosure.
4. Chillers, General Requirements (Air Cooled and Water Cooled)
   a. Calculate chiller capacity on the following,
      1) The sum of each building's cooling load less the duplicate people loads in areas such as student dining, staff dining, media center, gymnasium, and auditorium
      2) Increase chiller capacity to account for CHW pump energy (2545 BTUH/BHP x BHP)
      3) The total capacity of the cooling coils must not exceed the chiller capacity by more than 10%.
   b. Select chillers based on minimum 44°F leaving water temperature (LWT).
      1) Chiller LWT must be 1°F lower than the AHU cooling coil entering water temperature (EWT), (usually 45°F).
   c. HCFC and HFC refrigerants are acceptable, DO NOT use CFC refrigerants.

5. Air Cooled Chillers (in addition to item D.4. requirements)
   a. For elementary and middle schools select air-cooled chillers in accordance with DMS Section 15682.
   b. If justified, the District's Mechanical Engineer on the project-by-project basis may approve the selection of water-cooled chillers. For additional details, refer to item D.3.
   c. To meet 55-dB noise criteria at the property line the air cooled chillers may require optional factory sound reduction package to include, baffle hoods and/or noise reduction blankets on compressors, low noise condenser fans, and fan discharge extension hoods or equivalent options offered by equipment manufacturer.
   d. For additional noise attenuation measures see C.8.o.
   e. Define the following data in the equipment schedules:
      1) Tons, GPM, EWT, LWT, WPD, OAT, MCA/MFS/VOLTS/PHASE, 0.00025 fouling factor
         a) For a 50% vented enclosure, use 95°F OAT.
         b) For 3-sided (or less) solid, wall enclosure use 95°F OAT.
         c) For 4-sided solid wall enclosure, use 105°F OAT.
6. Water Cooled Chillers (in addition to item D.4. requirements)
   a. For high schools, or when the total cooling load exceeds 600 tons of refrigeration, select water-cooled chillers in accordance with DMS Section 23 64 16 (15684).
      1) For noise attenuation refer to C.8.p, and provide cooling towers per item D.7.
   b. Define the following data in the equipment schedules:
      1) CHW: Tons, GPM, EWT, LWT, WPD, MCA/MFS/VOLTS/PHASE, 0.00025 fouling factor
      2) CW: GPM, EWT, LWT, WPD, 0.00025 fouling factor
7. Cooling Towers
   a. Provide one stainless steel cooling tower per water-cooled chiller, with interconnecting piping independent of other adjacent chillers and towers within the same plant, do not use dual-cell or common sump towers.
      1) Design shall include the following instruction to the Contractor: After initial test and balance replace all adjustable pulleys with equivalent fixed belt drive pulleys supplied by cooling tower manufacturer.
      2) For additional requirements refer to Specifications, section 23 65 00 (15712).
      3) Provide condenser water system per item D.9.
   b. Define the following data in the equipment schedule:
      1) GPM, EWT, LWT, 80°FWB, HP/VOLTS/PHASE, variable speed drive motors
   c. For cooling tower drain(s) (non-valved emergency overflow and valved drain), provide 4" open hub drain(s) with trap primer(s), and recessed dome strainer(s).
      1) Connect to sanitary system coordinate with plumbing design.
   d. Provide cooling tower enclosure, design for easy authorized access, proper air circulation, and for sound attenuation; refer to item C.8.p, coordinate with the Architect and Structural Engineer.
   e. Coordinate with architectural and landscape design to prevent any overhangs (trees, structures, etc.) from intruding into the cooling tower enclosure.
8. Chilled Water (CHW) Systems
   a. Above 30-tons, CHW systems are preferred in lieu of DX systems.
   b. The following CHW systems are allowed:
      1) Variable Air Volume (VAV)
      2) Single Zone with face and by-pass dampers (F&BPDs)
      3) Multi-zone (MZ)
   c. DO NOT use any of the following CHW systems:
      1) Fan Coil Units.
      2) Unit Ventilators
      3) Packaged AHUs

d. For elementary and middle schools design CHW systems with a cooling coil minimum temperature difference of 12°F, to reduce pipe and pump sizes, and pump horsepower.
e. For high schools design primary/secondary, CHW loop systems (preferred).
   1) Constant flow primary chiller loop shall have minimum temperature difference of 10deg F and variable flow secondary loop shall have a minimum cooling coil temperature difference of 12 deg F.
   2) The primary GPMs must be 20% greater than the secondary GPMs in order to prevent secondary flow in the primary-secondary bypass line at design cooling load.
f. May use an alternate, a constant flow single loop CHW design with a minimum temperature difference of 12 deg F
g. Size CHW pipe: Note the GPM for constant flow systems and maximum GPM for variable flow systems.
   1) For below grade (exterior) CHW pipe, locate pipe offsets and swing-elbow take-offs to allow for proper thermal expansion-contraction.
      a) Pre-insulated welded steel pipe lines (up to 175' of straight run) with 36" of cover do not require thrust blocks, thermal expansion-contraction pipe offsets or swing elbows.
   2) For above grade (interior) CHW pipe, locate pipe anchors, pipe guides, swing-elbow take-offs, and thermal expansion-contraction devices.
h. Do not route CHW pipe under the building slab except to penetrate the exterior wall.
i. Do not route CHW pipe under sidewalks except to cross beneath them.
j. For CHW pumps refer to item D.10.
k. To accommodate an emergency portable chiller, provide two spare CHW flanged line-size connections with butterfly valves and blank flanges.
l. Insulate CHW piping; Refer to DMS Section 23 07 19 (15260).
m. Insulate CHW equipment (pumps, air separators, expansion tanks); refer to DMS Section 23 07 16 (15280).
n. Provide instruments for the chilled water systems to include temperature sensors, flow meters, pressure gauges, and thermometers; refer to items C.6 and C.7.
o. For systems with pump suction diffusers, provide note that reads “AFTER CHW SYSTEM FLUSHING AND PRIOR TO CHW SYSTEM BALANCING, REMOVE THE SCREENS FROM THE AHU STRAINERS AND HANG THE SCREENS NEXT TO THE STRAINERS".

9. Condenser Water System
   a. Design condenser water piping system so that any cooling tower can be isolated and can serve any chiller.
      1) For screw type chillers provide condenser water flow control (GPM) with butterfly control valve and fast response electric actuator (Bray or equal) controlled directly from the chiller (not via EMS) with refrigerant (evaporator/condenser) differential pressure signal.
   b. For CW, type pumps provide basket strainers.
   c. For CW, chemical treatment system, provide 4" open hub drain with trap primer and recessed dome strainer.
      1) Connect to sanitary system coordinate with plumbing design.
10. Pumps
   a. Define the following data in the equipment schedules:
      1) GPM, TDH, pump RPM, BHP, pump performance chart, motor RPM, motor HP/VOLTS/PHASE.
   b. In addition to duty, pump(s) provide one stand-by (back-up) pump for each chilled water system (CHW) and for each condenser water (CW) system.
   c. For pump construction and material details refer to DMS Section 23 21 23 (15540).
      1) Do not use vertical pumps due to high maintenance replacement costs and long deliveries of proprietary pump seals.

d. CHW pumps suction diffusers are acceptable but 'Y' or basket strainers are still required; refer to item D.8.o.

E. AIR HANDLERS

1. Air Handling Units (AHUs)

a. Limit the size of a single AHU to 15,000 CFM or a maximum coil face area in the AHU not to exceed 33 sq. ft.

1) The District's Mechanical Engineer may approve larger AHU on the project-by-project basis, if justifiable.

b. Design the HVAC system so that AHUs can operate independently of each other and still maintain proper air balances within each AHU zone.

1) Therefore, each AHU will have dedicated systems for outdoor air, exhaust air, relief air, and transfer air between AHU zones will (usually) be zero CFM. Exceptions are the dining and kitchen systems, and the gymnasium and locker/dressing room systems.

c. Define the following data in the equipment schedule: CFM_{SA}, CFM_{OA}, TSP, ESP, fan RPM, fan BHP, fan performance chart, motor HP/VOLTS/PHASE, motor RPM, filter APD, cooling coil data (item E.5.), and electric duct heater data (item E.6.).

d. Supply air CFM from AHU must not exceed the design sensible load requirements.

1) The CFM_{SA} in the equipment schedule is the concurrent block CFM with the allowed diversity that the AHU is selected on, and it is less than the supply air CFM in the air balance summary table shown on the individual HVAC plan sheets.

e. In multi-zone AHUs and AHUs with F&BPDs, coil bypass airflow is zero at design cooling load.

f. List all filters APD separately, do not include in the ESP.

1) Define all AHU components so the sum of the ESP and the component APDs equals the TSP.

g. Attenuate noise generated by AHUs in accordance with C.8.g.

h. Provide central station AHUs with the following features:

1) Casings for coil section and all sections down stream from coil section shall be double-wall with solid inner wall and 2" thick, 1.5 PCF insulation

2) Sloped, insulated, and double-wall stainless steel condensate drain pans with anti-microbial coating.

3) Field installed insulated copper condensate drain line with trap; refer to DMS Section 23 21 13 (15510).

4) Access modules (min. 15" width) with access doors to entering air and leaving airsides of the cooling coil, as listed in items 11 thru 14 below.

a) Bolted panels in lieu of access doors are not acceptable.

5) 2" thick, 30% dust spot efficiency air filters in accordance with ASHRAE 52.

6) High efficiency inverter duty motors

7) Differential pressure gauge for air filter pressure drop per item E.8.f.

8) Fan modules with internal vibration isolation

9) F&BPD modules with blade jam and edge seals.

a) Maximum leakage rate shall be 5 CFM/SF of blade area at 1" WG.

b) In order for an external F&BPD to work properly, the by-pass duct connection must be located upstream from coil face motorized damper.

10) Multi-zone damper module with blade jamb and edge seals

a) Maximum leakage rate shall be 9 CFM/SF of blade area at 1" WG.

11) For AHUs with F&BPDs (CHW), provide the following:

a) Mixing/filter module with door

b) External F&BPD module

c) Medium access module with door

d) Coil module

e) Medium access (vertical or horizontal) module with door

f) Fan module with door

12) For VAV AHUs (CHW & DX), provide the following:
   a) Mixing/filter module with door
   b) Medium access module with door
   c) Coil module
   d) Medium access (vertical or horizontal) module with door
   e) Fan module with door

13) For Multi-zone AHUs (CHW & DX), provide the following:
   a) Mixing/filter module with door
   b) Fan module with door
   c) Medium access module with door
   d) Multi-zone coil module with door downstream of coil and equalizing baffle in hot deck
   e) Multi-zone damper module

14) For 100% Outdoor Air AHUs (DX), provide the following:
   a) Flat filter module with door
   b) Medium access module with door
   c) Cooling coil module
   d) Medium access module with door
   e) Internal F&BPD module
   f) Hot gas reheat coil module
   g) Fan module with door

15) For alternative module offered by some manufacturers in lieu of filter or mixing/filter modules refer to Note in item F.8.c.

2. VAV Systems
   a. Refer to VAV design details for a typical classroom.
   b. Select VAV boxes in accordance with the VAV Box Selection Procedure for the SDPBC.
      1) This procedure calculates room sound pressure levels based on sound power levels for VAV boxes, CDs, and RGs.
      2) Appropriate selection of VAV boxes should eliminate the need for duct silencers downstream of the VAV boxes.
   c. To reduce air turbulence at the AHU discharge and decrease noise provide air foil plug fan for VAV systems or forward curved fan for constant volume systems, limit the outlet velocity of the fan to 3000 FPM, and size the supply air (round or oval) duct per item F.4.d.
   d. For sizing high velocity supply air ducts (AHU discharge to VAV box inlet), refer to F.4.b. & c.
   e. Locate static pressure sensor in high velocity supply air duct approximately 2/3 downstream of the AHU.
   f. For sizing low velocity supply air ducts (downstream of VAV box), refer to F.4.a.
   g. For routing of VAV high velocity supply air ducts refer to item C.8.i. and for noise attenuation refer to C.8.j.
   h. For noise attenuation in main low velocity return air ducts refer to C.8.k.

3. VAV Terminal Boxes
   a. Define the following data in the equipment schedule:
      1) Box: Minimum CFM, maximum CFM, pressure differential at maximum CFM, discharge and radiated sound powers at 1" WG differential pressure for octave bands 2-7
      2) Electric Heater (EH): KW/VOLTS/PHASE, control steps, EAT, LAT; refer to E.6.b.2.
   b. Do not locate VAV boxes with bottom access to be above the ceiling light fixtures, etc., and provide working clearance for electric duct heaters. Coordinate HVAC floor plans with reflective ceiling plans.
   c. At the inlet to the VAV terminal box, provide rigid round duct equal to the inlet diameter of the VAV box with minimum straight length of 3 feet or 3 duct diameters (whichever is longer).

4. DX Systems
    a. The LEED PA shall provide the SDPBC PM evidence of system performance and attendant economics associated with building energy system selection and performance.
    b. When CHW systems are not economically feasible, the Engineer may use one of the following:
        1) Split System Multi-zone: Provide dual refrigerant circuits, 100%-75%-50%-25% capacity steps, and row-split or intertwined coil.
        2) Split System Single Zone: Provide dual refrigerant circuits, 100%-75%-50%-25% capacity steps, and face-split coil.
        3) Rooftop (RTU) Single Zone: Provide dual refrigerant circuits, 100%-75%-50%-25% capacity steps, and face-split coil.
            a) Provide outdoor air hood with motorized OAD and manual VD.
            b) Mount the motorized OAD inside the RTU.
        4) Split System VAV: Provide dual refrigerant circuits, 100%-75%-50%-25% capacity steps, and row-split or intertwined coil.
        5) If four capacity steps are not available, provide hot gas reheat coil (not hot gas bypass).
            a) To control the amount of reheat, provide internal F&BPDs for the reheat coil.
        6) 100% Outdoor Air Unit: Provide dual refrigerant circuits, 100%-75%-50%-25% capacity steps, row-split or intertwined cooling coil, and hot gas reheat coil with F&BPDs.
        7) Provide capacity steps using either multiple hermetic compressors or semi-hermetic compressors with electric un-loaders.
            a) Suction un-loaders are not acceptable.
            b) Hot gas bypass does not provide a capacity step.
        8) Small capacity, constant volume DX systems, with single refrigerant circuit, controlled with thermostats, are used in the following areas:
            a) Administration's Data Processing (DP) Room
            b) ILS Communication Equipment Room (CER)
            c) Kitchen's Dry Food Storage
            d) Media Center (see item B.1. for details)
            e) Kitchen Manager's Office
            f) PE Coach's Office/Planning Room
            g) Interior Electrical Equipment rooms with heat producing transformers; refer to item H.2.y
            h) In areas a, b and c above, provide additional T-sensors for monitoring via EMCS, for additional details refer to criteria for specific areas listed above.
        9) Small capacity DX systems usually will not require smoke detectors; refer to item F.3.
        10) For other small capacity equipment that does not fit the above criteria, discuss selections with the District's Mechanical Engineer.
        11) PTAC type system may be acceptable for specific applications when approved.
5. Coils
    a. Select cooling coils based on 45°F EWT.
        1) For additional design details, refer to Section B, HVAC System Load Calculations, items A.2.n, o, and p.
    b. Define the following data in the equipment schedules:
        1) Cooling Coils: Provide computer printouts.
            a) Air: Total MBH, CFM, EATs, LATs, FPF (144 max), rows (8 max), APD (1.25" WG max), coil face velocity (550 FPM max)
            b) H_2O: GPM, EWT, LWT, WPD (15' max)
            c) R22: SST (2 deg F higher than for condensing unit)
        2) Hydronic Heating Coils: Provide computer printouts.
            a) Air: MBH, CFM, EAT, LAT, FPF, rows, APD
            b) H_2O: GPM, EWT, LWT, WPD

3) Hot Gas Reheat Coils: Provide computer printouts.
   a) Air: MBH, CFM, EAT, LAT, FPF, rows, APD
4) Heat Pipe Coils: Provide computer printouts.
   a) Air: MBH, CFM, EAT, LAT, FPF, rows, APD

c. Condenser coils: refer to DMS Section 15682 for coating requirements.

6. Electric Duct Heaters
   a. Locate electric duct heaters (EDHs) in supply ducts, inside the mechanical equipment rooms, down stream from the smoke detector and up stream from the supply air T-sensor.
      1) For installation of EDHs inside the double wall ducts provide solid inner liners that start 6" up stream and end 6" down stream from the EDH.
      2) For multi-zone systems, provide EDH in each zone.
      3) For VAV systems, provide EDH in each VAV box.
      4) Provide working clearances for EDHs per NEC, Article 110-26.
   b. Define the following data in the equipment schedule:
      1) CFM, EAT, LAT, APD, control steps, KW/VOLTS/PHASE.
      2) Limit the air temperature rise not to exceed 30 to 35 deg F. EH should be sized at approximately 1kW per each 100 CFM of airflow, resulting in average temperature rise of 32 deg F.
7. Fans
   a. Use ceiling and inline fans rather than roof-mounted fans.
      1) Do not install in-line fans in ceiling spaces above classrooms.
      2) Install inline fans in horizontal ducts that are within 2' of the accessible ceiling.
      3) If ceiling space is not accessible, provide ceiling access panel.
      4) Exceptions are roof-mounted fans for the kitchen hood, dishwasher, and fume hoods.
   b. For small fans use direct drive fans rather than belt drive fans.
      1) Provide volume damper for TAB (no speed controllers).
      2) Exhaust fans require a back draft damper.
   c. Provide fan interlocks for each fan controlled by the EMCS system.
      1) Also, provide fan status for all fans with airflows of 300 CFM and larger that affect building pressurization and are part of the air balance for the AHU zone.
      2) Fans that utilize non-conditioned air and are not interlocked with zone AHUs do not require status monitoring.
   d. Define the following data in the equipment schedule:
      1) CFM, ESP, motor HP/VOLTS/PHASE, motor RPM, fan RPM, fan performance chart (major fans only)
   e. The outlet velocity of the fan in a VAV type AHU should not exceed 3000 FPM.
   f. All variable speed fans shall have inverter duty rated motors appropriate for the application.
8. Air Filters
   a. Select, install, and maintain air filters, in keeping with LEED for Schools Indoor Environmental Quality Credit 5 Indoor Chemical and Pollutant Source Control.
   b. Filters installed in HVAC equipment shall be Minimum Efficiency Reporting Value (MERV) 13.
   c. AHU filters shall be an industry standard size, refer to DMS Section 23 40 00 (15885).
   d. For VAV systems with VFDs, select fan motor HP based on loaded filters (0.6" WG).
   e. For constant volume systems, select fan motor HP based on clean filters.
   f. To facilitate the maintenance of clean air filters provide differential pressure gauges connected to the filter modules with metal tubing refer to DMS Section 23 05 19 (15135).

F. DUCT WORK

1. Dampers

a. Provide manual Volume Dampers (VDs) where required for test and balance (TAB) work; refer to item A.9., and DMS Section 23 33 00 (15895).
b. Provide gravity back draft dampers where required (exhaust fans, gravity relief air systems, etc.)
c. Where required provide two position (open/closed) motorized dampers (MDs) or modulating motorized dampers for air flow (CFM) control; refer to EMCS control schematics.
   1) All motorized dampers located in non-insulated ductwork shall be of the double flange frame option, which bolts to the duct on side, allowing the actuator and damper linkage to be external of the ductwork and making the damper removable and accessible for service.
   2) Motorized dampers located in insulated ductwork shall be slip-in type with linkage inside the duct.
d. Layout the ductwork so that all dampers are located above accessible ceilings, or provide ceiling access doors
   1) To service motorized dampers provide duct access panels.

2. Fire Dampers (FDs) and Smoke Dampers (SDs)
   a. Design shall comply with FBC-Building Chapter 7, FBC-M chapter 6, NFPA 101, NFPA 90A and NFPA 92.
   b. At duct penetrations through fire-resistance-rated assemblies, provide required fire dampers.
   c. At duct penetrations through smoke barriers, provide required smoke dampers.
   d. At smoke partitions, provide smoke dampers in air transfer openings.
      1) At duct penetrations through smoke partitions/corridor, enclosures (required to have smoke draft control doors) provide smoke dampers if there are duct openings serving the corridor.
      2) Smoke dampers are not required if there are no duct openings serving the corridor.
   e. Type 'B' fire dampers with blade stack configured out of the air stream are standard.
   f. In low velocity ducts with a depth of at least 13" and District's Mechanical Engineer approval, the designer may use Type 'A' fire dampers with blade stack intruding into the air stream.
   g. Layout the ductwork so all fire and/or smoke dampers are located above accessible ceilings, or provide ceiling access doors.
      1) To service fire and/or smoke dampers provide duct access panels.
3. Smoke Detectors, Heat Detectors and Smoke Control Systems
   a. Provide smoke detectors in the supply and return systems of the air handling equipment; refer to FBC-M 606.2 and NFPA 90A 6.4.2.
   b. In boiler and kiln rooms of non-sprinklered, buildings provide heat detectors connected to the school fire alarm system. Refer to item B.7.b.6. for kiln room heat detector.
   c. For a stage area greater than 1000 sq ft or with a height greater than 50' provide a fan powered smoke control emergency ventilation system.
      1) The designer shall also comply with NFPA 92A, 92B, and 204.
      2) Interlock smoke evacuation exhaust fans with stage sprinkler system flow switch and with manual test switch.
      3) Smoke evacuation exhaust fans shall include back draft dampers and full size duct openings just below the bottom of the deck.
      4) For make-up air provide roof intake ventilator(s) (Greenheck model WIH with 2000 sq. in. throat, or equal) on roof curb with transition duct to a 1600 sq. in grille 10 ft above the stage floor with motorized damper to open and close with smoke evacuation fan operation.
      5) The designer may use roof vents only with written approval of the District's Mechanical Engineer.
4. Ductwork Sizing
   a. Low Velocity Ducts (SA, RA, and EA): Size ducts based on a pressure loss of 0.1" WG/100' and a maximum velocity of 1600 FPM using the following sizing rules:
      1) Airflows less than 9000 CFM, size ducts based on 0.1" WG/100'
      2) Airflows greater than 9000 CFM, size ducts based on 1600 FPM

b. High Velocity Ducts (AHU discharge to VAV box inlet): Size ducts based on a pressure loss of 0.5" WG/100' and a maximum velocity of 3000 FPM using the following sizing rules:
   1) Airflows less than 8,000 CFM, size ducts based on 0.5" WG/100'
   2) Airflows greater than 8000 CFM, size ducts based on 3000 FPM
c. To size the high velocity supply air ducts, start at the VAV boxes (with maximum design CFMs) and sum the CFMs for each branch duct back to the AHU discharge.
   1) When the supply air CFM in the main duct exceeds the scheduled CFM for the AHU, set the main duct CFM equal to the AHU CFM.
d. To reduce air turbulence at the discharge from the VAV air-handling unit size the supply air (round or oval) duct to match the outlet velocity of the fan and use full radius elbows for turns.
   1) For outlet velocity of the fan in a VAV air-handling unit, refer to item E.7.e.

5. Ductwork Construction - Supply Air (SA) & Return Air (RA)
   a. Refer to DMS Section 23 31 00 (15890) and SMACNA.
   b. Provide galvanized sheet metal ducts with flexible duct run out to CDs and from RGs.
      1) Without exceptions, ducts of the fiberglass board construction are NOT ALLOWED in SDPBC projects.
   c. To address noise attenuation, (at the inlet and discharge of AHUs) provide double-wall ducts; refer to C.8.g
      1) Except for return air systems, all double wall and medium pressure, high velocity ductwork shall be flat oval or round with spiral seal ducts and welded fittings, refer to DMS Section 15890.
   d. Provide non-metallic flexible duct run from branch SA ducts to CDs and from RGs to RA ducts.
      1) Refer to C.8.h. for flexible duct length required for noise attenuation.
      2) At branch duct connection, use collar with manual VD.
      3) Use insulated flexible duct for supply air and non-insulated flexible duct for return air systems, for details refer to item F.6.
   e. DO NOT use bottom taps of branch ducts to CDs and from RGs.
   f. Provide smoke detectors and heat detectors at required locations; refer to item F.3.
   g. Provide electric duct heaters at required locations; refer to item E.6.a.
   h. Provide manual volume dampers and motorized dampers at required locations; refer to item A.9.

6. Ductwork Insulation
   a. Refer to DMS Section 15290 for more details.
   b. Supply Air Ducts; Insulation is always required.
   c. Return Air Ducts.
      1) Not required if located within the conditioned thermal envelope.
      2) Exterior ducts; insulation is required, same as for supply air ducts
   d. Exhaust Air Ducts; insulation is not required.
   e. Outdoor Air Ducts
      1) Non-conditioned OA; insulation is not required.
      2) Conditioned OA with or without reheat, provide insulation the same as for supply air ducts.
   f. Ceiling Diffusers and Return Grilles except those in RA systems per item c.1 above; insulate the back of the ceiling diffusers and return grilles.
   g. Flexible Duct Run outs; insulation requirements are the same as for rigid metal ducts.

7. Ducted Return Air (RA) Systems.
   a. Ducted RA systems are standard.
   b. Design routing of the return air ductwork to allow the RA grilles to be located near the exterior walls and windows.
   c. The designer may use an all plenum air system only with written approval form the District's Mechanical Engineer for specific application on project-by-project basis.

8. Outdoor Air (OA) Systems

a. Provide galvanized sheet metal ducts and plenums; refer to Section 15890 and SMACNA. Refer to section H. HVAC Load Calculations, items H.2.i and.H.2.j for outdoor air requirements
b. Typical outdoor air system shall include:
   1) OA intake louver, consult with Architect and refer to DMS Section 10211.
   2) Motorized OA two-position (open/closed) damper with duct access panel
      a) Do not use the motorized OA damper for balancing; see item F.8.b.5) below.
   3) Straight duct section with duct traverse test ports or airflow measuring station (for minimum required straight duct lengths refer to airflow equipment manufacturer).
   4) Three possible OA system options:
      a) Atmospheric type (without fan)
      b) Outdoor Air Fan (for VAV systems)
      c) Outdoor Air Unit (OAU) with filter section, cooling coil (to pre-cool and dehumidify OA), and OAU fan
   5) Manual volume damper (provide manual VD in addition to motorized OA damper, see item F.8.b.3) above)
c. Note: Some manufacturers (e.g. Trane) offer Traq Damper Mixing Box Module for the central AHU with bell mouth inlet guides, motorized butterfly dampers and flow sensing rings. The Engineer may delete from the outdoor air system items F.8.b.3), 4) and 5) listed above, when this type of module is included in the central AHU.

9. Exhaust Air Systems
   a. Refer to DMS Section 23 31 00 (15890) and SMACNA. Provide galvanized sheet metal ducts except for special exhaust systems:
      1) For fume hood exhaust, kitchen hood exhaust and dishwasher exhaust provide stainless steel ductwork
      2) For shower area, exhausts provide aluminum or stainless steel ductwork.
      3) For design, requirements of exhaust systems in kiln room, custodial rooms and in toilets refer to items B.7, B.8, and B.9, respectively.
      4) Provide welded aluminum plenum box on the back of each exterior wall louver.
10. Relief Air Systems
   a. Relief air systems are required in buildings or spaces pressurized with Outdoor Air.
      1) Provide galvanized sheet metal construction; refer to DMS Section 23 31 00 (15890) and SMACNA.
   b. If the exfiltration (pressurization) air exceeds 0.15 CFM/SF for any AHU zone, provide fully ducted relief air system for that zone vented to the outdoors as in c and d below.
   c. Ducted Gravity Relief Air System**:** (Preferred because they are self-balancing with respect to unplanned leaks due to poor building construction)
      1) Provide system with the following features: ductwork (sized for 500 FPM), relief grille (sized for 0.025"WG), motorized two-position (open/closed) damper (controlled by EMCS), counterbalanced gravity back draft damper (set to open at 0.05"WG), roof or exterior wall discharge (sized for 0.05"WG) with ½" corrosion resistant bird screen.
      2) Interlock the open/close function of the motorized control damper with the open/close of the OA damper or with start/stop of the OA fan via the EMCS.
   d. Fan Powered Relief Air System are preferred standard design:
      1) System shall exhaust relief air from the main RA duct prior to the OA duct connection.
      2) System shall have the following features: 45° side-tap in the RA duct, inline fan with back draft damper, volume damper, and roof or wall discharge.
      3) For adequate maintenance access, locate the inline fan in the horizontal relief air duct to be within 2' of the ceiling.
      4) Show location of duct traverse test ports in accordance with item A.9.g. interlock the start/stop of the relief fan with the open/close of the OA damper via the EMCS.

e. Plenum Relief Air System (not preferred, requires pre-approval in writing by the District's Mechanical Engineer):
   1) CAUTION: Plenum relief air system triggers multiple code restrictions in architectural, HVAC, plumbing and electrical design, and results in significant cost increase.

G. GRILLES

1. Ceiling Diffusers (CDs)
   a. The LEED Team shall exhibit to the SDPBC that all grills and diffusers have been evaluated for their role in meeting IEQ Prerequisite 1 Minimum Acoustical Performance.
   b. Use fixed blade type diffusers without damper or equalizing grid, aluminum construction (steel construction for fire-rated assembly), off-white color, Titus TDC-AA, or equal.
   c. Use collar with volume damper at SA branch duct and insulated flexible duct as run out to CD.
      1) Refer to C.8.h for flexible duct length required for noise attenuation.
   d. For T-bar ceilings, provide 24"x24" extended panel and insulate back of CD and extended panel - independent of ceiling grid.
   e. For other ceilings, secure CD to 1" x 1" x 18-gauge angles (located above the ceiling).
   f. Define CDs and CFMs on floor plans using the following format: CD/12x12/4W/300 CFM.
      1) For throws other than 4-way, show throw directions
   g. In corridors, locate CDs min. 12' away from exterior doors to prevent condensation on CDs.
2. Return Grilles (RGs)
   a. Use 45° fixed louvers, 2" spacing, aluminum construction (steel construction for fire-rated assembly), off-white color, Titus 4FL or equal.
   b. Use collar with volume damper at the RA branch duct with flexible duct run out from RG.
      1) Refer to item C.8.h for flexible duct length required for noise attenuation.
      2) For insulation requirements refer to item F.6.g.
   c. For T-bar ceilings, provide 24"x24" extended panel.
   d. For other ceilings, secure RG to 1" x 1" x 18-gauge angles (located above the ceiling).
   e. Define RGs and CFMs on floor plans using the following format: RG/12x12/330 CFM
   f. In corridors, locate RGs near exterior doors
3. Exhaust Grilles (EGs)
   a. Use 45° fixed louvers, 2" spacing, aluminum construction (steel construction for fire-rated assembly), off-white color, Titus 4FL or equal.
   b. Provide separate volume damper for balancing each EG.
      1) Locate volume damper a minimum of five duct diameters from the EG.
   c. Layout the exhaust ductwork so the volume dampers are located above accessible ceilings, or provide ceiling access door (Most toilets have inaccessible ceilings.)
   d. Define EGs and CFMs on floor plans using the following format: EG/12x12/330 CFM
   e. Provide rigid duct connections to EGs.
4. Transfer Grilles (TGs)
   a. Use 45° fixed louvers, 2" spacing, aluminum construction (steel construction for fire-rated assembly), off-white color, Titus 4FL or equal.
   b. Define TGs and CFMs on floor plans using the following format: TG/12x12/220 CFM
   c. Size TGs for a maximum of 0.025" WG and the duct for a maximum velocity of 500 FPM
   d. Show CFMs for TGs on plans to assure proper air balance
5. Door Grilles (DGs)
   a. Use 70° opposed angle, 1" inverted "V" louvers, double flange, aluminum construction, off-white color, Titus CT-700 or equal.
   b. Define DGs and CFMs on floor plans using the following format: DG/12x12/170 CFM
   c. Size DGs for a maximum pressure loss of 0.05" WG
   d. Show CFMs for DGs on plans to assure proper air balance

6. Door Undercuts (UCs)
    a. Limit door undercuts to 3/4", if fire rating allows, coordinate with Architect, which corresponds to 150 CFM at a pressure loss of 0.05" WG for an interior 3' x 7' door, and coordinate with Architect.
    b. Define UCs and CFMs on floor plans using the following format: UC/115 CFM
    c. Show CFMs for UCs on plans to assure proper air balance.
    d. UCs are allowed in fire rated doors but not in smoke doors.

H. HVAC CALCULATIONS

1. HVAC Cooling Load Calculations
    a. LEED for Schools projects must conform to computer modeling procedures found in the Energy and Atmosphere Prerequisites and Credits.
        1) Provide computer calculations in accordance with ASHRAE's methodology.
        2) Use ASHRAE Energy Design Guide for K12 School Buildings.
    b. The LEED Team shall provide the SDPBC PM electronic copy of all inputs and outputs generated from the building energy system computer modeling no later than the completion of Design Development.
    c. Use input data in item 2 below to design HVAC systems.
        1) The LEED PA shall provide the SDPBC with evidence the final design parameters are in keeping with LEED for Schools Energy and Atmosphere Prerequisites and Credits.
    d. The Engineer may submit a written request to deviate from standard District input data when dictated by good engineering practice or economics.
        1) The District's Mechanical Engineer will respond in writing either approving or disapproving the request.
2. Input Data for HVAC Load Program
    a. Summer Design Conditions
        1) Indoor Conditions:
            a) Administration: 75° F_{DB} / 50% RH
            b) Media Center: 75° F_{DB} / 50% RH
            c) Classrooms, Shops and Labs: 75° F_{DB} / 50% RH
            d) Dining: 75° F_{DB} / 50% RH
            e) Kitchen: 80° F_{DB} / 50% RH
            f) Gymnasium and Locker/Dressing Rooms: 75° F_{DB} / 50% RH
            g) Auditorium: 75° F_{DB} / 50% RH
            h) Electrical Equipment Rooms: not to exceed 80° F_{DB} even when central HVAC systems are off
        2) Outdoor Conditions: 92°F_{DB} /80°F_{WB} (1% design point)
        3) Note: Input the appropriate design outdoor conditions into the load program so that the output from the load program defines the outdoor conditions as 92°F_{DB} /80° F_{WB} at 1500 hours for July and August with south or west exposure.
        4) Daily Range: 16deg F
        5) Clearness Factor: 0.90
    b. Winter Design Conditions
        1) Indoor: 70° FDB
        2) Outdoor: 41° FDB (99% design point)
        3) Clearness Factor: 0.95
        4) Note: Do not reduce heating capacity for heating loads from lights, equipment, and people.
        5) Do not increase heating capacity by the use of pickup factors.
    c. Ground Reflectance: 0.20
    d. Latitude for Palm Beach County: 26.7° North

e. Longitude for Palm Beach County: 80.1° West
f. Elevation for Palm Beach County: 15 feet above sea level
g. People Loads:
   1) Elementary Schools: SENSIBLE / LATENT LOADS
      a) Student Areas: 190 BTUH / 190 BTUH
      b) Administration: 250 BTUH / 250 BTUH
      c) Kitchen: 250 BTUH / 250 BTUH
   2) Middle and High Schools: SENSIBLE / LATENT LOADS
      a) Student Areas: 250 BTUH / 250 BTUH
      b) Administration: 250 BTUH / 250 BTUH
      c) Kitchen: 250 BTUH / 250 BTUH
      d) Wresting and Weight Rooms: 710 BTUH / 1090 BTUH
      e) Dance and Gymnastics Rooms: 710 BTUH / 1090 BTUH
h. Occupancy Levels: Base Occupancy on:
   1) The LEED PA shall provide the SDPBC with evidence the parameters were used to generate the LEED for Schools Full Time Equivalent (FTE) number; unless otherwise determined (ie OEF 208 form provided by the Architect) the FTE will be calculated using the following:
   2) Classrooms:
      a) 25 students plus 1 teacher per classroom for pre-kindergarten through 8th grade, exceptional student education, science, art, etc.
      b) 27 students plus 1 teacher per classroom in high schools.
   3) Resource Rooms: 15 students plus 1 teacher per room.
   4) Student Dining: The seating capacity of the Phase II furniture plan (usually 1/3 of the core student design capacity).
   5) Staff Dining: The seating capacity of the Phase II furniture plan
   6) Stage for Cafetorium: 30 students for non-working stage.
   7) Gymnasium: Minimum of 120 students plus four teachers, and the maximum on the bleacher seating capacity.
   8) Auditorium: Seating capacity
   9) Media centers: For the reading/stacks area, use the Phase-II furniture plan (usually 10% of the core student design capacity).
   10) Music and Choral Rooms: Intermittent occupancy of 60 students for Elementary and 100 students for Middle and High Schools
i. Ventilation Rates:
   1) Provide outdoor air in accordance with the FBC-M section 403 or the latest revision of ASHRAE Standard 62.
   2) May use either "Ventilation Rate Procedure" or "IAQ Procedure"
      a) May use the occupant diversity factor to account for variations in occupancy within the zones served by the system
      b) 20 CFM_{OA}/person Administration
      c) Designer may use the design based on the time average conditions per ASHRAE 62 if it is known that peak occupancy is of a short-term or duration or ventilation is varied or interrupted for a short period.
      d) The Estimating such variations could include occupancy scheduled by time-of-day, a direct count of occupants, or an estimate of occupancy or ventilation rate per person using occupancy sensors such as those based on indoor CO_2 concentrations.
j. Outdoor Air:
   1) Calculate exhaust air (EA), transfer air (TA), and exfiltration air (XFA) to determine the correct amount of outdoor air (OA).
   2) Outdoor air is the maximum of either a) or b) below.

a) OA = (CFM based on ventilation rate procedure or IAQ procedure)
b) OA = EA + TA + XFA, where
(1) EA: Toilets and custodial closets in conditioned areas, calculate exhaust air based on 2 CFM/sq. ft. or 50 CFM per water closet or urinal (whichever is larger)
(2) TA: Transfer air from the system is usually zero. Exceptions are the dining and kitchen systems, and the gymnasium and locker/dressing room systems.
(3) XFA: Building pressurization causes exfiltration (air leaks) from the system to the exterior preventing the infiltration of unconditioned outdoor air into the building. Calculate exfiltration air based on 0.1 CFM/sq ft; see Section H.7.a.5) a) exceptions.

k. Lighting Loads:
1) Since lighting loads are a dominant factor in cooling requirements, the LEED Team shall provide the SDPBC PM evidence that the project has undergone a thorough evaluation of day lighting and attendant controls designed to minimize the need for supplemental electrical lighting. Present evidence all lighting modeling; fixture selection and design implementation have met the following LEED for Schools Prerequisite and Credit requirements.
a) Energy and Atmosphere Prerequisite 2 Minimum Energy Performance
b) Energy and Atmosphere Credit 1 Optimize Energy Performance
c) Indoor Environmental Quality Credit 6.1 Controllability of Systems – Lighting
d) Indoor Environmental Quality Credit 8.1 Daylight and Views - Daylight
2)
3) Coordinate fixture selection with Electrical Engineer.
a) Use light fixtures with energy savings 32 W, T8 lamps and electronic ballast
b) A four-lamp fixture consumes 128 W
c) The ballast factor is 1
d) Appropriate values of Watts/room or Watts/square foot are acceptable

l. Miscellaneous Sensible Loads: Use documented electrical loads.

m. Miscellaneous Latent Loads: Usually zero.

n. The moisture content of supply air from the AHU must not exceed 65 grains H_2O/LB_{DA} (maximum humidity ratio W=0.093). (This requirement means that in most cases the cooling coil Leaving Air Temperatures (LATs) shall be 55°F_{DB} (at 54.8°F_{WB}) or lower. Most cooling coils will have 6 or 8 rows. These cooling coils will produce air with LATs that will be very close to saturation. For 45°F chilled water, the lowest feasible cooling coil LAT_{DB} is 50°F.)

o. Input minimum cooling coil LAT of 50°F_{DB} and the following maximum LATs and other parameters to the cooling load program:
1) 50°F_{DB} for Dining, Auditorium, Gymnasium
a) These are usually constant volume single zone systems.
(1) 8 row coils with 144 fins per foot (FPF)
(2) Sized for 500-to-550-ft/min-face velocity
(3) Air Press Diff = 1.25" WG or less
(4) CHW Temp Diff = 12 deg F (2.00 GPM/ton)
(5) CHW Press Diff = 15 ft HD or less
b) If cooling load program calculations determine that the 50°F_{DB} LAT input is too low try the following:
(1) Lower CHW Temp Diff to 11 or 10 degrees F. This increases CHW Flow (GPMs) to 2.18 or 2.40 GPM/ton and the CHW Press Diff up to 15 ft HD.
(2) Increase coil fins to 156 FPF. This will increase Air Press Diff and motor HP.
(3) Finally try using the larger A/C unit with coil size of 400-to-450 ft/min face velocity.
(a) With larger coil use: 8-row coil with 144 FPF
(b) Air Press Diff = 1.25" WG or less
(c) CHW Temp Diff = 12 deg F (2.00 GPM/ton)

(d) CHW Press Diff = 15 ft HD or less

2) 53°F_{DB} for Classrooms, etc

   a) These are usually VAV systems

3) 54°F_{DB} for Administration area

   a) These are usually constant volume SZ or VAV systems

      (1) 6-row coil with 144 fins per foot (FPF)

      (2) Sized for 500 to 550 ft/min face velocity

      (3) Air Press Diff = 1.25" WG or less

      (4) CHW Temp Diff = 12 deg F (2.00 GPM/ton)

      (5) CHW Press Diff = up to 15-ft HD

4) 56.5°F_{DB} for Kitchen

   a) This is usually a constant volume SZ system

5) The above input values should force the cooling load program to calculate the correct dry bulb Supply Air Temperatures (SAT_{DB}).

p. Coil Bypass Factor: 0.02 (use in Carrier load program)

q. To calculate the temperature rise across the fan, input the following parameters to the load program:

	Fan TSP	Motor EFF	Fan EFF
1) System Type			
2) Constant Volume	2.5"	0.85	0.60
3) Variable Air Volume	4.0"	0.85	0.60

r. Safety Factors: 0.0.

s. Heating Pickup Factor: 0.0

t. Computer/Equipment Loads:

1) ILS Communication Equipment Rooms (CER): If actual data is not available, use the largest of 13 W/SF or 5000 BTUH for equipment loads.

2) ILS Communication Closet Rooms (CCR): If actual data is not available, use the largest of 6 W/SF or 300 BTUH for equipment loads.

3) Classrooms including art, music, choral, exceptional student education, labs, etc: Use 8 computers at 200 W/computer

4) Resource Rooms: Use 4 computers at 200 W/computer (approx. 700 BTUH/computer)

5) Offices, Secretarial/Reception areas: Use 1 computer per staff member at 200 W/computer

6) Media Centers: Coordinate number of computers with the Phase-II furniture plan use 200 W/computer.

u. CCTV Loads:

1) In production room, review the electrical drawings (lighting) for studio lights.

   a) Studio lights are additional loads to the general room lighting.

2) Control room; review the electrical drawings (power) for equipment connections.

3) Provide table with loads itemized.

   a) For the load calculation, use the actual loads times a diversity of 1/3.

4) In Phase II calculations (if actual data is not available), use the following inputs (for studio lights and for equipment) to the load program:

   a) Elementary schools: 3 W/SF and 3 W/SF.

   b) Middle schools: 7 W/SF. and 7 W/SF.

   c) High schools: 10 W/SF and 10 W/SF.

5) In Phase-III calculations use actual data

v. Use the following occupancy schedules to determine cooling load profiles so that the cooling loads will peak at the appropriate times.

1) 600 to 2200 hours AHUs and Chillers are on.

2) 800 to 1700 hours — Administration
3) 800 to 1600 hours — Classrooms, Media Center, Dining, Gymnasium, & Auditorium
4) 600 to 1500 hours — Kitchen
5) 800 to 2200 hours — Custodial
6) 2200 to 600 hours — HVAC systems are OFF
7) Weekends and Holidays — HVAC systems are OFF
8) Cooling and heating is scheduled for Monday thru Friday per item 1) above.
9) Schedules for people, lights, equipment, exhausts, and outdoor air are per items 2) thru 5) above.

w. For cooling load calculations, assume year-round school schedule including summer months.

x. Pre-kindergarten and Kindergarten: These areas have a microwave oven and a 21 cu. ft. refrigerator. Use the following heat loads
1) Microwave Oven: 750 W (2600 BTUH)
2) 21 cu. ft. Refrigerator: 410 W (1400 BTUH)

y. Electrical Equipment Rooms: The following data may be used in estimating heat loads in electrical equipment rooms with dry-type transformers, 600 Volts and under:

•	@ 80° C rise	@ 150° C rise
15 KVA	2250 BTUH	3000 BTUH
30 KVA	3500 BTUH	5000 BTUH
45 KVA	4250 BTUH	7500 BTUH
75 KVA	6000 BTUH	10000 BTUH
112 KVA	9000 BTUH	12000 BTUH
150 KVA	11000 BTUH	17500 BTUH
225 KVA	14500 BTUH	21500 BTUH
300 KVA	21000 BTUH	25000 BTUH
500 KVA	25000 BTUH	38000 BTUH

1) Design the ventilation or cooling systems so the temperatures in the electrical equipment rooms will not exceed 80°F at any time, even when the central HVAC system is off.
   a) To make the ventilation option feasible, coordinate with architect to locate electrical equipment rooms at the exterior building walls.
   b) If ventilation is not feasible, use split DX cooling equipment.
   c) To design the cooling systems use the actual heat loads from the transformer equipment manufacturer.

3. Cooling Load Calculation Procedure

a. LEED for Schools projects must conform to computer modeling procedures found in the Energy and Atmosphere Prerequisites and Credits.
1) Provide computer calculations in accordance with ASHRAE's methodology.
2) Use ASHRAE Energy Design Guide for K12 School Buildings.

b. The LEED PA shall provide the SDPBC PM electronic copy of all inputs and outputs generated from the building energy system computer modeling no later than the completion of Design Development.

c. Use input data in item 2 below to design HVAC systems. The LEED PA shall provide the SDPBC with evidence the final design parameters are in keeping with LEED for Schools Energy and Atmosphere Prerequisites and Credits

d. The following procedure is for all areas with the design conditions of 75°F_{DB}/50%RH, except in Kitchen; substitute 80°F_{DB} for 75°F_{DB}.

e. Step 1: Verify the results from the load program. The space RH must be between 45 and 50%, and the cooling coil leaving air humidity ratio W must be less than 65 Grains H_2O/LB_{DA} (0.093

LBS H_2O/LB_{DA}). If the above conditions are not satisfied, determine why. Try alternatives listed in Section H.2.o, and rerun the load program.

1) When the results from the load program are acceptable, mark the following data for later use
   a) Zone sensible load ($ZONE_{SEN}$). No outdoor air load
   b) Fan sensible load (FAN_{SEN})
   c) Calculate total sensible load ($TOTAL_{SEN}$)
      (1) Blow-thru AHUs: $TOTAL_{SEN} = ZONE_{SEN}$
      (2) Draw-thru AHUs: $TOTAL_{SEN} = ZONE_{SEN} + FAN_{SEN}$
   d) Zone latent load ($ZONE_{LAT}$) No outdoor air load
   e) Calculate sensible heat ratio (SHR)
      (1) $SHR = TOTAL_{SEN} / (TOTAL_{SEN} + ZONE_{SEN})$
   f) Outdoor air CFM (CFM_{OA})
   g) Block CFM for the zone (CFM_{BLOCK})
2) Note: The coil LATs from the load program are not used for anything! The correct coil LATs are from the coil selection program, (see item e, Step 4, below).

f. Step 2: Submit psychometric analysis for the coil.

1) Plot design zone conditions (75°F_{DB}/50%RH) on the psychrometric chart (p-chart).
2) Calculate coil leaving air temperature (LAT). Draw a process line with the sensible heat ratio (SHR) slope from 75°F_{DB}/50%RH to the saturation line.
   a) Note 1: When SHR range is 1.0 to 0.78, the coil LAT_{DB} will range between 55°F to 50°F.
   b) Note 2: In 6-row and 8-row coils (used in humid climates), the difference between the LAT_{DB} and LAT_{WB} will be small (less than 0.2°F).
   c) Note 3: Input the LAT_{DB} (Dry Bulb) to the coil program.
3) Calculate supply air CFM (CFM_{SA}).
   a) $CFM_{SA} = TOTAL_{SEN} / [1.08 \times (75.0 - LAT_{DB})]$
   b) VAV AHUs: Go to item d.6).
   c) Constant Volume AHUs:
      (1) Calculate the approximate CFM_{SA} using the above equation, complete items H.3.g.2) thru-d.5), the correct CFM_{SA} is equal to the total CFM_{SA} from the air balance analysis, using this value continue to item 4) below.
   d) Note: Input CFM_{SA} to the coil program
4) Calculate fan temperature rise (DT_{FAN}) See item H.2.q.
   a) $DT_{FAN} = FAN_{SEN} / (1.08 \times CFM_{SA})$
5) Calculate supply air temperatures (SAT)
   a) Blow-thru AHUs: The SATs are equal to the cooling coil LATs See H.3.f.2)
   b) Draw-thru AHUs: Calculate the SAT_{DB}
      (1) $SAT_{DB} = LAT_{DB} + DT_{FAN}$
      (2) Plot same on the p-chart
6) Plot the 1% design outdoor air DB temperature and 1% design WB temperature (92°F_{DB}/80°F_{WB}) on the p-chart.
7) Calculate the mixed air DB temperature (MAT_{DB})
   a) $MAT_{DB} = 75.0 + [(92.0 - 75.0) \times CFM_{OA} / CFM_{SA}]$
   b) Plot same on the p-chart. Determine the MAT_{WB} from the p-chart
8) Coil Entering Air Temperatures (EAT):
   a) Blow-thru AHUs: Calculate the cooling coil EAT_{DB}
      (1) $EAT_{DB} = MAT_{DB} + DT_{FAN}$
      (2) Plot same on the p-chart determine the coil EAT_{WB} from the p-chart.
   b) Draw-thru AHUs: The coil EATs are equal to the MATs. Refer to item 7) a) above.
   c) Note: Input the coil EATs to the coil program.

9) If the SHR is less than 0.78, the coil LAT will be less than 50°F for a zone RH of 50%. This problem usually occurs for student dining, gymnasiums, and auditoriums. Try alternatives listed in item H.2.o or contact the District's Mechanical Engineer to discuss the coil selection.

g. Step 3: Submit room-by-room air balance analysis.
   1) Note: For a constant volume AHU, items 2) thru 4) below should have been completed as part of item H.3.c.3). Skip to item 5) below.
   2) Refer to the Room-by-Room Air Balance, Notes A thru M for the proper air balance procedure. Based on the number of ceiling diffusers in the room, round up the CFMs so that the airflows for all ceiling diffusers are in increments of 5 CFM or 10 CFM.
   3) Calculate the ratio of CFM_{SA} from item H.3.f.3) to the CFM_{BLOCK} from item H.3.e.1)g).
      a) $RATIO = CFM_{SA} / CFM_{BLOCK}$
   4) Multiply the RATIO from item H.3.g.3) by the individual room CFMs from the load program.
      a) This calculation corrects for any differences in the coil LAT_{DB} between the load program and the psychometric analysis.
   5) In a constant volume AHU, the total CFM_{SA} from the room-by-room air balance should equal the CFM_{SA} from item c.3).
   6) In a VAV AHU, the total CFM_{SA} from the room-by-room air balance will be larger than the CFM_{SA} from item c.3) due to zone diversity.
      a) Use the CFM_{SA} from item c.3) in the coil program.

h. Step 4: Use coil selection (computer) program to select the proper coil. Coil selection (computer) programs are available from various coil manufacturers.
   1) Input CFM_{SA} from item c.3)
   2) Input EAT_{DB} and EAT_{WB} from item c.8)
   3) Input LAT_{DB} from item c.2)
   4) Run the coil selection program. Select a coil with 8-rows or less, 144 FPF or less, 1.25" WG APD or less, 15' WG WPD or less, and 550 FPM face velocity or less.
   5) Use the input (CFM_{SA}, EAT_{DB}, EAT_{WB} & LAT_{DB}) and output (total MBH, LAT_{WB}, rows, FPF, APD, WPD, and face velocity) from the coil selection program in the AHU schedule.

4. Variable Air Volume AHU- Static Pressure Calculations
   a. Calculate the static pressure for variable air volume system show the results on the attached form.
5. Single Zone AHU- Static Pressure Calculations
   a. Calculate the static pressure for a single zone system show the results on the attached form.
6. Multi-Zone AHU- Static Pressure Calculations
   a. Calculate the static pressure for a multi-zone system show the results on the attached form.
7. Room-By-Room Air Balance Analysis
   a. Complete the analysis as outlined below and provide the necessary information on the attached form.
      1) Sign Convention: CFM into the room is positive (+); CFM out of the room is negative (-).
         a) Numbers in brackets following different CFM values [e.g. CFM_{SA} (1)] correspond to the column or item numbers in the Room-by-Room Air Balance forms.
      2) Step #1: Calculate CFM_{SA} (1) use the values from the load program times the ratio from d.3).
         a) Round CFMs so that the CFM_{SA} per ceiling diffuser is in increments of 5 CFM or 10 CFM, CFM_{SA} is always positive (+).
      3) Step #2: Calculate CFM_{EA} (3) to satisfy code -- usually 2 CFM/SF. Round CFMs so that CFM_{EA} per exhaust grille is in increments of 5 CFM or 10 CFM.
         a) Refer to Section A, items 14 and 15. CFM_{EA} is always negative (-).
         b) In Kitchens, use the net exhaust for the kitchen hood (exhaust - supply) in order for total CFM_{SA}, total CFM_{RA}, and CFM_{OA} in the air balance to agree with those values in the AHU schedule.

4) Step #3: Determine CFM_{TA} (4). Round CFMs so that CFM_{TA} per transfer grille or door undercut is in increments of 5 CFM or 10 CFM. CFM_{TA} is positive (+) when transferred into the room and is negative (-) when transferred out of the room.
5) Step #4: Set CFM_{EXFILT} (5) equal to 0.10 CFM/SF. Round CFMs so that CFM_{EXFILT} is in increments of 5 CFM or 10 CFM
   a) Exceptions to the above statement are:
      (1) Kitchens, CFM_{EXFILT} equals 0
      (2) Toilets and janitor closets, CFM_{EXFILT} equals 0
      (3) Locker/dressing rooms, CFM_{EXFILT} equals 0
      (4) Increase CFM_{EXFILT} up to 0.15 CFM/SF, if the larger values allow the elimination of the relief system.
6) Step #5:
   a) If ducted gravity relief system is used to relieve air from the room, calculate CFM_{RELIEF} (6) from the room.
      (1) Round CFMs so that CFM_{RELIEF} is in increments of 5 CFM or 10 CFM. CFM_{RELIEF} is always negative (-).
      (2) The SDPBC prefers ducted gravity relief systems because they are self-balancing with respect to unplanned leaks due to poor building construction.
   b) If fan powered relief systems are used to exhaust relief air from the main return air duct, calculate CFM_{RELIEF} (8) from the main return air duct.
      (1) CFM_{RELIEF} is always negative (-). CFM_{RELIEF} (8) is listed under CFM_{RA} (2) subtotal as a positive number (+) in order for the total CFM_{RA} (10) to be correct.
7) Step #6: Calculate CFM_{RA} (2) using the following equation:
   a) $(-)\,CFM_{RA} = (+)CFM_{SA}+(-)CFM_{EA}+(+/-)CFM_{TA}+(-)CFM_{EXFILT}+(-)CFM_{RELIEF}$.
8) Total CFM_{TA} (12) will be zero if all CFM_{TA} (4) airflows stay within the AHU zone; this is the normal operational mode.
   a) The AHUs for cafetoriums and gymnasiums are exceptions.
9) Area (16) is the air-conditioned floor area for the AHU zone and defined by the load program.
10) CFM_{SA} (17) and CFM_{OA} (19) are defined by the AHU schedule.
11) CFM_{RA} (18) = CFM_{SA} (17) - CFM_{OA} (19)
12) CFM_{OA} set by occupancy level, CFM_{OA} and CFM_{RELIEF} are calculated by the following equations:
   a) $CFM_{OA} = (CFM_{OA}$ /person) x (Number of People)
   b) $(-)\,CFM_{RELIEF}$ = (+) CFMOA +(-) CFMEA +(-) CFMEXFILT +(+/-) CFMTA
13) CFM_{OA} set by CFM_{EA}, CFM_{EXFILT}, and CFM_{TA}, CFM_{OA} and CFM_{RELIEF} are calculated by the following equations:
   a) $CFM_{OA} = -[(-)\,CFM_{EA} +(-)\,CFM_{EXFILT} +(+/-)CFM_{TA}]$
   b) $CFM_{RELIEF} = 0$

8. VAV Box Selection Procedure
   a. Complete the analysis as outlined below and provide the necessary information on the attached form.
      1) For ceiling diffusers and return grilles, select sound power levels from the values below based on the NC design levels. (Obtaining a classroom noise level of NC35 will be difficult, unless ceiling diffusers are selected at NC20 and return grilles are selected at NC25.)

a) Frequency (HZ)	125	250	500	1000
(1) Octave Band	2	3	4	5
(2) Sound power for NC20	40	33	26	22
(3) Sound power for NC25	44	37	31	27
(4) Sound power for NC30	48	41	35	31

(5) Sound power for NC35 52 45 40 36

2) Use this table to combine (logarithmic addition of) sound power levels.
   a) Difference between two sources
      (a) To be combined (DB) 0-1 2-3 4-9 10+
   b) Number of DB's to be added
      (a) To the highest noise level
      (b) To obtain the combined level +3 +2 +1 0
3) A deviation of +2 DB per octave band is acceptable.
   a) A deviation greater than +2 DB in any octave band requires the selection of a different VAV box or, if that is not possible, the use of a silencer.
4) The attenuation values defined below are for the SDPBC typical classroom layout for VAV systems. If the classroom layout is not typical, the engineer must provide noise calculations for that layout.
   a) The attenuation values for the box radiated sound power consist of the environmental adjustment factor, 0.5" thick/6 pcf ceiling tile, and space effect.
   b) The attenuation values for the box discharge sound power consist of the environmental adjustment factor, 5' duct, tee, 50% power division, 5' duct, 50% power division, 6' flex duct with elbow, and space effect.
   c) The attenuation values for the ceiling diffuser sound power consist of the environmental adjustment factor and space effect, and are for four (4) ceiling diffusers or less.
   d) The attenuation values for the return grille sound power consist of the environment adjustment factor and space effect, and are for two (2) return grilles or less.

I. INDEX OF ABBREVIATIONS AND ACRONYMS
   1. Attached at the end of this document

STATIC PRESSURE CALCULATION FOR VARIABLE AIR VOLUME AHU
THE SCHOOL DISTRICT OF PALM BEACH COUNTY

AHU NO: ______________ BUILDING NO: ________________ DATE: _________________

RETURN AIR STATIC PRESSURE LOSS

1. Grille (0.05"-0.10") ____
2. Volume Dampers (0.05"/VD) ____
3. Duct ____
4. Fittings ____
5. Other ____
6. Subtotal: ____

SUPPLY AIR STATIC PRESSURE LOSS

7. AHU Discharge System Effect (0.0"-0.25") ____
8. High Velocity, Duct: ____
9. High Velocity, Fittings: ____
10. VAV Box: ____
11. Low Velocity, Duct: ____
12. Low Velocity, Fittings: ____
13. Volume Dampers (0.05"/VD): ____
14. Ceiling Diffuser (0.05"-0.10") ____
15. Other: ____
16. Subtotal: ____

AIR HANDLER UNIT STATIC PRESSURE LOSS

17. Loaded Filter (0.60"): ____
18. Cooling Coil (0.50"-1.25"): ____
19. Heating Coil (0.10"-0.20"): ____
20. Heat Pipe or Reheat Coils (0.10"-0.30"): ____
21. Other: ____
22. Subtotal: ____

EXTERNAL STATIC PRESSURE (ESP) LOSS

23. Subtotal (Line 6 + 16) ____
24. Installation Safety Factor (10%-20%) ____
25. Design ESP (Line 23+24) ____

DESIGN TOTAL STATIC PRESSURE (TSP) LOSS (Line 22+25): _____________________

NOTE: For not applicable items insert N/A in static pressure column.

STATIC PRESSURE CALCULATION FOR SINGLE ZONE AHU
THE SCHOOL DISTRICT OF PALM BEACH COUNTY

AHU NO: ____________ BUILDING NO: ______________ DATE: ______________

RETURN AIR STATIC PRESSURE LOSS

1. Grille (0.05"-0.10") ____________________
2. Volume Dampers (0.05"/VD) ____________________
3. Duct ____________________
4. Fittings ____________________
5. Other ____________________
6. Subtotal: ____________________

SUPPLY AIR STATIC PRESSURE LOSS

7. AHU Discharge System Effect (0.0"-0.25") ____________________
8. Electric Duct Heater (0.05"-0.15"): ____________________
9. Duct: ____________________
10. Fittings: ____________________
11. Volume Dampers (0.05'/VD): ____________________
12. Ceiling Diffuser (0.05"-0.10") ____________________
13. Other: ____________________
14. Subtotal: ____________________

AIR HANDLER UNIT STATIC PRESSURE LOSS

15. Clean Filter (0.10"-0.20"): ____________________
16. Cooling Coil (0.50"-1.25"): ____________________
17. Heating Coil (0.10"-0.20"): ____________________
18. Heat Pipe or Reheat Coils (0.10"-0.30"): ____________________
19. Face & Bypass Dampers (0.03"-0.10") ____________________
20. Other: ____________________
21. Subtotal: ____________________

EXTERNAL STATIC PRESSURE (ESP) LOSS

22. Subtotal (Line 6 + 14) ____________________
23. Installation Safety Factor (10%-20%) ____________________
24. Design ESP (Line 22+23) ____________________

DESIGN TOTAL STATIC PRESSURE (TSP) LOSS (Line 21+24): ______________

NOTE: For not applicable items insert N/A in static pressure column.

STATIC PRESSURE CALCULATION FOR MULTI-ZONE AHU
THE SCHOOL DISTRICT OF PALM BEACH COUNTY

AHU NO: __________ BUILDING NO: __________ DATE: __________

RETURN AIR STATIC PRESSURE LOSS

1. Grille (0.05"-0.10") __________
2. Volume Dampers (0.05"/VD) __________
3. Duct __________
4. Fittings __________
5. Other __________
6. Subtotal: __________

SUPPLY AIR STATIC PRESSURE LOSS

7. Zone Damper (0.05") __________
8. Electric Duct Heater (0.05"-0.15"): __________
9. Duct: __________
10. Fittings: __________
11. Volume Dampers (0.05'/VD): __________
12. Ceiling Diffuser (0.05"-0.10") __________
13. Other: __________
14. Subtotal: __________

AIR HANDLER UNIT STATIC PRESSURE LOSS

15. Clean Filter (0.10"-0.20"): __________
16. Cooling Coil (0.50"-1.25"): __________
17. Heating Coil (0.10"-0.20"): __________
18. Heat Pipe or Reheat Coils (0.10"-0.30"): __________
19. Multi-Zone Dampers (0.03"-0.10") __________
20. Other: __________
21. Subtotal: __________

EXTERNAL STATIC PRESSURE (ESP) LOSS

22. Subtotal (Line 6 + 14) __________
23. Installation Safety Factor (10%-20%) __________
24. Design ESP (Line 22+23) __________

DESIGN TOTAL STATIC PRESSURE (TSP) LOSS (Line 21+24): __________

NOTE: For not applicable items insert N/A in static pressure column.

ROOM-BY-ROOM AIR BALANCE ANALYSIS
THE SCHOOL DISTRICT OF PALM BEACH COUNTY

AHU NO.:______ BUILDING NO.:________ PREPARED BY:______________________ DATE: ________

Room Number	Supply CFM(+) (1)	Return CFM(-) (2)	Exhaust CFM(-) (3)	Transfer CFM(+/-) (4)	Exfiltration CFM(-) (5)	Relief CFM(-) (6)
__________	(+)_________	(-)__________	(-)_________	( )_________	(-)__________	(-)___________
__________	(+)_________	(-)__________	(-)_________	( )_________	(-)__________	(-)___________
__________	(+)_________	(-)__________	(-)_________	( )_________	(-)__________	(-)___________
__________	(+)_________	(-)__________	(-)_________	( )_________	(-)__________	(-)___________
__________	(+)_________	(-)__________	(-)_________	( )_________	(-)__________	(-)___________
__________	(+)_________	(-)__________	(-)_________	( )_________	(-)__________	(-)___________
__________	(+)_________	(-)__________	(-)_________	( )_________	(-)__________	(-)___________
__________	(+)_________	(-)__________	(-)_________	( )_________	(-)__________	(-)___________
__________	(+)_________	(-)__________	(-)_________	( )_________	(-)__________	(-)___________
__________	(+)_________	(-)__________	(-)_________	( )_________	(-)__________	(-)___________
__________	(+)_________	(-)__________	(-)_________	( )_________	(-)__________	(-)___________
__________	(+)_________	(-)__________	(-)_________	( )_________	(-)__________	(-)___________
__________	(+)_________	(-)__________	(-)_________	( )_________	(-)__________	(-)___________
__________	(+)_________	(-)__________	(-)_________	( )_________	(-)__________	(-)___________
__________	(+)_________	(-)__________	(-)_________	( )_________	(-)__________	(-)___________
__________	(+)_________	(-)__________	(-)_________	( )_________	(-)__________	(-)___________
__________	(+)_________	(-)__________	(-)_________	( )_________	(-)__________	(-)___________
__________	(+)_________	(-)__________	(-)_________	( )_________	(-)__________	(-)___________
__________	(+)_________	(-)__________	(-)_________	( )_________	(-)__________	(-)___________
__________	(+)_________	(-)__________	(-)_________	( )_________	(-)__________	(-)___________
__________	(+)_________	(-)__________	(-)_________	( )_________	(-)__________	(-)___________
__________	(+)_________	(-)__________	(-)_________	( )_________	(-)__________	(-)___________
__________	(+)_________	(-)__________	(-)_________	( )_________	(-)__________	(-)___________
__________	(+)_________	(-)__________	(-)_________	( )_________	(-)__________	(-)___________
__________	(+)_________	(-)__________	(-)_________	( )_________	(-)__________	(-)___________
__________	(+)_________	(-)__________	(-)_________	( )_________	(-)__________	(-)___________
SUBTOTAL	(+)_________	(-)__________	(-)_________	( )_________	(-)__________	(-)___________
Relief Air From Return Air Duct		(+)_________ (7)				(-)___________ (8)
TOTAL	(+)_________ (9)	(-)__________ (10)	(-)_________ (11)	( )_________ (12)	(-)__________ (13)	(-)___________ (14)
Outdoor Air		(-)[(-)_______ (11)	+( )_________ (12)	+(-)________ (13)	+(-)________] (14)	=____________ (15)

ROOM-BY-ROOM AIR BALANCE ANALYSIS

AHU NO.:_____ BUILDING NO.:_______ PREPARED BY:____________________ DATE: ______

CHECK OF BUILDING PRESSURIZATION

AREA SF	EXFILTRATION CFM	EXFILTRATION/AREA =CFM / SF
__________ (16)	__________ (13)	__________ (13/16)

CFM_{EXFILT}/SF should be 0.10. However, the range of acceptable values for CFM_{EXFILT} /SF is 0.11 to 0.15, if the larger values allow the elimination of the relief system.

CHECK OF AIR BALANCE TOTALS WITH AHU SCHEDULE

	Supply CFM	Return CFM	Outdoor CFM
AHU Schedule	__________ (17)	__________ (18)	__________ (19)
Difference (Constant Volume)	__________ (17-9)	__________ (18-10)	__________ (19-15)

Difference is calculated for constant volume systems and should be 0.

Difference (Variable Air Volume)	__________ (17/9)	__________ (18/10)	__________ (19/15)

1. Diversity is calculated for variable air volume systems.
2. The range of acceptable values for CFM_{SA} diversity is 0.85 to 1.0.
3. The CFM_{OA} diversity is 1.
4. For step-by-step instructions refer to CRITERIA, Section F.

VAV BOX SELECTION PROCEDURE
THE SCHOOL DISTRICT OF PALM BEACH COUNTY

VAV Box Data

Manufacturer: ________

Model: ________

Inlet Diameter: ________ Inches

Design Airflow: ________ CFM

Differential Pressure: ________ " WG

Notes for VAV Box Selection Procedures are in - Mechanical, CRITERIA, Section G.

	125	250	500	1000
Frequency (HZ)	125	250	500	1000
Octave Bands	2	3	4	5
1. Box Radiated Sound Power	____	____	____	____
2. Less Insertion Loss for Ceiling and Room	-19	-19	-19	-22
3. Box Radiated Sound Power in Room (1+2)	____	____	____	____
4. Box Discharge Sound Power	____	____	____	____
5. Less Insertion Loss for Ductwork and Room	-19	-23	-35	-38
6. Less Insertion loss for Duct Silencer	____	____	____	____
7. Box Discharge Sound Power in Room (4+5+6)	____	____	____	____
8. Ceiling Diffuser Sound Power (NC__) (G.a.)	____	____	____	____
9. Plus Correction Factor From Catalog Data	+8	+8	+8	+8
10. Less Insertion Loss for Room	-7	-9	-10	-11
11. Ceiling Diffuser Sound Power in Room (8+9+10)	____	____	____	____
12. Return Grille Sound Power (NC __) (G.a.)	____	____	____	____
13. Plus Correction Factor From Catalog Data	+10	+10	+10	+10
14. Less Insertion Loss for Room	-7	-9	-10	-12
15. Return Grille Sound Power in Room (12+13+14)	____	____	____	____
16. Combine Box Sound Power (3+7) (G.b.)	____	____	____	____
17. Combine Outlet Sound Power (11+15) (G.b.)	____	____	____	____
18. Resultant Room Sound Pressure (16+17) (G.b.)	____	____	____	____
19. Design Room Sound Pressure (NC 35)	52	45	40	36
20. Difference in Room Sound Pressure (18-19) (G.c.)	____	____	____	____

INDEX OF HVAC SYSTEM ABBREVIATIONS and ACRONYMS
THE SCHOOL DISTRICT OF PALM BEACH COUNTY

AFF	Above Finished Floor
AHU	Air Handling Unit
APD	Air Pressure Differential
ASHRAE	American Society of Heating Refrigerating and Air Conditioning Engineers
BHP	Brake Horsepower
BTUH	British Thermal Units per Hour
CCR	Communication Closet Room
CCTV	Closed Circuit TV
CD	Ceiling Diffuser
CER	Communication Equipment Room
CFC	Chlorofluorocarbon (refrigerant)
CFM	Cubic Feet per Minute
CHW	Chilled Water
CMU	Concrete Masonry Unit (block)
CW	Condenser Water
DA	Dry Air
DB	Dry Bulb (temperature)
dB	Decibel (unit of logarithmic sound power or sound pressure ratio)
dBA	Decibels with A-weighting scale
DG	Door Grille
DMS	District Master Specifications
DP	Differential Pressure
DT	Differential Temperature
DX	Direct Expansion (coil)
EA	Exhaust Air
EAT	Entering Air Temperature
EDH	Electric Duct Heater
EFF	Efficiency
EG	Exhaust Grille
EMCS	Energy Management & Control System
ESP	External Static Pressure
EWT	Entering Water Temperature
F&BPD	Face & By-Pass Damper
FBC	Florida Building Code
FBC-M	Florida Building Code-Mechanical
FPF	Fins per Foot (in the coil)
FPM	Feet per Minute
GPM	Gallons per Minute
HCFC	Hydro chlorofluorocarbon (refrigerant)
HFC	Hydro fluorocarbon (refrigerant)
HP	Horsepower
HVAC	Heating Ventilation and Air Conditioning
IEQ	Indoor Enviromental Quality
IESNA	Illuminating Engineering Society of North America
ILS	*Instructional (or Integrated) Learning Systems*
KVA	Kilo-Volt-Ampere = 1000 Volt-Amps
KW	Kilowatt = 1000 Watts
LAT	Leaving Air Temperature
LAT	Latent (heat load)
LEED	Leadership in Energy and Environmental Design
LFS	LEED for Schools
LWT	Leaving Water Temperature
MAT	Mixed Air Temperature
MBH	Thousands of BTUs per Hour
MCA	Minimum Circuit Amps
MER	Mechanical Equipment Room
MFS	Maximum Fuse Size
MR	Materials and Resources
MZ	Multi Zone (type of air handling unit)
NC	Noise Criteria
OA	Outdoor Air
OAD	Outdoor Air Damper
OAF	Outdoor Air Fan
OAT	Outdoor Air Temperature

P-CHART	Psychrometric Chart
PCF	Pounds per Cubic Foot
RA	Return Air
RG	Return Grille
RH	Relative Humidity (%)
RPM	Revolutions per Minute
RTU	Roof Top Unit
SA	Supply Air
SAT	Supply Air Temperature
SCBA	Self Contained Breathing Apparatus
SDPBC	School District of Palm Beach County
SEN	Sensible (heat load)
SF	Square Feet
SHR	Sensible Heat Ratio
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SS	Sustainable Sites
SST	Saturation Suction Temperature
SZ	Single Zone (type of AHU)
T	Temperature
TA	Transfer Air
TAB	Test and Balancing
TDH	Total Dynamic Head (for pumps)
TES	Thermal Energy Storage
TG	Transfer Grille
TON	12,000 BTUH (unit of refrigeration)
TSP	Total Static Pressure
UC	Door Undercut (in HVAC drawings)
USGBC	United States Green Building Council
VAV	Variable Air Volume (type of HVAC equipment)
VD	Volumetric Damper
VFD	Variable Frequency Drive
W	Humidity Ratio (weight of water vapor per weight of dry air)
W	Watt (unit of power)
WB	Wet Bulb (temperature)
WE	Water Efficiency
WG	Water Gauge (inches of H_2O)
WPD	Water Pressure Differential
XFA	Exfiltration Air