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 FGCU Master Specifications 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 unless directed otherwise by the FGCU Personnel.

C. Goals:
   1. Design HVAC systems to create safe and comfortable environmental indoor conditions conducive to learning.
   2. 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.
   3. Design HVAC systems and building envelope to maintain 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.
   4. Design the HVAC systems and building envelope to meet applicable energy efficiency code requirements.
   5. Design of HVAC systems must be coordinated with the architect to be 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. Room-By-Room Air Balance Analysis.
   6. VAV Box Selection Procedure.
   7. 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.

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. FGCU 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. LEED (Leadership in Energy and Environmental Design): The design engineer, in collaboration with the LEEP Accredited Professional shall implement the requirements into the HVAC system design to assist in obtaining the minimum “Silver” LEED Certification for new construction on all FGCU projects.

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. Use data from section "H" HVAC Calculations in addition to the requirements of this section.
   3. Cooling Load Calculations:
      a. Follow the procedure listed in section "H" HVAC Calculations.
   4. 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. Coordinate with Architect.
   5. Floor Plans and Sections:
      a. The design shall include all necessary information to clearly indicate areas of potential coordination conflicts via enlarged partial plans and detailed sections.
   6. Roof Plans:
      a. FGCU encourages the location of the majority of all mechanical air handling equipment to be located within the building. Utilize gravity relief and/or gravity intake ventilators. All roof-mounted equipment shall be on minimum 14 inch high roof curbs provided with the specified equipment.
      b. All roof-mounted equipment shall meet the Miami-Dade protocol for wind resistance and wind-driven rain resistance. If necessary for specialized hazardous exhaust, all roof-mounted equipment shall be located to prevent re-entry into outside air intakes.
      c. All plumbing vents shall be located a minimum of 15 feet from outside air intakes.
      d. Roof-mounted equipment shall be located such that the minimum distances are provided from the building roof edge per OSHA requirements.
   7. Energy Rebates

a. FGCU prefers the equipment with highest efficiency, and also requires competitive bidding for the equipment; therefore, equipment specifications should avoid single-source supply.
   1) In case of conflicts, FGCU shall review available options, to determine the minimum specifications for acceptable equipment.
   2) Determine if the equipment from the major manufacturers can qualify for the FPL rebates.

8. Design for Test and Balance (TAB) Work
   a. Design HVAC systems to allow TAB work to be properly completed.
   b. Show all CFMs on floor plans.
   c. Show collars and manual VDs for insulated flexible duct run-outs (maximum six feet) to CDs and from RGs.
   d. Locate manual VD's 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. If a system cannot be balanced using a flow hood, show locations for duct traverse test ports.
      1) Dimension the minimum upstream length (of 2 duct equivalent diameters) and minimum downstream length (of 1 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. Electrical Rooms
   a. Review the heat load of electrical equipment rooms with transformers. Provide ventilation system or chilled water fan coil unit (located outside the room) to maintain room temperature below <u>90°F</u> , 24 hours a day 7 days per week.
   b. Mechanical Engineer to coordinate with the Electrical Engineer and Architect.
2. MDF (I/T) Room
   a. Provide ceiling concealed chilled water fan coil unit (located outside the room) to maintain room temperature of 76°F, 24 hours a day 7 days per week.
      1) There is one MDF room on the first floor in each building.
3. IDF (I/T) Room
   a. During normal business hours, provide cooling and outdoor air via the area's AHU.
4. 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. 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 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 other areas of this design guide.
e. Show all ductwork double-line.
f. The Engineer shall provide detailed plans and sections in minimum ¼" scale. There are no exceptions.
g. Show CHW and A/C Condensate piping.
h. 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
i. Provide a minimum of 24" of clearance on all sides of the AHU. Coil side of AHU shall be per manufacturer's recommended clearance requirements. Clearances may be shared in design where multiple AHU's are located in an MER.
    1) The Engineer, with approval may reduce the 24" clearance in tight rooms, in this order: (1) inlet end (RA), (2) back side, and (3) discharge end (SA).
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) Drain line shall have 1" air-gap above hub lip.
    2) Trap vent and trap primer are not required.
    3) 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 15' 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.

5. Toilet Rooms and Custodial Closets
    a. Each toilet room shall be provided with conditioned supply and exhaust air. Maintain the minimum exhaust ventilation rates per the FBC-M and maintain minimum 10% negative pressure with respect to adjacent spaces, corridors, etc.
    b. Provide exhaust from each custodial closet to meet FBC-M.
6. Elevator Machine Rooms
    a. Elevator machine rooms shall be provided with independently controlled ventilation systems per FBC-M.

C. HVAC DESIGN – EQUIPMENT/CONTROLS

1. Equipment Identification Marks
   a. Define HVAC equipment using building number, floor number and equipment number. For example the first AHU and its associated systems in Building 8, first floor are identified as follows:
      1) AHU: AHU 8-1.1
      2) Associated VAV Terminal Boxes: VAV 8-1.1.1, VAV 8-1.1.2, VAV 8-1.1.3, etc.
      3) Outdoor Air Fan: OAF 8-1.1
      4) Outdoor Air Damper: OAD 8-1.1
      5) Relief Air Damper: RAD 8-1.1
      6) Toilet, Custodial and General Exhaust Fans: EF 8-1.1, EF 8-1.2, EF 8-1.3, etc.
2. 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.
3. Installation Details:
   a. Provide details on drawings, not in the project manual.
   b. The engineer, not the contractor, shall provide proper detail design.
4. Control Schematics
   a. Provide Control Schematics and Control Sequences on drawings.
   b. Provide HVAC systems with individual classroom temperature control.
   c. The Vendor for EMCS equipment will be Johnson Controls, Inc.
   d. The design of the EMCS will be a joint effort between the Engineer, the EMCS Vendor, and the FGCU Physical Plant.
   e. The EMCS Vendor will assist in providing the campus standard control schematics and specifications.
   f. The Engineer must edit and/or revise the standard control schematics, control sequences, and specifications to address the specific design requirements for each project.
5. Temperature Sensors, Relative Humidity Sensors,Thermostats and CHW Control Valves
   a. 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.
      2) Sensors shall utilize the wireless sensor technology of Johnson Controls.
   b. 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.
   c. H-Sensor:
      1) Provide one RH-sensor per AHU.
         a) For VAV systems, locate RH-sensor in a typical exterior zone.
   d. Chilled Water Control Valves:

1) Provide two-way, pressure independent, characterized control valves (PICCV). The Basis of Design standard shall be BELIMO.

6. Noise Attenuation of Mechanical Equipment
   a. Design the classroom spaces for a maximum noise criterion level of NC30.
      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 should be added logarithmically.
   b. 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 not allowed.
      2) Single Zone: 20' RA duct, 20' SA duct
      3) VAV: 20' RA duct, 20' SA duct
      4) 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.
      5) Show locations of double-wall ducts on floor plans. Note referring to “X feet of double wall duct” is not acceptable.
      6) For quality control, double-wall ductwork must be factory made.
         a) Field fabricated double-wall ducts and fittings are not acceptable.
   c. 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 other sections of this design guideline.
   d. 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.
   e. 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.
   f. To attenuate noise from VAV boxes, select boxes in accordance with the VAV Box Selection Procedure for the SDPBC.
   g. 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.
   h. 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.

i. 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 Division 23 Sections.

D. MAIN MECHANICAL EQUIPMENT ROOM (1ST Floor)

1. General
   a. The Engineer shall provide detailed plans and sections in minimum ¼” scale. There are no exceptions.
   b. Show CHW and A/C Condensate piping.
   c. Show locations of starters, disconnects, EMCS panels, chiller control panels, variable frequency drives, etc.
   d. Show working/access clearances for equipment.
   e. Provide equipment housekeeping pads and/or supports. Coordinate with Structural Engineer.
   f. Show locations of pipe supports and provide pipe support details.
   g. Provide hose bibb(s) with tamperproof anti-siphon vacuum breaker(s), coordinate with plumbing.
   h. Provide duplex receptacle(s), coordinate with Electrical Engineer.
   i. Size CHW and A/C condensate pipe. Note the 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 where required.
   j. Do not route CHW pipe under the building slab except to penetrate the exterior wall.
   k. Do not route CHW pipe under sidewalks except to cross beneath them.
   l. Insulate interior CHW piping with cellular glass pie insulation; Refer to applicable Division 23 Section.
   m. Insulate CHW equipment (pump impellers, etc.). Refer to applicable Division 23 Section.
   n. 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".
2. Pumps (Tertiary Loop/Variable Flow) in the Building.
   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 in each building.
   c. Provide variable frequency drive for each pump.

d. Provide triple duty valves and suction diffusers. Bell & Gossett pumps are the FGCU standard.
e. For pump construction and material details refer to applicable Division 23 Section.
f. CHW pumps suction diffusers are acceptable but 'Y' or basket strainers are still required.
g. Pumps shall be base-mounted, end-suction type. Mount pumps on independent 6” thick, concrete equipment pads. Where vibration is a concern in relation to the adjacent spaces, set pump on inertia base frames in lieu of the concrete pads.
h. Provide a bypass in the chilled water main supply and return piping to permit by-pass around the tertiary pumps.

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) FGCU may approve larger AHU on the project-by-project basis, if justifiable.
b. Design the HVAC system so that AHU’s 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, electric duct heater data.
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. 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 APD’s equals the TSP.
f. Provide Single-Path or Split Path 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, foam injected 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 applicable Division 23 Section.
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) Pre-Filters 2" thick, MERV-8 pleated media, disposable.
6) Final-Filters, 4”thick, MERV-13 pleated media, disposable.
7) High efficiency motors.
8) Differential pressure gauge for air filter pressure drop.
9) Fan modules with internal vibration isolation.
10) For VAV AHUs (CHW), provide the following:

  a) Mixing/filter module with door. If MER space does not permit, flat filter (pre/final) section module is acceptable.
  b) Medium access module with door
  c) Coil module
  d) Medium access (vertical or horizontal) module with door
  e) Fan module with door

11) All AHU's that require 15% or more of outside air in relation to the total AHU supply air shall be designed with Split-Path AHU's.
12) Energy Recovery Units, provide the following:
  a) Provide enthalpy wheel type, Energy Recovery Ventilator where design permits and to implement energy savings and procure potential FPL Rebates. Provide Greenheck Model ERV/Arrangement A for indoor applications. Incorporate the supply and exhaust fans with the ERV and utilize single-point power connection.
13) Provide return air fans in the AHU system design where necessary.

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.
   d. For sizing high velocity supply air ducts (AHU discharge to VAV box inlet).
   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.6.f. and for noise attenuation refer to C.6.g.
   h. For noise attenuation in main low velocity return air ducts refer to C.6.h.
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;
   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 per NEC, Article 110-26. 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. Coils

a. Select cooling coils based on FGCU standards for EWT/LWT off the campus chilled water loop.
   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. All 100% outside air coils that are part of a split path AHU design and AHU chilled water coils that incorporate mixed OA and return air shall be provided with corrosion resistant seacoast coatings for extended coil life.

5. 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 VAV systems provide EDH in each VAV box unless the VAV serves electrical rooms/closets or IDF rooms.
      3) Provide working clearances for EDHs per 2002 NEC.
   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 temp rise of 32 deg F.
6. Fans
   a. Use ceiling and inline fans rather than roof-mounted fans.
      1) Install inline fans in horizontal ducts that are within 2' of the accessible ceiling.
      2) If ceiling space is not accessible provide ceiling access panel.
      3) 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.
   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.
7. Air Filters
   a. AHU filters shall be installed in a pre/final filter arrangement and an industry standard size, refer to appropriate Division 23 Section, Air Filters.
   b. Design for 2" thick pleated media pre-filter, MERV 8/30% dust spot efficiency filters and 4” thick pleated media/MERV 13

c. For VAV systems with VFD’s, select fan motor HP based on loaded filters (0.6" WG).
d. For constant volume systems, select fan motor HP based on clean filters.
e. To facilitate the maintenance of clean air filters provide differential pressure gauges connected to the filter modules with metal tubing.

F. DUCT WORK
1. Dampers
   a. Provide manual Volume Dampers (VDs) where required for test and balance (TAB) work.
   b. Provide gravity back draft dampers where required (exhaust fans, gravity relief air systems, etc.)
   c. Where required provide two position opposed blade(open/closed) motorized dampers (MDs) or modulating, opposed blade 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, FBC-M, NFPA 101, NFPA 90A and NFPA 92.A and B.
   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. 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 and NFPA 90A.
   b. Refer to appropriate Division 23 Sections and SMACNA.
   c. 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 FGCU projects.

    2) Without exceptions, the use of duct tape is ***NOT ALLOWED*** in FGCU projects.
  d. To address noise attenuation, (at the inlet and discharge of AHUs) provide double-wall ducts.
    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 applicable Division 23 section.
  e. Provide non-metallic flexible duct run from branch SA ducts to CDs and from RGs to RA ducts.
    1) At branch duct connection, use collar with manual VD.
    2) Use insulated flexible duct for supply air and non-insulated flexible duct for return air systems.
  f. DO NOT use bottom taps of branch ducts to CDs and from RGs.
  g. Provide smoke detectors and heat detectors at required locations.
  h. Provide electric duct heaters at required locations.
  i. Provide manual volume dampers and motorized dampers at required locations.

4. Ductwork Insulation
  a. Refer to applicable Division 23 section 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.
5. 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 FGCU Facilities Division for specific application on project-by-project basis.
6. Outdoor Air (OA) Systems
  a. Provide galvanized sheet metal ducts and plenums; refer to applicable Division 23 Section(s) and SMACNA.
  b. Typical outdoor air system shall include:
    1) OA intake louver, consult with Architect and refer to the appropriate Division 23 louver specification. Louver shall be recessed type, frameless type, in new construction and shall meet the Florida requirements for wind-driven rain resistant louvers. FGCU standard louver shall be Greenheck Model______. Finish shall be the FGCU standard to match the building.
    2) Opposed Blade motorized O/A two-position (open/closed) damper with duct access panel.
      a) Do not use the motorized O/A damper for balancing.

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 O/A 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 O/A damper).

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 listed above, when this type of module is included in the central AHU.

7. Exhaust Air Systems
   a. Refer to the appropriate Division 23 Section and SMACNA. Provide galvanized sheet metal ducts except for special exhaust systems:
      1) For fume hood exhaust, kitchen hood exhaust and dishwasher exhaust provide minimum 18 gage, stainless steel ductwork with welded, liquid-tight joints and seams.
      2) For shower area exhausts provide aluminum or stainless steel ductwork.
      3) For design requirements of exhaust systems in custodial rooms and in toilet rooms refer to items B.5.
      4) Provide plenum box on the back of each exterior wall louver. Material shall match the exhaust system ductwork. Reinforce plenum where dimensions are larger than 36 x 36 inches.
8. 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 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):

1) CAUTION: Plenum relief air system triggers multiple code restrictions in architectural, HVAC, plumbing and electrical design, and results in significant cost increase.

G. REGISTERS, GRILLES AND DIFFUSERS (RGD's)

1. Ceiling Diffusers (CDs)

a. Use louvered-face, fixed blade type diffusers with opposed blade damper or equalizing grid, aluminum construction (steel construction for fire-rated assembly), white, Krueger Model ______ or equal. The diffuser damper shall only be utilized for fine air balancing. Primary diffuser balancing shall be at the branch volume damper. Select diffuser with NC 20 or less.

b. Use collar with volume damper at SA branch duct for main balancing and insulated flexible duct as run out to CD. Flexible duct is not permitted above hard/inaccessible ceilings. Use insulated, rigid metal duct for all ductwork distribution above hard/inaccessible ceilings.

1) Refer to C.7.e for flexible duct length required for noise attenuation.

c. For T-bar ceilings, provide 24"x24" full face louvered diffuser and insulate back of CD, independent of ceiling grid. 24" x 24" extended panel diffusers are not acceptable in order to maintain the consistent appearance of the ceiling throughout the spaces.

d. For other ceilings, secure CD to 1" x 1" x 18-gauge angles (located above the ceiling).

e. Define CDs with CFMs on floor plans.

1) For throws other than 4-way, show throw directions.

f. In corridors, locate CDs min. 12' away from exterior doors to prevent condensation on CDs.

2. Return Grilles (RGs)

a. Use 45° fixed louvers, 3/4" spacing, aluminum construction (steel construction for fire-rated assembly), white color, Krueger Model _____ 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.7.e 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" full face grilles with full plenum box (interior painted flat black)

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 in the face with opposed blade damper. Fixed louver shall have 3/4" spacing, aluminum construction (steel construction for fire-rated assembly), white, Krueger Model ______ 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 that 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, 3/4" spacing, aluminum construction (steel construction for fire-rated assembly), white, Krueger Model _____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. Supply Registers (SRs)
   a. Use 45° adjustable louvers, 3/4"" spacing, opposed blade damper, aluminum construction (steel construction for fire-rated assembly), white, Krueger Model ___ or equal.
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.

H. HVAC CALCULATIONS
1. HVAC Cooling Load Calculations
   a. Provide computer calculations in accordance with ASHRAE's methodology.
   b. Provide computer printouts for both input data and output data.
   c. Use input data in item 2 below to design HVAC systems.
   d. The Engineer may submit a written request to deviate from standard FGCU input data when dictated by good engineering practice or economics.
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 and Labs: 75° F_{DB} / 50% RH
         d) Auditorium: 75° F_{DB} / 50% RH
         e) 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. People Loads:
   1) Classroom Buildings: SENSIBLE / LATENT LOADS
      a) Student Areas: 250 BTUH / 250 BTUH
      b) Administration: 250 BTUH / 250 BTUH

e. 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 of time.
      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.

f. 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.

g. Lighting Loads:
   1) Coordinate fixture selection with Electrical Engineer.
      a) Use light fixtures approved by FGCU.
      b) Appropriate values of Watts/room or Watts/square foot are acceptable.

h. Miscellaneous Sensible Loads: Project specific and use documented electrical loads.
i. Miscellaneous Latent Loads: Project specific.
j. 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.)
k. Safety Factors: 0.0.
l. Heating Pickup Factor: 0.0
m. 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, Auditorium.
   4) 800 to 2200 hours — Custodial
   5) 2200 to 600 hours — HVAC systems are OFF
   6) Weekends and Holidays — HVAC systems are OFF
   7) Cooling and heating is scheduled for Monday thru Friday per item 1) above.
   8) Schedules for people, lights, equipment, exhausts, and outdoor air are per items 2) thru 5) above.
n. For cooling load calculations assume year-round school schedule including summer months.
o. 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.
      a) To make the ventilation option feasible, coordinate with architect to locate electrical equipment rooms at the exterior building walls.
      b) To design the cooling systems use the actual heat loads from the transformer equipment manufacturer.

INDEX OF HVAC SYSTEM ABBREVIATIONS and ACRONYMS
FLORIDA GULF COAST UNIVERSITY

AFF	Above Finished Floor
AFMS	Air Flow Measuring Station
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
CHWR	Chilled Water Return
CHWS	Chilled Water Supply
CMU	Concrete Masonry Unit (block)
CWR	Condenser Water Return
CWS	Condenser Water Return
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
DP	Differential Pressure
DT	Differential Temperature
DX	Direct Expansion (coil)
EA	Exhaust Air
EAT	Entering Air Temperature
EDH	Electric Duct Heater
EF	Exhaust Fan
EFF	Efficiency
EG	Exhaust Grille
EMCS	Energy Management & Control System
ESP	External Static Pressure
EWT	Entering Water Temperature
FBC	Florida Building Code
FBC-M	Florida Building Code-Mechanical
FGCU	Florida Gulf Coast University
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
KEF	Kitchen Exhaust Fan
KVA	Kilo-Volt-Ampere = 1000 Volt-Amps
KW	Kilowatt = 1000 Watts
LAT	Leaving Air Temperature
LAT	Latent (heat load)
LWT	Leaving Water Temperature
MAT	Mixed Air Temperature
MBH	Thousands of BTUs per Hour
MCA	Minimum Circuit Amps
MD	Motorized Damper
MER	Mechanical Equipment Room
MFS	Maximum Fuse Size
MOCP	Maximum Over-Current Protection
NC	Noise Criteria
OA	Outdoor Air
OAD	Outdoor Air Damper
OAF	Outdoor Air Fan
OAT	Outdoor Air Temperature
OBD	Opposed Blade Damper

PCF	Pounds per Cubic Foot
PICCV	Pressure Independent Characterized Control Valve
RA	Return Air
RAF	Relief Air Fan
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
SEN	Sensible (heat load)
SAF	Supply Air Fan
SF	Square Feet
SHR	Sensible Heat Ratio
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
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)
TG	Transfer Grille
TON	12,000 BTUH (unit of refrigeration)
TSP	Total Static Pressure
UC	Door Undercut (in HVAC drawings)
VAV	Variable Air Volume (type of HVAC equipment)
VD	Volumetric Damper (Manual)
VFD	Variable Frequency Drive
W	Watt (unit of power)
WB	Wet Bulb (temperature)
WG	Water Gauge (inches of H_2O)
WPD	Water Pressure Differential

INDEX OF ACCEPTABLE HVAC EQUIPMENT MANUFACTURER'S
FLORIDA GULF COAST UNIVERSITY