

**Jefferson County School District, No. R-1  
Support Services Division**

**TECHNICAL GUIDELINES**

**DIVISION 23 - January 27, 2005  
Heating, Ventilating and Air-conditioning (HVAC)**

**Jefferson County School District, R-1 TECHNICAL GUIDELINES 2005**  
**Division 23 – Heating, Ventilating, and Air-conditioning (HVAC)**

**DIVISION 23 – HEATING, VENTILATING AND AIR-CONDITIONING (HVAC)**  
**23 00 01 General - January 14, 2005**

- Documents reviewed by Jefferson County School District, R-1 shall be prepared in the form of redlined plans and annotated specifications. These documents will be reviewed with the Design Team. At the conclusion of the review the team may borrow them for a period not to exceed five working days. If the documents are not returned within the allotted period, the design team will not be allowed to remove documents for future reviews from Facilities Planning and Design offices.
- Only the Construction Project Manager is authorized to accept delivery of equipment or spare parts specified to be delivered to the owner. The specifications shall define time of delivery as a milestone early in the project and relative to some identifiable event.
- Warranties – Reference “General Conditions” for warranty periods and conditions except for special conditions, e.g. 5 year warranty on refrigerant compressors or 10 year on water heaters.
- When the contractor submits a request for substitution of the equipment specified, he shall include in his submittal complete drawings to the same level of detail as the construction documents. With written permission of Jefferson County School District, R-1 he may hire the consultant to prepare the drawings.
- Roofing details relating to the installation of mechanical equipment shall be shown on Architectural or Roofing drawings not on Mechanical.
- Do not attach or route any mechanical components directly to the roof of in any manner that could interfere with future roof maintenance or replacement.
- Design Documents shall include a list of all parts and equipment deliverable to the owner (meters, gages, valve handles, etc. etc.).
- Design Documents for renovation of existing equipment or piping shall include a specific list of work items. Statements of a global nature to rehabilitate "as required or "as necessary" are not acceptable.
- Design Documents for modification or demolition of existing systems shall include drawings of equipment and materials to be removed. Statements of a global nature such as “Remove all pipe in this area” are not acceptable.
- Carefully and completely coordinate between Fire alarm, Electrical, Temperature Control and Mechanical disciplines for the installation of Combination Smoke and Fire Dampers. Fire and Smoke dampers shall be included in the Coordination Schedule.
- The Architectural and Engineering design shall accommodate the largest and heaviest equipment listed as "acceptable" in the specifications. This includes structural loading capabilities and mechanical spaces.
- Pay particular attention to the O&M Manual requirements and assure that all project drawings including temperature control diagrams and electrical one-line diagrams appear on the same size mylar film as that used for the other project drawings. The intent is to archive all frequently referenced drawings into a single same-sized durable project drawing set.

END SECTION 23 00 01

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**23 00 02 HVAC Criteria - January 27, 2005**

- The "Educational Specifications – Facilities Planning Standards" contain criteria for HVAC (Mechanical) systems and shall be considered a part of these Guidelines.
- Where there is a conflict between the IMC and the IBC, the latter shall prevail.
- Accessibility – Install all HVAC control devices in "Readily Accessible" locations as defined by Chapter 1, Article 100, of the most recent issue of the National Electrical Code.
- Include access doors or hatches in hard ceiling or walls where needed to reach mechanical devices such as valves, strainers, dampers, etc. or where in the judgment of the designer maintenance access will be necessary.
- When reusing or connecting to existing piping, clarify to what extent the contractor is to clean and test the existing system. Connections to existing pipe shall be made with new isolation valves.
- Applicable codes: UMC, IBC, AGA, UL, ASME, NEC ,ADA (Americans with Disabilities Act), IFGC.
- Evaluate discharge plenums vs. horizontal discharge ductwork on Roof Mounted Air Handling Units for the effect on cost, noise and unit efficiency.
- Equipment Room Recommendations - Comply with ASHRAE Standards 15-1992 with special emphasis on:
  - \* Oxygen Deprivation Sensor for A1 Refrigerants or a Refrigerant Sensor for B1 and all other refrigerants
  - \* Equipment Room Alarm
  - \* Mechanical Ventilation.
- Comply with ASHRAE 62-89 *Ventilation for Acceptable indoor air Quality* Paragraph 6.1.3.1 Multiple Spaces.
- Schools at elevations below 7,000 feet shall be air-conditioned. Schools above 7,000 feet elevation shall not be air-conditioned.
- Design for major remodels of existing buildings that do not have air-conditioning shall include the addition of air-conditioning.
- HVAC Design Conditions:
  1. Temperature:
    - a. Outside:
      - (1) Cooling – 87°F db, 62°F wb
      - (2) Heating - (-10°F) at elevations below 7,000 feet and - 20°F at elevations above 7,000 feet.
    - b. Inside:
      - (1) Occupied Spaces:
        - (a) Cooling - 75°F, +/- 2.0°F
        - (b) Heating - 72°F, +/- 1.5°F
      - (2) Unoccupied Spaces:
        - (a) No cooling.
        - (b) Heating - 65°F

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2. Occupancy and Ventilation (occupancy to be verified):
  - a. Classrooms: 30 occupants, ventilation 15 cfm per occupant.
  - b. Gymnasiums:
    - (1) Elementary Schools
      - (a) Occupied Cycle 30 occupants, ventilation - 20 cfm per occupant.
      - (b) Events Cycle 500 occupants, ventilation – 15 cfm per occupant.
    - (2) Middle Schools
      - (a) Occupied Cycle 60 occupants, ventilation - 20 cfm per occupant.
      - (b) Events Cycle 600 occupants, ventilation – 15 cfm per occupant.
    - (3) High Schools
      - (a) Occupied Cycle 90 occupants, ventilation - 20 cfm per occupant.
      - (b) Events Cycle 2,500 occupants, ventilation – 15 cfm per occupant.
  - c. Cafeterias:
    - (1) Elementary Schools – Cafeteria
      - (a) Class Cycle 30 occupants, ventilation - 15 cfm per occupant.
      - (b) Lunch Cycle 160 occupants, ventilation – 15 cfm each. HVAC w/ Eco
    - (2) Middle Schools – Auditoria
      - (a) Class Cycle 60 occupants, ventilation - 15 cfm per occupant.
      - (b) Lunch Cycle 300 occupants, ventilation – 15 cfm per occupant.
      - (c) Events Cycle 600 occupants, ventilation – 15 cfm per occupant.
    - (3) High Schools - Commons
      - (a) Class Cycle 100 occupants, ventilation - 15 cfm per occupant.
      - (b) Lunch Cycle 650 occupants, ventilation – 15 cfm per occupant.
  - d. Kitchens: Air changes for ventilation and equipment heat gain.
    - (1) Coordinate with Kitchen design.
  - e. Auditoriums – High Schools only
    - (1) Stage:
      - (a) Occupied Cycle 60 occupants, ventilation - 20 cfm per occupant.
    - (2) House Seating:
      - (a) Events Cycle 575 occupants, ventilation – 15 cfm per occupant.
  - f. Music Rooms – Minimum air circulation 1.5 cmf/sq.ft.
- Heating and Cooling Calculations – When sizing heat transfer media quantities, heat transfer equipment, pumps, boilers and chillers base calculations on the use of a 30% Propylene glycol solution heat transfer media.
- Roof mounted equipment and piping Refer to Division 7 of these guidelines for thermal and moisture barrier criteria.

END SECTION 23 00 02

**23 00 03 HVAC Systems - January 14, 2005**

- Suggested System Configurations: The systems described below are based upon experience and reflect a high probability of success. However, they do not cover all possible scenarios. The details in these descriptions and in Section 25 95 00 "Sequence of Operation" are intended to serve as a guide to mechanical systems design and control. It remains the responsibility of the Design Engineer to verify applicability of these designs and to refine them and/or offer alternative solutions to better meet the needs of each project. See also Section 23 77 00 "Air Handling Units (AHU)".
- Central Heating Plant – Gas fired hot water, boilers, two @ 65+/- % or three @35 to 45 % of design heating load, with Boiler Circulating Pump (BCP) on each boiler. Two "Heating Water Pumps" (HWP), one stand-by. Install three-way valves at end of heating water branches and on AHU coils. Minimum water flow through three-way valves in the building heating water system shall be 40% of design total. Boiler room / boiler piping arrangement to be reverse return with full pipe size bypass of boilers. BCP capacity to match boiler output at design  $\Delta T$ . Capacity of each HWP shall equal capacity of the sum of BCPs. Include cold start factor in load calculations. If diversity is considered in calculations, use with extreme care.
- Central Cooling Plant – Cooling water generating plant – For new buildings, buildings receiving a major replacement of mechanical equipment or others authorized for mechanical cooling, use: Electric water chiller with single primary chilled water pump. Chiller types: Elementary and Middle Schools - Air Cooled, High Schools – Air or Water Cooled as determined by an engineering evaluation. Install three-way valves at air-handling unit coils. Minimum water flow through the chilled water system shall be 40% of total design flow or chiller required minimum, which ever is greater
- Special Use Areas
  1. Administration Area – Constant volume unitary unit w/ DX cooling. In duct heating coils (IHC). Design for at least one interior and one exterior zone. Size IHCs for low entering air temperature (40 +/- °F). This option may not be required if the cooling plant has a capacity turn down ratio adequate to match the Admin Area demand and other loads coincidental with Admin hours of operation.
  2. Nurses Station (Clinic)
  3. Auditorium Minimum of two air-handling units one for Stage and one for House Seating. Units shall be inside or roof mounted air handling units, constant volume with, hot water heating, chilled water cooling, air side economizer and return fan. Circulating pumps on coils. All rotating equipment, coils and controls shall be mounted on the roof or in readily accessible spaces within the building. Do not mount equipment requiring maintenance at ceiling of Auditorium.

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4. Gymnasium Inside or Roof mounted air handling unit (AHU), constant volume with, supply fan, no return/exhaust fan, hot water heating, chilled water cooling and air side economizer. Associated with the unit will be a separate Relief Hood w/ motorized damper. Coil circulating pumps. Cooling shall be sized for “occupied” cycle cooling load. Heating shall be sized for “Events” cycle heating load. All rotating equipment, coils and controls shall be mounted on the roof or in readily accessible mechanical spaces within the building. Do not mount equipment requiring maintenance at ceiling of Gym. Large systems may incorporate:
  - a. multi-speed fan or
  - b. multiple units, one with/out cooling for events cycle.
5. Kitchen/Cafeteria Coordinate with kitchen design Consultant and conform to requirements of NFPA 96. Kitchen shall be negative with respect to adjacent areas. Commons/Kitchen High School, & Cafeteria/Kitchen Elementary School: - One air handling unit with complete HVAC. Roof mounted exhaust fan over kitchen for dishwasher. Food Coolers refrigeration units shall be split system with roof mounted condensing units. Auditoria (Auditorium/Cafeteria) Middle School: - Minimum of one roof mounted air handling unit with complete HVAC. Large systems may require more than one air handler. Roof mounted exhaust fan over kitchen for dishwasher, condensing units etc.
6. Kitchen Make-up-air Kitchen - Heating only gas fired unit for tempered make-up air to match required exhaust for Grease hood. HVAC and ventilation and make-up air for other exhaust to come from adjacent mechanical system. Grease and dishwasher exhaust shall be separate systems. Distribute supply air to avoid drafts.
7. Computer Classroom The room shall be served by two separate systems controlled by a single controller. Primary system will be an individual temperature control zone served from the area AHU with air quantity and induct coil sized as a normal classroom of thirty students. Secondary system will be a split system DX sized to meet special equipment (computers, servers, etc.) load. DX system shall include low ambient (-10 °F) package. Locate condenser on the roof and fan evaporator coil where the noise impact will not exceed District Acoustic Standards. Supply air to the space using slot diffusers. Alternate diffuser locations from the two systems.
8. Music Classroom
9. Communication Room Install a 1 1/2 ton DX unit with remote condenser. Electrical: 240 or 208 v, 1 ph. Condenser shall be located on the roof and include a low ambient (-10 °F) package. Smaller or larger units may be used if accurate installed equipment loads are available.
10. Vestibule/Entry
11. Corridors do not normally require a separate control zone. Provide ventilation air from adjacent zones.
12. Kilns:
  - a. Gas fired: Meet all requirements for fuel fired boiler
  - b. Electric: Include accommodation for unit mounted “Enviro-vent” and return air grills above kiln.

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- Classroom (individual)
  1. Standard each classroom and other occupied space not served by space specific unit(s) shall have its' own Induct Heating Coil (IHC) and zone control.
  2. Science & Preparation - Preparation room – Install a canopy hood with roof mounted exhaust fan and crank timer control. Exhaust about 700 cfm. Details to be discussed with District Engineer. Class room – Design to selectively return or exhaust 100% of the air supplied to the space. Install control dampers in room return and exhaust systems. A one-hour crank timer shall control a roof mounted exhaust fan. When fan is off the return dampers will be open and the exhaust dampers closed. Reverse the sequence when the fan is on. Discuss details with the District Engineer
- Classrooms (multiple) Inside or roof mounted air handling units (AHU), constant volume with, hot water heating, air side economizer, chilled water cooling and return fan. Circulating pumps on coils
- Temperature Control Zoning: Since reheat is not an option in system design, careful attention must be paid to the areas served and by an air handling unit. Dissimilar cooling loads in rooms served by a single unit will cause over/under cooling of spaces. For example: exterior vs. interior and west exterior vs. east or north
- Thermal Storage
- Piping
  1. Mechanical Equipment Room
  2. Two pipe Two-Pipe Heating/Cooling System: Consider the use of a two-pipe hydronic heating/cooling system. Discuss with the District Mechanical Engineer. See Division 25 for system description and sequence of control.
- Air Handling Units Air handling units should include Return Fans. If not, relief shall be accomplished through separate relief units and not through the air handling unit. Do not use units with RA and EA chamber upstream of the Return Fan. If there is no Return Fan do not use units with RA and EA chamber. Roof mounted Air Handling Units: Do not use Vertical discharge units
- Boilers
- Cabinet Unit Heaters
- Supplemental Heating – Hot water baseboard radiation, with self-contained control valves.
- Design Considerations:
  1. Do not install air handling equipment above ceilings or in spaces between structural members within the building. Mount on roof or install in mechanical rooms.
  2. Provide shut-off valves and unions to isolate each item of equipment, branch circuit or section of piping.
  3. Provide three-way valves in heating and cooling lines serving equipment as required to avoid dead end runs.
  4. Provide strainers at temperature control valves.
  5. Do not use solder containing lead.
  6. Install pipe accessories and valves in easily accessible locations for service.
  7. Do not locate pipe in exterior walls. If it is impossible to avoid provide heat or warm air circulation.
  8. Provide isolation and drain valves on pressure gauges.
  9. Pumps, fans, coils, unions, valves etc shall not be located in ceiling spaces above class rooms, gymnasiums or auditoriums.

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10. Test water pipe at 120 psig for two hours with no sign of leaks or pressure loss.
11. Test all operating devices. Keep written records of all tests, at minimum: the date of the test, system or subsystem tested; test medium and pressure used; duration of test; test results; name and signature of individual performing test.
12. Use cabinet or unit heaters in entries or areas where ventilation requirements are minimal. Avoid the use of unit heaters to heat ceiling spaces.
13. Locate any equipment or duct mounted devices, which may require maintenance or replacement in locations where maintenance activities will have minimal disruption to the function of the school.
14. Install entry cabinet unit heaters inside occupied spaces beyond vestibules not in the vestibule.
15. Pipe Material and Manufacturers Markings: When reviewing submittals and on site observations include a careful check for pipe origin, manufacture and markings.
16. Use built driven fans. Avoid direct driven if at all possible.
- Do not use the following Systems or Equipment without approval of Jefferson County School District, R-1 Engineer.
  1. Unit ventilators: Units are noisy. Proper controls costs the same as an air-handling unit.
  2. Radiant Panels
  3. Variable Air Systems
  4. Radiators or other heating units on walls of student restrooms
  5. Reheat - District mechanical cooling is locked out from early November through March. Thoughtful design of heating, economizer and cooling sequences; increased supply air quantities; proper sizing of coils, reset of discharge air temperatures etc. should negate the necessity of using "Reheat".
  6. Direct evaporative cooling or evaporative condensers
  7. Gas fired furnace heating except for restricted applications e.g. Kitchen make-up air.
  8. The reuse of existing under floor radiant panel heating systems
  9. Heat pumps except in small single application services approved by Jefferson County School District, R-1 Engineer
  10. Plastic, Fiberglass or composition "space-age material" drive-gears.
  11. Mechanical joints piping systems.

END SECTION 23 00 03

**23 00 04 HVAC Restoration and Retrofit - January 14, 2005**

- When reusing existing ductwork specify cleaning and pressure testing of the existing duct system. Pressure testing criteria may be limited to eliminating audible sound caused by leaks.
- When reusing or connecting to existing piping, clarify to what extent the contractor is to clean and test the existing system. Connections to existing pipe shall be made with new isolation valves between the new and existing and a full size valved bypass on the new piping side of the system. Include valved flushing tees where needed to clean the system.

END SECTION 23 00 04

**23 05 13 Common Motor Requirements for HVAC Equipment - January 27, 2005**

- Work in this section is restricted to specific manufacturers that have been previously approved by Jefferson County School District, R-1.
  1. Allen Bradley
  2. Cutler-Hammer
  3. S & S
  4. Square-D
- Motor starters shall be provided by the Manufacturer as an integral feature of motorized equipment.
  1. Standard magnetic contactor-type with HAND-OFF-AUTO switch, overload heaters, 120 volt control transformer, single phase protection, under voltage protection and spare N.O. and N.C. contacts for control by Divisions 23 and/or 25. NEMA enclosure appropriate for the service or 3R for wet areas.
  2. Use combination disconnect/motor starters whenever possible. Ensure redundant disconnects and starters are not specified or installed. Boilers are particularly susceptible to this error. Coordinate manufacturer provided equipment.
  3. Specify electronic (adjustable) overload protection.
  4. Specify phase protection down stream of over-current and over-load protection devices.
  5. Specify liquid tight conduit on motor connections.
  6. Specify bonding bushings on conduits serving HVAC equipment motors.
- With two-speed starters on mechanical equipment such as cooling tower fans that use two-speed motors include an adjustable time delay device within the starter enclosure to allow the motor to come to a complete stop when switching from high to low speed. No time delay is required when switching from low to high speed.
- Use magnetic starters for motors 3/4 HP and larger.
- Electric motor drives
  1. Motors 3/4 HP and larger: 480 Volt, Three-Phase, 60 Hertz, 1,800 and/or 1,200 rpm, ODP enclosure, 40 C ambient, continuous duty, service factor of 1.15, copper windings, Class B or F insulation, standard mounting.. Lower voltage motors are acceptable for buildings without 480 volt power but 3 phase is preferred.
  2. Bearings: Double shielded ball in accordance with ANSI B3.16-1972.
  3. Motor wiring: Terminate in a NEMA terminal box mounted on the motor case and of the manufacturer's standard size. The terminal box shall have a bolt type copper ground connector.
  4. Motors 1/2 HP or less may be split capacitor single phase with sleeve bearings, standard frame size and RPM, available from more than one manufacturer.
  5. Motor Efficiency shall conform to IEEE-112 and NEMA Chart 12-10.

END SECTION 23 05 13

**23 05 23 General-Duty Valves for HVAC Piping - September 7, 2004**

- Work in this section is open to any product or material meeting the requirements of this Technical Guideline.
- Comply with MSS-92-1980, *Valve Users Manual*
- Ball valves shall be full port.
- Submit names of proposed valve manufacturers.
- Natural gas service: iron body lubricated plug type with square nut actuator and matching nut wrench.
- UL list solenoid valves intended for fuel gas shut off.
- Butterfly: full flanged or lug - no wafer configuration.
- Drain valves shall be ball valves with GHT male end and chained cap.

END SECTION 23 05 13

**23 05 45 Noise and Vibration Control - September 7, 2004**

- Work in this section is open to any product or material meeting the requirements of this Technical Guideline.
- Mechanical noise in classrooms is of particular concern because of the adverse effect on student performance. Often, noise levels exceed criteria because of insufficient installation details. Therefore, in addition to proper equipment selection and coordination with other disciplines, system design must include adequate detail to eliminate contractor design in critical areas.
- Sound attenuators shall be used only in extreme conditions. Discuss with Jefferson County School District, R-1 Engineer before including them in the design.
- Hydronic isolators, flex connectors or expansion joints: Use only EPDM material. Do not use devices with exterior metal braiding.

END SECTION 23 05 45

**23 05 53 Identification for HVAC Piping and Equipment - September 7, 2004**

- Work in this section is open to any product or material meeting the requirements of this Technical Guideline.
- Provide markers, labels and schedules for HVAC pipes, equipment, control panes, switches, magnetic starters, relays etc.
- A list of the wording, symbols, letter size, and color coding used for pipe and equipment identification shall be included in maintenance manuals.
- Reference Standards: Comply with ANSI A13.1 - Identification of Piping Systems.
- Valve Tags are not required.

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- Equipment labels:
  1. Equipment symbols or name abbreviations used on design documents shall be in the form: AAANNN. AAA is a two or three letter abbreviation for the type of equipment. NNN represents any number in the sequence 1 to 999.
  2. When numbering equipment, begin in the northwest corner of the building and end in the southeast corner, like reading a map. The same number (NNN) may be reused if it has a unique prefix.
- Small Equipment Tags
  1. Stamp tags with the unique identification used on the drawings to indicate the system and type of equipment followed by a number. (Example: CWP-1, CWVenturi-2, HWRP-1, etc.).
- Marker Materials & Methods:
  1. Pipe Markers (above grade):
    - a. Pressure sensitive markers: Brady type B-350 flexible film identification markers and tape, with legend size and color coding per ANSI A13.1 - 1981.
    - b. Stenciled markings: Use clear cut stencils and black oil base spray paint. Provide 1 inch high letters on small pipe sizes and 2 inches high on larger pipe sizes. Flow arrows shall be at least 6 inches long.
    - c. Plastic wrap around labels taped in place.
  2. Pipe Markers (below grade): Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.
  3. Ductwork Markers: - Not required.
  4. Equipment Labels: White (black) plastic laminate with black (white) engraving, or standard brass bars. Provide labels to uniform size commensurate with the size of the equipment to which attached. Minimum - ½ inch high letters. Pressure-sensitive embossed labels are not acceptable.
- Installation:
  1. Install Equipment Labels with corrosive-resistant mechanical fasteners or adhesive. Degrease and clean surfaces to receive adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
  2. Install tags with corrosion resistant chain or cable
  3. Provide ceiling tacks to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment.
  4. Do not paint or insulate over nameplates.
- Piping
  1. Identify service and direction of flow of piping in crawlspaces, above ceilings, etc., as well as exposed to view. Provide identification markings at valves, equipment, terminal points, both sides of piping passing through walls and floors and at approximately every forty feet.
  2. Stenciled Markers: Apply after completion of finished coat of paint. Wipe pipe clean. Perform stenciled-on markings without over spray, drips or other flaws.
  3. Pressure Sensitive Markers: Apply in accordance with manufacturer's recommendations. Marker adhesion will be tested for permanence. Replace any markers showing loose corners, bubbles, or other failings.
  4. Use an arrow with each pipe identification marker. The arrow shall always point away from the marker and in the direction of the flow. Color and height of arrow to be same as the marker. If flow can be both directions, use a double-headed arrow.

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5. Apply markers near valves to show proper identification of pipe contents and direction of flow.
6. Apply markers so lettering is in the most legible position. For overhead piping, apply on the lower half of the pipe where view is unobstructed so it can be read from floor level.
7. Install preformed and lettered plastic markers completely around pipe in accordance with manufacturer's instructions.
8. Clearly distinguish between potable hot water and heating hot water. Do not use simply "HW".
9. Install underground plastic pipe markers 6 to 8 inches below finished grade directly above buried pipe.

END SECTION 23 05 53

**23 05 93 Testing, Adjusting, and Balancing for HVAC - January 27, 2005**

- Work in this section is restricted to specific sub-contractors that have been previously approved by Jefferson County School District, R-1 Facilities Services Department.
  1. Checkpoint Balance
  2. Complete Mechanical,
  3. Controlled Air
  4. Griffith
  5. JPG Engineering Finn
  6. Midwest, Denver
  7. Rocky Mtn.
  8. TAB Services, Inc.,
  9. Any of the above firms under new management or ownership shall no longer be "pre-qualified".FF
- Test and Balance services shall be bid to the Mechanical Contractor
- The Engineer shall include in his review comments on the balance report an identification of any values that deviate from the allowed tolerances and an explanation of why the values cannot be met. Is the balance report incorrect? Is the installation incorrect? Is there a design problem?
- Duct systems designed for 3 inches or greater static pressure shall be pressure tested per SMACNA standards. Duct systems designed for less than 3 inches static pressure do not require pressure testing, however, the system must be free of any undue noise caused by air leaks.
- Use procedural standards for TAB of environmental systems as outlined in the latest versions of AABC, NEBB, and/or SMACNA procedural manuals. Once a procedural standard is selected, that same standard shall be applied to all equipment of that class for TAB work on this project.
- TAB field work shall be performed under the direct supervision of a AABC or NEBB certified TAB supervisor or a Professional Engineer. This individual shall perform the work or be on-site at least 33% of the total time TAB work is in progress.

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- Contract payment retainage may be withheld against the General Contractor until the final completion of this section of work has been demonstrated by the submission of the TAB report and an evaluation of its contents has been made by the coordinating Engineer, Commissioning Authority or his representative.
- The contractor shall submit a list of balance devices (dampers & valves), that he perceives as necessary for proper balance of the systems, but are not indicated in the construction documents. The contractor shall submit the list to the Architect and Project Manager within twenty working days of contract award. If the Engineer agrees that any of the devices on the list are necessary, a change order will be issued to cover the cost of installation. If such devices are not identified but required for balancing, they shall be installed at the expense of the contractor.
- Coordinate scheduling of work with the General Contractor, appropriate subcontractors and the District Commissioning Engineer.
- Provide written notification to the Project Manager five (5) working days prior to commencing TAB and a schedule for completing the work.
- Provide written notification to the General Contractor Mechanical Contractor and District Commissioning Engineer, within 24 hours, of an equipment failure preventing TAB work from proceeding.
- Air and hydronic TAB work shall not begin until the applicable system is cleaned, flushed, is in full working order and has been accepted by the District Commissioning Engineer.
- Hydronic systems requiring glycol shall have the designated percentage installed prior to balancing.
- Requirements of Work:
  1. Adjust air handling systems to the following tolerances
    - a. Supply systems within +/- 10% of design value.
    - b. Economizer damper systems shall be verified in the minimum and maximum positions.
  2. Adjust hydronic systems to the following tolerances:
    - a. Heating water systems within +/-10% of design value.
    - b. Chilled water systems within +/- 5% of design value.
- Permanently mark the final balance position of all balancing valves and dampers.
- Unit ventilators shall be tested for supply air and outside air quantities at maximum and minimum outside air damper positions. Adjust dampers to meet scheduled values.
- Tab Report
  1. Provide a preliminary report to the Engineer and District Commissioning Engineer within 5 days of finishing preliminary balancing.
  2. Provide a draft TAB report to the Engineer. This shall be reviewed within 5 days and approved for use by Jefferson County School District, R-1 Commissioning Engineer. The Commissioning Engineer shall use the draft report for the purpose of verifying data within the draft TAB report. Upon completion, the draft TAB report and notes will be returned to the Engineer
  3. The draft TAB report shall be in the same format and contain information as will be included in the final TAB report.

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- Verification
  1. Upon completion of the TAB work the balancing firm shall demonstrate fluid flow quantities indicated in a preliminary TAB report
    - a. The TAB representative shall be a member of the same team used during the original testing.
    - b. Equipment used during the random testing shall be the same equipment used during the original testing.
    - c. The system or equipment being verified shall be in the same operating mode as during the original TAB test.
    - d. Up to 10% of the air readings shall be re-tested. Ninety percent (90%) of the re-tested readings must be within tolerances of the specifications.
    - e. Up to 10% of the balanced heating hydronic component readings shall be re-tested. Ninety percent (90%) of the re-tested readings must be within tolerances of the specifications.
    - f. Up to 20% of the balanced chilled water component readings shall be re-tested. Ninety percent (90%) of the re-tested readings must be within tolerances of the specifications.
    - g. Whenever system verifications do not meet specifications the entire system shall be re-balanced and rechecked
  2. When required by the Engineer, the TAB contractor shall perform unique tests to verify proper operation of special systems? An example of this would be testing of an ice bank thermal storage system.

END SECTION 23 05 93

**23 07 00 HVAC Insulation - September 7, 2004**

- Work in this section is open to specific manufacturers that have been previously approved by Jefferson County School District, R-1 Facilities Services Department.
  1. Certainteed
  2. Knauf
  3. Manville
  4. Owens-Corning
- Provide materials with flame spread index of 25 or less and smoke development index of 50 or less as tested in accordance with ASME E84 (NFPA 225)

**Jefferson County School District, R-1 TECHNICAL GUIDELINES 2005**  
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- Pipe Insulation:
  1. Insulation on pipe joints exposed in occupied spaces shall be jacketed with Zeston 2000 PVC or approved alternate, factory cut and curled to size
  2. Only packaged exterior mounted refrigerant line sets may use closed cell foam rubber, or other similar material approved by the Engineer. Seal joints and seams.
  3. All other cold line exterior piping shall be insulated with fiber glass insulation with integral vapor barrier stapled and finished with heavy coat of brushed on vapor barrier. Fit insulation with a sealed all-weather jacket of aluminum cladding.
  4. Cold line interior piping shall be insulated with fiber glass insulation with integral vapor barrier stapled and finished with heavy coat of brushed on vapor barrier.
  5. Horizontal portions of roof drains and roof drain bowls shall be insulated with fiber glass insulation with integral vapor barrier stapled and finished with heavy coat of brushed on vapor barrier
  6. Insulation on hot services shall conform to ASHRAE Standard 90.1-1989.
- Equipment and Tank Insulation:
  1. Either flexible fiberglass blanket meeting ASTM C-553 Type 1 or rigid fiberglass board meeting ASTM C-612 Class 2 with all-service jacket
  2. Insulation for hot services shall conform to current edition of ASHRAE Fundamentals Handbook.
  3. Do not insulate heating water pumps or heating system and cooling system expansion tanks.
  4. Insulate chilled water pumps.
  5. Insulate all heating and cooling water and refrigerant piping inside cabinets of Unit Ventilators, Air Handling Units, Unitary Air Conditioning Equipment and terminal heating and cooling units.
- Duct Insulation:
  1. Thermal insulation is not required on ventilation only or return air ductwork not exposed to outdoor temperatures.
  2. Ductwork exposed to the weather – See Section
- Install per manufacturers recommendation as minimum standard.
- Self sealing laps on pipe insulation cover to be stabled a 6 inches OC and then painted with vapor proof sealant.

END SECTION 23 07 00

**Jefferson County School District, R-1 TECHNICAL GUIDELINES 2005**  
**Division 23 – Heating, Ventilating, and Air-conditioning (HVAC)**

**23 21 13 Hydronic Piping - January 14, 2005**

- Work in this section is restricted to specific manufacturers that have been previously approved by Jefferson County School District, R-1.
- Included:
  1. Pipe – Heating water, Cooling (Chilled) water, Condenser water (cooling tower), Condensate, and Refrigerant
  2. Piping Specialties
    - a. Flow measuring devices – Venturi Type
  3. Refrigeration Specialties
  4. Water Treatment Equipment & Materials - Glycol makeup units, Filter Feeder, – Heating and Cooling water systems Chemical feed system - Condenser water
  5. System Cleaning
- Size pipe at 6'/100' max. pressure drop
- Steel Pipe
  1. Heating, Cooling and Condenser water pipe allowed for all sizes.
    - a. ASTM-A53, Grade B, Schedule 40
    - b. ASTM A106 Schedule 40 (for high temperature)
    - c. ASTM A120: Not permitted in any service
- Copper Pipe and Tubing
  1. Heating and Cooling piping allowed on sizes 2½ inches and smaller only: - ASTM B88 Type L hard drawn
  2. Drains and Condensate piping: - Type DWV per ASTM-B306 or Type L hard ASTM B88
  3. Refrigeration piping: - Type ACR per ASTM-B280
- Fittings
  1. Steel pipe: flanged or butt weld for larger sizes, ASTM B31.
  2. Copper water or drain: wrought copper or cast bronze. Lead free solder.
  3. Refrigerant:
    - a. Brazed joint or flared
    - b. Brazed joints: long radius wrought-copper or forged-brass sweat fittings. Do not use cast sweat-type fittings. Cadmium free filler metal.
    - c. Flare joints: standard SAE forged brass short-shank.
    - d. Make all connections between ferrous and non-ferrous material through dielectric nipples or flanges. Install isolation valve on ferrous side of dielectric.

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- Pressure Gauges: Work in this section is open to specific manufacturers that have been previously approved by Jefferson County School District, R-1 Facilities Services Department.
  1. Four and One-half inch minimum face diameter, ¼ inch NPT brass bottom mount, steel case, adjustable steel pointer, accuracy 1% of full scale or better.
  2. Stainless steel case, phosphorous bronze Bourdon tube and corrosion resistant movement.
  3. Maximum range: approximately double the expected working pressure of the service.
  4. Install with an isolation valve and a drain valve between the gauge and the isolation valve.
  5. White face with black lettering.
  6. Calibration adjustment by screwdriver.
  7. Acceptable manufacturers:
    - a. Ashcroft
    - b. Duro
    - c. Dwyer
    - d. Foxboro
    - e. Honeywell
    - f. Johnson
    - g. Marsh
    - h. Meriam
    - i. Mueller Brass
    - j. Terice
    - k. U.S. Gauge
  8. Manometers and gauges calibrated in pressures less than 50 inches of water shall be by Dwyer or Meriam.
- Thermometers Work in this section is open to specific manufacturers that have been previously approved by Jefferson County School District, R-1 Facilities Services Department.
  1. Battery powered electronic
  2. Bottom or back pipe thread connection.
  3. Use thermal wells with heat transfer enhancement compound in piping services.
  4. Range(s):
    - Heating Water: 50°F to 300°F with 2°F scale divisions
    - Cooling Water: 20°F to 100°F with 2°F scale divisions
  5. Accuracy: 1% of full scale or better.
  6. Acceptable manufacturers:
    - a. Cooper
    - b. Davis
    - c. Duro
    - d. Foxboro
    - e. Marsh
    - f. Taylor
    - g. Terice

**Jefferson County School District, R-1 TECHNICAL GUIDELINES 2005**  
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7. Test Kit - Deliver to the Project Manager a kit consisting of:
  - a. One pressure gauge 0-60 psi, 0.5% accuracy with adapter
  - b. One pressure gauge 0-100 psi, 0.5% Accuracy with adapter
  - c. Two bimetal thermometers minus 40°F to 160°F, 0.5% accuracy.
  - d. Two bimetal thermometers 0°F to 220°F, 0.5% accuracy
- Piping specialties Work in this section is open to specific manufacturers that have been previously approved by Jefferson County School District, R-1 Facilities Services Department.
  1. MPT pressure temperature taps, ¼ inch or ½ inch. Stainless steel for condensate services, brass or bronze for water and air services, extended stem for insulated pipes.
  2. Acceptable manufacturers:
    - a. Universal Lancaster
    - b. Sisco
    - c. Peterson Equipment Co.
  3. Backflow Prevention: See Division 22.
  4. Automatic Air Vents: High capacity float-type with brass or semi-steel body, copper float and removable top for cleaning. Install only on air purgers and with isolation valve.
  5. Expansion Tanks: Closed hydro-pneumatic diaphragm or bladder type, welded steel, rated for 125 psig, cleaned, prime coated, steel support saddles.
    - a. Acceptable expansion tank manufacturers:
      - (1) Amtrol
      - (2) Armstrong
      - (3) Bell & Gossett
      - (4) Taco
      - (5) Thrush
  6. Air Purger: Line size with automatic air vent and vent isolation valve. Do not connect to bottom tap. Air purgers are preferred over Air separators.
    - a. Acceptable manufacturer
      - (1) Amtrol
  7. Air Separators:
    - a. Tangential type; fabricated, tested and stamped in accordance with the ASME code; cast iron or steel tank, removable galvanized steel strainer, perforated stainless steel air collector tube, 125 psig working pressure.
    - b. Acceptable manufacturers:
      - (1) Amtrol
      - (2) Bell & Gossett
      - (3) Taco
  8. Relief Valves:
    - a. Bronze or iron body, bronze trim, bronze lifting gear, ASME rated direct spring loaded type, lever operated, non-adjustable factory set discharge pressure.
    - b. Acceptable Manufacturers:
      - (1) Bell & Gossett
      - (2) A.W. Cash
      - (3) Armstrong
      - (4) Farris
      - (5) Kunkle
      - (6) Watts

**Jefferson County School District, R-1 TECHNICAL GUIDELINES 2005**  
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9. Combination Check and Shut-off Valves:
  - a. Cast iron body, contoured disc, calibrated balancing adjustment, back seating valve stem. Install on discharge side of pump with stem up, suitable for 175 psig working pressure and 300° operating temperature.
  - b. Pressure Reducing Valve: all bronze, adjustable spring and diaphragm; integral strainer, female thread connections.
  - c. Acceptable manufacturers:
    - (1) A. W. Cash
    - (2) Armstrong
    - (3) Bell & Gossett
    - (4) Fisher
    - (5) Taco
10. Refrigeration specialties.
  - a. Filter-dryers:
    - (1) Conform to ARI Standard 710
    - (2) Full flow replaceable core in sizes 1/2" and larger
    - (3) Sealed type in sizes smaller than 1/2"
    - (4) Use desiccant cores that will not plug, cake, channel, or break down, but remove water, acid, and foreign material from the refrigerant.
    - (5) Construct so that no desiccant can pass into the refrigerant lines.
    - (6) Minimum bursting pressure, 1,500 psi
    - (7) Provide in liquid line to each evaporator
  - b. Strainers:
    - (1) Brass or cast iron body
    - (2) Not less than 60-mesh noncorrodible screen of a free area not less than ten times the pipe diameter
  - c. Sight Glass in the liquid line preceding each expansion valve
  - d. Discharge-line oil separator:
    - (1) Rated capacity equal to or greater than that of the compressor
    - (2) Provide with an oil-float valve assembly or needle valve and orifice assembly, drain-line shutoff valve, and sight glass.
    - (3) Connect oil-return line to the compressor
  - e. Charging valves: General purpose type with brass body, flared or solder ends, removable valve core and quick coupling connection at valve inlet.

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11. Flow Measuring Devices:

- a. Flow measuring devices 2 inches and smaller may be a combination measuring device and balancing/shut off valve assembly or a separate venturi with a remote balancing valve.
  - (1) Non-ferrous pressure die-cast construction with sweat or threaded ends, 300 psi WSP at 250°F
  - (2) Venturi/ball valve with integral flow measuring tops, adjustable memory set, and full size locking indicating handle.
  - (3) Orifice-type balancing devices are not acceptable.
  - (4) Minimum accuracy +/-3%,
  - (5) Acceptable manufacturers:
    - (a) Barco
    - (b) Gerand
    - (c) Presco
- b. Flow Design
- f. Flow measuring devices 2 ½" and larger shall consist of a venturi unit and separate balancing valve.
  - (1) Cast steel with weld ends or machined steel for butt welding, 150 psi WSP at 250°F
  - (2) Venturi unit shall include manual shut-off valves and quick-disconnect fittings at meter taps and shall be furnished with tags marked with Venturi size, station designations, GPM, and meter reading for GPM.
  - (3) Orifice-type balancing devices are not acceptable.
  - (4) Venturi bore sizes shall be selected so that meter read-out at specified flow rate is between 7 inches and 27 inches w.g.
  - (5) Minimum accuracy +/-3%,
  - (6) Meter in High Impact case to match venturi output values.
  - (7) Acceptable manufacturers:
    - Barco                      Gerand                      Preso
- Water Treatment Equipment Work in this section is open to specific manufacturers that have been previously approved by Jefferson County School District, R-1 Facilities Services Department.
  - 1. Glycol Feeder Unit shall be a packaged unit manufactured by a company with a minimum of 5 years of manufacturing experience. Field assembled or built up systems by the Contractor are not acceptable. Unit shall include but not be limited to:
    - a. Reservoir tank - 30 gallon minimum, polyethylene with removable cover and hose bibb drain mounted on steel stand with four legs with foot pads.
    - b. Positive displacement rotary gear pump 115/60/1, by Oberdorfer, Dresser, Pulsafeeder, Viking or approved alternate.
    - c. NEMA type 1, control enclosure.
    - d. Control panel shall be UL listed as a unit.
    - e. Momentary spring loaded push button switch for testing the operation of the pump.
    - f. Relief valve adjustable between 10 and 20 psi.
    - g. Dual point float switch to protect pump from low level and dry contacts to connect alarm to Division 25.
    - h. Pressure switch for pump(s) control shall be Furnas Model or 69WB3 (3-35psi). Locate pressure switch in loop main.

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- i. Provide 30 sec delay on pump start.
  - j. All rigid piping shall be type L copper.
  - k. Manual fill only with an air gap connection from the potable water supply down stream of the building Back Flow Preventer. Make NO hard connections to the water supply.
  - l. Acceptable Manufacturers:
    - (1) Aquachem
    - (2) Calcium Control
    - (3) Morr
    - (4) Neptune
    - (5) RM Aquatech
  - m. Deliver system to the owner with a full reservoir tank of 30% glycol solution.
2. Filter Feeder:
- a. By pass type Two gallon capacity steel tank, with 3 ½" feed opening and integral metal basket & 5 micron cloth media filter. No funnel.
  - b. Approved Manufacturer:
    - (1) Neptune Chemical Pump Company or Ca Control.
3. Chemical Feed System for Cooling Towers:
- a. Water treatment Subcontractor shall have been in business and providing water treatment services in the geographical area for a minimum of 5 years.
  - b. System shall be a Total-Dissolved-Solids Bleed and Pulse Feed Treatment System for automatic injection of Biocides and Inhibitors determined by the subcontractor. System shall include but not be limited to: Makeup water meter, Dual Biocide feed with timer control and two positive displacements pumps, Bleed solenoid valve, conductivity controller (bleed or blowdown control by Beta Hydac, Pulsa Feeder or acceptable alternate) and Automatic Blowdown valve.
  - c. Chemicals shall include but not be limited to: Inhibitor – 360 PPM organophosphate and Biocide – Level determined by subcontractor
  - d. Clean and flush towers and all piping.
  - e. System subcontractor/supplier shall provide complete service including chemicals for one full cooling season.
  - f. Subcontractor/supplier shall provide one hour of training to the owner.
  - g. Contractor to furnish for inclusion the O&M manual:
    - (1) Water test data on chemical concentrations and
    - (2) MSDS sheets and manufacturer and supplier of ll chemicals used.
  - h. Acceptable subcontractors:
    - (1) Dearborn,
    - (2) Garret-Calahan
    - (3) HOH
    - (4) Nalco
- Automatic Air Vents shall be installed with ball type isolation valves upstream and unions on vent discharge pipe.
  - Wye type strainers shall be installed upstream of all control valves.
  - Coil valves and drains – All heating and cooling coils shall have ball type isolation valves and drain valves with GHT, cap and chain.
  - Install pressure-temperature taps on each side of all pumps and heat transfer devices.
  - Install one hydronic balancing valve, as defined above, at all air handling unit coils, heat exchanger, each section of fin tube radiation.

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- Provide valves on lines before they enter and after they leave a relatively inaccessible areas such as basement, crawl space or trench.
- Dielectric Fittings – Install dielectric nipples or flanges at connections between dissimilar metals. Install an isolation valve upstream of dielectric.
- Provide filter feeders in the heating and cooling systems.
- Refrigerant pipe - Pitch suction lines 1 inch in 15 feet toward the compressor. Install oil traps, consisting of short radius fittings, at the bases of vertical suction lines. Contractor to furnish shop drawings of refrigerant pipe sizing, layout and accessories.
- Expansion tanks, air separators and other devices heavier than 200 pounds may not be suspended from overhead without written permission from the Structural Engineer.
- Flow (paddle) Switches are not recommended. They may be used if required by equipment manufacturer. The Engineer shall carefully and fully detail flow switch installation if used.
- Provide Rectorseal Products pipe dope as recommended by the manufacturer for glycol systems with threaded piping.
- Gauges and Thermometers: Calibrate all gauges and thermometers in the presence of the District Engineer prior to installation.
- Test refrigerant pipe in accordance with ARI standards. Pressure test only, Vacuum Testing is not acceptable
- Cooling Tower (Condenser) Water System:
  1. Install flanged connection at outlet basin.
  2. Install solenoid valves in the drain and make-up water lines See Division 25.
  3. Design piping so any pipe subject to freezing will drain when drain line solenoid valve opens.
  4. Do not install strainer in the suction pipe between the tower and condenser water pump.
- Pre-operational flush and cleaning:
  1. Notify the Jefferson County School District, R-1 Project Manager five (5) work days in advance of starting the cleaning. Cleaning and flushing of all systems shall take place in the presence of the Jefferson County School District, R-1 Project Manager or his designated representative. “Certification of Work Certificate” documents the cleaning procedure and personnel involved. The designated representative observing the cleaning shall sign the certification. School personnel or custodial staff are not authorized to certify the procedure.
  2. Closed piping systems, heating water and chilled water, shall be cleaned using a cold alkaline cleaning solution at normal system pumping pressures. At the Contractors option he may use chemicals furnished by the Owner (at no additional cost to the contractor) or he may use commercially available chemicals furnished by the contractor (at no additional cost to the School District).

a. Owner Furnished Cleaning Solution:

<u>Chemicals</u>	<u>Oz per 100 gal. of system volume</u>
Trisodium phosphate (alkaline)	16 oz
Sodium Hydroxide (alkaline)	1 oz
Dawn dishwashing soap (surfactant)	1 oz
Sodium Sulfite (oxygen scavenger)	1 oz

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3. The cleaning solution must begin with a minimum pH of 12.0.
4. Procedure to Clean an Entire Hydronic System:
  - a. Isolate the expansion tank from all cleaning solutions.
  - b. Fill system with the alkaline cleaning solution. Make sure that the cleaning solution circulates through all piping and heat transfer components in the hydronic system.
  - c. Circulate the alkaline cleaning solution in any heating water or chilled water system for 48 hours. Repair any leaks while circulating.
  - d. Drain the alkaline cleaning solution and fill the system with domestic cold water. Circulate and flush as necessary until the circulated rinse water reaches a pH of 8.5 maximum at all end points of the hydronic system.
  - e. When the rinse water has reached 8.5 pH, remove and clean all piping strainers throughout the system. Do not drain the rinse water from the piping system until the propylene glycol is ready to be installed. The Jefferson County School District, R-1 Project Manager or representative must verify and approve the cleanliness of the system. A minimum of three samples will be taken of each hydronic system. The Contractor and the Owner will each retain one sample and one sample will be sent for chemical analysis.
  - f. Drain and partially fill the hydronic system with clean domestic cold water. Install the uninhibited propylene glycol to a concentration of 30%. The Owner will sample and install the water treatment chemicals after the glycol is charged into the system -- pH buffer, oxygen scavenger, and corrosion inhibiting surfactant.
  - g. Before using the glycol feeder, thoroughly clean the tank of dirt, oil, grease, and solids. Fill the tank completely full with domestic cold water and one gallon of chlorine bleach. Allow to stand overnight. Rinse the tank free of chlorine.
  - h. Fill the glycol feeder with a solution of water and propylene glycol, 30% minimum or +9°F or lower freeze point. Maintain a full glycol tank (30% minimum) until the system has been thoroughly vented of air and all of the leaks have been repaired. Leave a full tank of 30% PG upon project completion.
  - i. Submit the “Certification of Work” and the quantity of propylene glycol that was charged into the piping system. Transmit the information to the District Project Manager.
  - j. Include a copy of the “Certification of Work,” the propylene glycol quantity, the MSDS sheets, and the name of the chemical supplier in the O&M Manuals.
  - k. Glycol feed system(s) – leave tanks filled with a 30% solution Uninhibited Polypropylene Glycol.
  - l. Provide 1 hour of training on Condenser water chemical system.
  - m. Deliver venturi flow meter to Jefferson County School District, R-1 Project Manager prior to installation of venturis.

END SECTION 23 21 13

### 23 21 23 Hydronic Pumps - January 27, 2005

- Work in this section is restricted to specific manufacturers that have been previously approved by Jefferson County School District, R-1 Facilities Services Department.
- Specify and include in the Equipment Schedule two operating points for any pump that is designed to operate singly and in parallel with another pump.
- Pump seals – Jefferson County School District, R-1 continues to experience leaking pump seals because the specified seals are not installed. Consultants are responsible for checking submittals.
- Applicable codes, standards and regulations:
  1. HI - Hydraulic Institute - *Standard for Centrifugal Pumps*
  2. ASTM - American Society for Testing and Materials
  3. NEC - National Electrical Code
  4. NEMA - National Electrical Manufacturer's Association
- Service
  1. Vibration shall be such that the value of self-excited vibration velocity is less than 0.10 inch/second when measured with a vibration meter on the frame or bearings of the pump assembly in any of the three axes. The pump and motor assemblies shall be both statically and dynamically balanced so as not to exceed the vibration limits specified.
  2. 70% minimum efficiency at the design point for pumps larger than 3 HP
  3. The nameplate horsepower rating without consideration of the service factor, shall not be exceeded at any point along the performance curve of any pump at its rated rpm.
- Construction Details for Pumps larger than ½ HP.
  1. Use horizontal centrifugal end suction or split case, cast iron bronze fitted. Close coupled units are not recommended.
  2. Constantly rising characteristic curve from design point to minimum flow.
  3. Bronze impeller.
  4. Re-greasable ball bearings
  5. Mechanical seals with carbon seal rings and ceramic seats.
  6. Non-ferrous metal nameplate with manufacturer's name, model number, GPM, head, impeller diameter and RPM.
- Acceptable manufacturers for water pumps larger than 1/2 HP:
  1. Armstrong
  2. Peerless
  3. Taco
  4. Bell & Gossett
  5. Worthington
- Bronze fitted in-line centrifugal or cartridge pumps of 1/2 HP or less may be used as circulators or boosters in heating closed loop water systems. In-line pumps larger than 1/2 HP are not recommended. If space limitations do not permit base mounted pumps, Discuss with the District Engineer.

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- Acceptable manufacturers for water pumps 1/2 HP and less:
  1. Amtrol
  2. Armstrong
  3. Bell & Gossett
  4. Grundfos
  5. Oberdorfer
  6. Taco
- Documentation – Submittal and Maintenance manuals shall include:
  1. Two copies of submittal for each pump service offered
  2. Certified dimensional drawings including locations, sizes and types of each piping connection, baseplate mounting details and electrical connections.
  3. Installation, maintenance, disassembly, operating and parts-list manuals.
  4. Recommended spare parts list.
  5. Characteristic design curve.
  6. Standard manufacturer's catalog data.
  7. Factory test certification of vibration testing.
- Installation
  1. Place unions or flanges between all pumps and the isolation valves on the suction and discharge lines so that the pump may be removed for service without cutting the piping.
  2. Include pressure gauges and P/T taps in the suction and discharge lines in locations that will provide a reasonably accurate check of pump performance, and on both sides of the strainer or suction diffuser.

END SECTION 23 21 23

**23 31 00 HVAC Ducts and Casings - September 9, 2004**

- Work in this section is open to any product or material meeting the requirements of this Technical Guideline.
- Consultant shall specify pressure and show on drawings using SMACNA standards.
- When the design includes the use of existing ductwork, that duct shall be cleaned and tested for leaks. Include an allowance for sealing excessive leaks and include as a line item in the bid.
- Do not use fiberglass ductwork.
- Use flexible ductwork only at low-pressure terminal points between branch ducts and diffusers and limit the length in all cases to eight feet.
- Duct Liner – Where indicated line duct work with 1 inch thick, 1.5lb/Ft<sup>3</sup>, anti-microbial impregnated fiberglass. Install in compliance with current edition of SMACNA and manufacturers recommendations.
- Comply with current edition of SMACNA "Round Industrial Duct Construction" manual for ducts carrying particulate or corrosive fumes.
- Make from galvanized steel conforming to ASTM A525 and A527 or Aluminum sheet conforming to ASTM B209.

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- Exterior ductwork: Use SMACNA T-24 flanged transverse joint reinforcement or manufactured equivalent by Ductmate. Minimum 22 gallon sheet metal Install 2 inches thick liner to a minimum R value of 8.
- Kitchen Ductwork –. Grease hood exhaust duct may be black iron construction. Dishwasher exhaust shall be stainless steel. Be sure the Architect includes a fire rated enclosure.
- Do not use dovetail connections.
- Make duct size changes and offsets with 15° transitions.
- Unequal ells shall be radius type without turning vanes. Use transitions and duct splits with equal ells.
- Use 45 standard branch at square and rectangular duct branch connections. Do not use "extractors" Extractors may be used at duct mounted side-wall diffusers.
- Do not use splitter dampers.
- Include volume control devices required for air balancing on the contract drawings.
- Pressure Testing of duct systems designed for less than 3 inch static pressure is not required. However, the system must be free of undue noise caused by air leaks.
- Install and seal ductwork in accordance with Current edition of SMACNA *HVAC Duct Construction Standards*.
- Allow no sharp metal edges to extend into the air stream of ducts. Air inlet collars on mixing units shall conform to and be flush with the flexible tubing or other inlet connections.
- Install fire dampers and combination smoke & fire dampers with code-approved sleeves in accordance with the UL requirements. Use frame CR for all round ducts. Use frame B for rectangular and square ducts.
- Open access doors against air pressure.

END SECTION 23 31 00

**23 33 00 Air Duct Accessories - January 27, 2005**

- Work in this section is restricted to specific manufacturers that have been previously approved by Jefferson County School District Facilities Services Department.
- Square and Rectangular Dampers:
  1. Design to withstand a wind pressure of 45 pounds per square foot (134 mph) with a maximum blade deflection measured at mid-span of 1/180 of blade span. No permanent set acceptable.
  2. Damper Blades shall be galvanized steel and side (jamb or blade end) seals shall be stainless steel. Prior to including any of the manufacturers listed below verify that they offer galvanized/stainless steel dampers.
  3. Max pressure drop through a wide open damper with a free area ratio (total open area between blades divided by the nominal area) of 0.75 and at an approach velocity of 800 fpm (standard air): 0.015 inches WC
  4. Frames: Heavy gauge galvanized sheet steel hat channel.

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5. Blades:
  - a. Brake-formed at the edges to provide stiffeners
  - b. Galvanized steel shaft not less than ½ inch diameter
  - c. Nylon, teflon or oil impregnated sintered bronze bushings
6. Operating motor outside the air stream
7. Jack shafts and rods solid round galvanized steel
8. Acceptable damper manufacturers:
  - a. American Warming and Ventilating, Inc
  - b. Honeywell, Inc
  - c. Johnson Service Co
  - d. Louvers & Dampers, Inc.,
  - e. Pacific Air Products Co
  - f. Penn Ventilator Co.
  - g. Ruskin Manufacturing Co
- Round and Oval Dampers:
  1. May be made by the ductwork fabricator.
  2. Damper collars and blades: Fabricated of galvanized steel sheet in the following minimum thickness gauges:
 

<u>Diameter</u>	<u>Collar</u>	<u>Blade</u>
3 inches thru 14 inches	11	14
15 inches thru 26 inches	10	12
27 inches thru 36 inches	9	10
  3. Shaft: Solid steel rod, at least ¼ inch diameter galvanized, welded to the blade.
  4. Dampers shall have blade stops and be fitted with locking-type hand quadrant controls.
  5. Sleeve shaft bearings: Sintered bronze, teflon, nylon.
- Fire Dampers
  1. Conform to NFPA Standard 90A, construct and test in accordance with UL Safety Standard 555 for a 1 ½ hour rating and carry a UL label.
  2. Damper frame and blades: Galvanized steel.
  3. Dampers: Curtain-type with the blades held out of the air stream by a fusible link rated at the temperature recommended by the design engineer.
  4. Equip for vertical or horizontal installation as required by the location shown on the applicable drawing. Spring loaded in horizontal installations.
  5. Secure fusible links with "S" hooks.
  6. Access doors on the upstream or downstream side of the duct at each damper, of sufficient size to enable a worker to reset the damper.
  7. Damper frames: At least 16 gauge for ducts not over 24 inches high and 36 inches wide. 14 gauge for larger sizes.
  8. Acceptable fire damper manufacturers:
    - a. American Warming and Ventilating, Inc
    - b. Controlled Air Manufacturing Ltd.,
    - c. Honeywell, Inc.,
    - d. Johnson Service Co
    - e. Louvers & Dampers Inc
    - f. Ruskin Manufacturing Co.

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- Combination Smoke and Fire Dampers:
  1. Conform to NFPA Standard 90A, construct and test in accordance with UL Safety Standard 555 for a 1-1/2 hour rating and carry a UL label.
  2. Damper frame and blades: Galvanized steel.
  3. Factory sleeve in conformance with jurisdictional authority. Mount operator on exterior of sleeve and link to operating shaft.
  4. Operators shall be UL listed and labeled with 120 VAC electric motor operated with end switches for indication of closed damper position.
  5. Design Engineer shall carefully coordinate this item between FA, TC, Elec. and Mech.
  6. Include on the construction documents a strong statement that the installation of dampers shall be in strict accordance with manufacturer recommendation. No portion of a damper motor may be imbedded in structure
  7. Acceptable fire damper manufacturers:
    - a. Air Balance
    - b. National Controlled Air
    - c. Prefco
    - d. Ruskin Manufacturing Co
    - e. Safe-Air
- Access Doors:
  1. At automatic and manual dampers, fire dampers, coils, in-duct thermostats, and other devices requiring service and/or inspection.
  2. Hand entry access door openings: 24 inches x 24 inches minimum if the duct permits. Personnel entry doors: 18 inches x 42 inches minimum.
  3. Provide doors with a 22-gauge stiffening frame and construct so that they can be operated without distorting.
  4. Continuous reinforcing bar or angle against which the door will close.
  5. 1/8 inch neoprene gasket
  6. Galvanized hinges with bronze pins
  7. Brass sash-lock fasteners on hand entry doors and handles operable from either side on personnel entry doors.
  8. Insulate doors in insulated ducts.
  9. 14-gauge material of the same type as the duct construction.
- To minimize noise, locate manual air-flow control dampers for diffusers and registers as far from the device as possible but still in the room or adjacent corridor.

END SECTION 23 33 00

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**23 35 00 Special Exhaust Systems - September 9, 2004**

- Work in this section is open to any product or material meeting the requirements of this Technical Guideline.
- Table Canopy Hood: - “Lab Safety Supply” – Ph. 1.800.356.0783 – is an acceptable manufacturer.
- Lab (Fume) Hood: - Hoods shall be restricted bypass design. Exhaust fans shall be upblast with chemical resistant coating. “Safeaire” is an acceptable manufacturer.

END SECTION 23 35 00

**23 37 00 Air Outlets and Inlets - January 27, 2005**

- Work in this section is restricted to specific manufacturers that have been previously approved by Jefferson County School District, R-1 Facilities Services Department.
  - a. Anemostat
  - b. Barber-Coleman
  - c. Carnes
  - d. Kreuger
  - e. Titus
  - f. United McGill
- Grilles, Diffusers, Registers
  1. Painted steel or aluminum of a color approved by the Architect
  2. Grilles intended for use in gyms, locker rooms, bathrooms or in accessible openings large enough for a child to crawl through shall be steel security type, securely fastened to the wall or floor with tamperproof fasteners.
  3. Locate air volume adjustments above suspended ceilings or in locations that discourage tampering.
  4. Do not use perforated plates over diffusers. Use diffusers that do not need this feature.
  5. Ceiling diffusers: Mount flush with or extend below the ceiling: select diffuser for maximum coanda effect with minimal smudging. Diffuser shall be non-adjustable and without integral damper. For volume control use duct mounted manual volume damper accessible through the ceiling. Frame all diffusers etc. do not cut ceiling tile
  6. Transfer grilles through walls, floors or doors shall be privacy-type.

END SECTION 23 37 00

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**23 52 00 Heating Boilers - January 27, 2005**

- Work in this section is restricted to specific manufacturers that have been previously approved by Jefferson County School District, R-1 Facilities Services Department.
  1. Bryan
  2. Burnham
  3. Patterson Kelly
  4. Peerless
  5. Rite
  6. H.B. Smith
  7. Teledyne-Laars
  8. Weil-McLain
- Use water boilers only, do not use steam except to replace like equipment.
- Modular Boiler systems may be used only for replacement of like systems.
- Do not use finned water-tube boilers.
- Layout of equipment and routing of piping in boiler or HVAC Equipment rooms must consider the potential of freezing. Freeze avoidance shall not rely on:
  1. Unit heaters
  2. Dampers in combustion air ducts
  3. Heat tape on piping or equipment.
- Review design concepts with the Jefferson County School District, R-1 Engineer.
- Combustion air openings for appliances with draft hoods shall be “Engineered” per IBC.
- Start up proof of performance and flue gas testing and report by factory authorized personnel. The Contractor is not authorized to perform these services.
- Boilers:
  1. Thermal efficiency: 80% minimum over a range of 50% to 100% rated capacity, with CO<sub>2</sub> at 8% minimum.
  2. Rated at 50 psi minimum working pressure.
  3. Baked enamel finish, R15 insulation or greater
- Exclude combination starter disconnects from boiler package.
- Boiler Controls shall include operating control, safety controls integral to the boilers, local status, local alarms, and contacts for an alarm signal to Division 25 Direct Digital Controller on flame failure. These controls shall be contained in a boiler mounted cabinet and be capable of interface with a “Heating Plant Controller” specified and provided under Division 25. The “Heating Plant Controller” shall enable the Boiler Controls. All status and local alarms in the boiler mounted cabinet shall have pilot lights.
- Boiler Control Panel – Each boiler shall include a control panel with the following pilots:
  1. Power
  2. Call for heat
  3. Pilot
  4. Main
  5. Alarm – fail only with two position silence toggle.

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- Boiler Trim:
  1. Combination thermometer and pressure gage
  2. Water temperature control operator
  3. High Limit safety control
  4. Low water cutoff
  5. ASME safety relief valve(s) 40# minimum
  6. Electronic pilot safety control
  7. Auxiliary safety shutoff valve
  8. Electric gas valve operator
  9. Pilot and main gas pressure regulator
  10. Main manual gas shutoff valve
  11. Pilot cock
  12. 100% gas pilot safety shutoff
  13. Draft diverter or barometric draft control for atmospheric burners.
  14. Staged (preferred) or Modulating gas burner
  15. Spark ignition
- Cast Iron Boilers shall include at least two sections with inspection and cleanout tappings on each end.
- Tube type boilers shall include full opening and removable access doors at each end.
- Install boilers on 4 inch raised reinforced concrete housekeeping pad(s).
- Design system with isolation valves on the makeup water, gas and heating water lines so that any one unit may be taken out of service without affecting other unit(s)
- Install unions on discharge of Pressure relief valves.

END SECTION 23 52 00

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**23 55 00 Fuel Fired Heaters - January 27, 2005**

- Work in this section is restricted to specific manufacturers that have been previously approved by Jefferson County School District, R-1 Facilities Services Department.
  1. Reznor
  2. Trane
  3. Modin
  4. Hastings
  5. Greenheck
- Gas Fired Kitchen Make-up Air Unit
  1. Unit shall be single zone, constant volume, indirect gas fired with:
    - a. Supply Air Fan (SAF)
    - b. No cooling. Cooling shall be provided from adjacent systems.
    - c. Economizer dampers: Outside, and Return.
    - d. Sized and controlled to match Grease Hood exhaust fan capacity and operation.
    - e. Package controls. No connection to TC system.
    - f. Interlock with Kitchen Grease Hood exhaust fan provided by Division 16. Grease hood controlled by on-off switch also by Division 16. See Division 25 for FSIP Fire Suppression Interface Panel.
    - g. Safeties:
  2. Discharge air temperature of 40°F or less for more than five minutes will stop the fan.

END SECTION 23 55 00

**23 60 05 Refrigeration Equipment and Refrigerants - September 9, 2004**

- Work in this section is open to any product or material meeting the requirements of this Technical Guideline.
- Comply with applicable codes and standards regarding control, inventory control (tracking and disposition of refrigerants used. This shall include but not be limited to:
  1. Federal Register Part II EPAm 40CFR part 82.
  2. Colorado Department of Health, Regulation No. 15, Control of Emission of Ozone depleting Compounds.
  3. The Code of Colorado Regulations 5 CLR 1001-19.
  4. ASHRAE Guideline 3-1990.
  5. EPA, Clean Air Act.
- Refrigerants R-11 and R-12 for new equipment are no longer permitted in the District.
- Equipment containing refrigerant shall be tagged with an Identification Tag that identifies the type of refrigerant and the quantity held. Tags shall be engraved brass pop-riveted to the equipment.
- Test refrigerant systems using pressure not vacuum.
- Do not use the compressor for evacuating the system.
- Include a receiver to hold complete refrigerant charge for systems containing 50# or more of refrigerant. Include access valves on systems containing less than 50#
- Except for factory sealed units, furnish two complete charges of lubricating oil for each compressor crankcase. Use one charge during performance testing. Upon satisfactory completion of the tests, drain the oil and replace with the second charge.

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- Shut down system if initial start-up and testing takes place in winter and machines will remain inoperative. Repeat start-up and testing operation at beginning of first cooling season.
- Provide factory start-up services for the chiller and cooling tower.

END SECTION 23 60 05

**23 63 00 Refrigerant Condensers - January 27, 2005**

- Work in this section is restricted to specific manufacturers that have been previously approved by Jefferson County School District, R-1 Facilities Services Department.
  1. Carrier
  2. Copeland
  3. Lennox
  4. McQuay
  5. Trane
  6. TSI
  7. York
- Air Cooled Condensing Unit
  1. Self-contained, factory assembled, pre-wired, suitable for outdoor use with cabinet, compressors, condensing coil and fans with guards, integral sub-cooling coil, controls, liquid receiver, wind deflector, and louvered panels to adequately protect the condenser fins against hail.
  2. Hermetically sealed, 1,750 rpm, positive lubrication, crankcase heater, cylinder unloaders, motor overload protection, service valves, and filter dryer.
  3. Condenser:
    - a. Vertical discharge, direct drive axial fans, resiliently mounted with guard and motor.
    - b. Permanently lubricated ball bearing motors with built-in current and overload protection.
  4. Controls:
    - a. High and low pressure cutouts for compressor, oil pressure control, non-recycling pump-down, reset relay.
    - b. Timer circuits to prevent rapid loading and unloading of compressor.
    - c. Hot gas bypass.
  5. Weatherproof cabinet:
    - a. Galvanized steel with baked enamel finish
    - b. Removable access doors or panels with quick fasteners.
    - c. Corrosion resistant materials for parts exposed to the weather.

END SECTION 23 63 00

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**23 64 00 Packaged Water Chillers - January 27, 2005**

- Work in this section is restricted to specific manufacturers that have been previously approved by Jefferson County School District, R-1 Facilities Services Department.
  1. Carrier
  2. McQuay
  3. Trane
  4. York – Conditionally – see above.
- Applicable standards and regulations:
  1. ANSI - American National Standards Institute (Safety Codes for Mechanical Refrigeration)
  2. ARI - Air Conditioning and Refrigeration Institute - (All applicable equipment rating and construction standards)
  3. ASME - American Society of Mechanical Engineers - (Boiler and Pressure Vessel Code, Section VIII, Division 1, latest edition)
  4. NEC - National Electrical Code
  5. NEMA - National Electrical Manufacturer's Association - (Motors for Hermetic Refrigeration Compressors)
  6. ARI factory performance test required for chillers > 100 tons.
  7. ASHRAE - Standard 15, *Safety Code for Mechanical Refrigeration*
  8. Latest CFC regulations.
- Target efficiency: 0.62 KW/ton (centrifugal), 0.70KW/ton (screw) or 0.82KW/ton(reciprocating) at full rated load under the service conditions specified. Examine part load efficiency figures and base specify the optimal machine.
- Design chilled water supply temperature 44°F.
- Design condenser water temperature 73°F.
- Cooling/Chilled Water will be 30 % Propylene Glycol. The condenser cooling liquid will be water containing biocides and anti-scaling compounds.
- Air cooled chillers are preferred.
- Open compressor motor chillers manufactured by York are not acceptable to Jefferson County School District, R-1. This policy is in response to long standing and recent experience with shaft seal leakage... The basic design of the York shaft seal is the cause; "quick fix band-aids " will not correct the problem.
- Chillers:
  1. Preferred Electrical characteristics - 460v, 3ph, 60hz. No single phase equipment
  2. Single factory package with these minimum features:
    - a. Refrigerant compressor(s)
    - b. Air or water cooled refrigerant condenser
    - c. Evaporator
    - d. Expansion valve
    - e. Electric drive motors for the compressor(s) and oil pump
    - f. Controls mounted in a common panel
    - g. Water cooled oil cooler and oil circulating pump
    - h. Electric oil pre-heater
  3. Self-excited vibration velocity < 0.10 inch/second in any of the three axes.

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4. Heat exchanger fouling factor: 0.0005.
5. Evaporator
  - a. Shell-and-tube design with seamless copper tubes and designed, manufactured, tested and stamped in accordance with Section VIII, Division 1, latest edition of the ASME Boiler and Pressure Vessel Code and its addenda.
  - b. Shell: Carbon steel plate, incorporate rupture disc conforming to ANSI/ASHRAE 15-1978 Safety Code, and be furnished with a 150 psig cast-iron water box. Factory-applied thermal insulation.
  - c. Positive liquid and vapor seal between the refrigerant and water side of the shell
  - d. Copper tube wall thickness: 0.035 inch.
  - e. Position intermediate tube support sheets along the length of the shell to avoid contact and relative motion between adjacent tubes.
  - f. Use multiple layers of metal mesh screen or some other device to form an eliminator to be installed over the tube bundle along the entire length of the evaporator to prevent liquid refrigerant carryover into the compressor.
6. Water Cooled Condenser
  - a. Shell and tube design with seamless copper tubes, integral fins. Stamp in accordance with Section VIII, Division 1, latest edition of the ASME Boiler and Pressure Vessel Code.
  - b. Position intermediate tube support sheets along the length of the shell to avoid contact and relative motion between adjacent tubes.
  - c. Copper tube wall thickness: 0.035 inch.
7. Purge system to operate automatically for removing any non-condensables and water vapors which may be present in the refrigerant system. Automatic non-condensable discharge and refrigerant return. Remove water with a manual blow-off valve.
8. Controls and Safeties
  - a. Completely pre-wired control panel mounted on the chiller assembly: -120V single phase/60 Hz with its own transformer-numbered terminal strip for field interlock wiring-individually numbered and color coded panel wires-number wires same as the manufacturer's circuit drawings.
  - b. Automatic safety shutdown with a pilot light and a manual reset each for low evaporator refrigerant temperature, high condenser pressure, high motor temperature and low oil pressure.
  - c. Capacity control mechanisms to limit maximum amperage drawn by the compressor. Set point of the compressor demand limit adjustable to any value between 40 and 100% of full load
  - d. Individual dial-type pressure gauges to indicate purge drum, condenser, evaporator and oil pressures.
  - e. Anti-recycle timer to ensure safe intervals between successive compressor starts.
  - f. Panel-mounted meters to indicate total number of compressor starts and elapsed running time. A system pilot light to indicate control power "ON" to the panel.
  - g. Pilot lights:
    - (1) start-up in progress
    - (2) anti-recycle timer active
    - (3) condenser water pump on
    - (4) chilled water pump on
    - (5) oil pump on
    - (6) chiller on

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- h. Adjustable temperature controls:
    - (1) deadband
    - (2) Chilled water supply temperature setpoint between 45 °F and 55 °F
  - i. Wire safety controls to the starter to stop the chiller if:
    - (1) low evaporator temperature
    - (2) high condenser pressure
    - (3) high compressor motor temperature
    - (4) low oil pressure
    - (5) loss of condenser water flow
    - (6) loss of chilled water flow
    - (7) imminent freezing of chilled water
  - j. Include a device to reset the chilled water supply temperature set point from the return water temperature. Incorporate a minimum of two field adjustable reset schedules into the controls to match any application with the reset schedule.
  - k. Permit automatic chiller unloading during periods when the load decreases below the normal operation. Automatically restart upon an increase in load.
  - l. Provide connections to automatically start and stop or demand limit the chiller from a future remote energy management device.
  - m. Provide the capacity to unload the chiller from a remote signal.
  - n. Compressor motor starter: Factory mounted, wired and tested on the chiller. Free standing starters requiring field wiring are not acceptable unless mounted next to the chiller. Include an electronic motor protection system to monitor and protect against overload and phase unbalance.
  - o. Distribution fault protection to prevent reconnection of the compressor motor while it is out-of-phase with the line voltage. If a distribution fault is detected, the fault trip indicator shall be displayed and manual reset shall be required. Distribution faults of 1-1/2 electrical cycle durations shall be detected and the compressor motor shall be disconnected within six electrical cycles.
  - p. Manually reset high and low refrigerant pressure cutout switches.
  - q. Relief valve in compressor discharge circuit. No valves between the compressor discharge and the relief valve.
  - r. Interlocks that will permit field connections from these interrupt signals:
    - (1) The compressor motor power interrupted on loss of cooling or chilled water flow.
    - (2) The compressor motor cannot start until the chilled water pump and cooling water pump are operating.
  - s. Disconnect switch mounted on the frame near the starter.
  - t. Furnish with chilled and condenser water flow switches
  - u. An ammeter for each electrical power phase.
  - v. Display panes shall be under lockable panel doors and not exposed to sunlight.
9. Vibration Isolators - Free-standing, laterally stable without any housing, and complete with acoustical friction pads between the base-plate and the support.
10. Warranty - 5 year warranty on all reciprocating compressors
11. Options for Air cooled chillers – Include: Louvered Hail Guard Panels, Safety screens bolted to the unit frame and safety hasps on all doors and access panels.

END SECTION 23 64 00

**23 65 00 Cooling Towers - January 27, 2005**

- Work in this section is restricted to specific manufacturers that have been previously approved by Jefferson County School District, R-1 Facilities Services Department.
  1. BAC
  2. Marley
- Include in the design a temperature activated dump/fill system for freeze protection.
- Roof mounted locations are not acceptable. If roof mounting is unavoidable, mount on an open steel structural support of adequate height to allow access for re-roofing and provide a separate roof drain adjacent to the tower.
- Cooling Tower Components:
  1. Housing Propeller fan and multi-speed fan drive motor with controls and guard
  2. Sump with bottom outlet
  3. Drift eliminators
  4. Water distribution fill
  5. Make-up water float valve
  6. Do not use electric sump heaters
- Comply with the CTI (Cooling Tower Institute) Standards
- Design with an approach of not more than 8 F and a range of not more than 15 F.
- Vibration shall be such that the value of self-excited vibration velocity is less than 0.10 inch/second when measured with a vibration meter on the frame or bearings of the tower in any of the three axes. The fan and motor assembly shall be statically and dynamically balanced so as not to exceed the vibration limits specified.
- Hot dipped galvanized steel construction with a minimum coating of 2-1/2 ounces per square foot conforming to ASTM A-123. Fiber Glass, Plastic or other non metal “Space age material” is not acceptable.
- If more than one cell, separate each cell from the adjacent cell by a full galvanized steel wall. Include a center divider in each cell that will prevent wind blowing through the louvers and carrying out water spray.
- Bolts, nuts and washers: Silicon bronze or galvanized steel.
- Design louvers to prevent ice formation from blocking entering air during subfreezing weather.
- Tower Fill: Pre-assembled PVC meeting NFPA requirements.
- Limit drift losses to 0.2% of tower capacity.
- Cold water basin:
  1. Outlet – bottom depressed sump. Do not use side outlet.
  2. Basin shall be 14 ga. Stainless steel.
  3. Include stainless steel suction screen and cast bronze float fill valve.
  4. Remote basins are not recommended. If considered review with District Engineer.
- Drift eliminators: Two-pass non-corrosive
- Distribution.
  1. Individual upper distribution piping fed from main headers equipped with flow control valves so that any cell may be shut down for maintenance without interfering with the operation of any other cell
  2. Low pressure, splash-type distribution nozzles
  3. Single ASA 125 lb. serrated flat face flanged connection for the hot water inlet

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- Fans
  1. Propeller with cast aluminum blades
  2. Right-angle spiral bevel gear speed reduction
  3. Stainless steel drive shafts
  4. Drive and fan safety guards.
- Location – To minimize student vandalism, do not use Squeege or other rock material in the area of the cooling tower.
- Do not use condenser water filters or strainers.
- Design the pipe system so pipe subject to freezing will drain on automatic system drain down.
- Include automatic drain down and make-up water features in the condenser water system. See Division 25 for additional details.
- Install flanged connection at the basin low water level in condenser water return line.
- Consider PVC pipe for any portion of the system that drains and dries out when the tower is not running.

END SECTION 23 65 00

**23 75 00 Custom-Packaged Outdoor HVAC Equipment - January 27, 2005**

- Work in this section is restricted to specific manufacturers that have been previously approved by Jefferson County School District, R-1 Facilities Services Department.
- Building Over Pressurization is an on-going problem:
  1. A return/exhaust fan shall draw from the building and discharge into a chamber with return and exhaust dampers.
  2. If the unit has only a supply fan, use a separate building relief with motorized damper controlled by the same signal as the return and supply dampers in the unit. Do not use unit mounted exhaust. Small package units may be an exception. Consult with the Jefferson County School District, R-1 Engineer.
  3. The Engineers design shall insure an adequate return air path and include dampers necessary to balance the return air.
- Outdoor Air Handling Units:
  1. Components
    - a. Supply and return fans. Return fan shall discharge into exhaust and return dampers
    - b. Hot water heating coil, Chilled water or DX cooling coil
    - c. Filter section
    - d. Air Mixing Section for Full Economizer capability with:
      - (1) Outside Air Damper (OAD), Return Air Damper (RAD) and Exhaust Air Damper (EAD) with electric operated damper actuators
      - (2) No Minimum Outside Air Damper (MOD) is required.
    - e. Duplex, 110v. receptacle mounted on the outside of the cabinet and connected to the service side of the unit mounted disconnect.
    - f. Control power – include 24v power for Temperature controls on the load side of unit mounted disconnect.

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- g. DX compressor safety controls.
  - h. Controls: Acceptable factory mounted controls are Johnson Control. With the exception of internal compressor safeties. Unit manufacturers controls are not normally acceptable. Discuss with District Engineer.
2. Design and Construction:
- a. Cabinet
    - (1) Double-wall construction of galvanized steel outer wall and inner wall mounted on a welded structural frame.
    - (2) Panels shall withstand a positive or negative w.c. static pressure of 5 inches or 1.5 times design pressure (which ever is greater) or without visible distortion or discernable air leaks.
    - (3) Insulate walls and roof of cabinet to a minimum of R-12 with insulation conforming to NFPA 90 requirements.
    - (4) Include lifting lugs welded or bolted to the base.
    - (5) Draft gauge connections in filter section
    - (6) Hinged and latched access doors in each section. Construction shall be the same as cabinet. Safety Hasps on all doors. by manufacturer or by contractor. If by contractor secure to unit with through bolts, do not weld.
    - (7) Provide all bearings and lubrication points with lubrication fittings placed in accessible locations.
    - (8) Floor panels shall be double wall insulated steel capable of bearing a 200 lb. load placed on a one square foot with a deflection not to exceed 1 inch per 200 inches span... Turn up the sides of the floor panels in Drain Pan section a minimum of 2 inches and seal. All sections to be sealed water tight.
    - (9) Pipes shall be sleeved and sealed through the floor to a height of four inches above the floor.
    - (10) Drain connection in each fan and coil section – 2 inch floor drain.
    - (11) Prepare the exterior surface with a procedure designed for galvanized steel, paint with a factory primer and a finish coat of enamel.
    - (12) Cabinet or cabinet vestibule shall have adequate space for installation of and maintenance access to circulating pumps, TCVs and associated piping for heating and cooling coils. Access to pumps and TCVs shall not require personnel to enter unit for maintenance. Size of vestibules by the Mechanical Engineer.
    - (13) Supply and Return fan shall be horizontal configuration for ductwork connections. No down blast (vertical) discharge. Do not use discharge plenums.
    - (14) Pitch roof to insure positive drainage. Overlap roof cap 2" minimum.
    - (15) Electrical and control panels shall be designed to insure prevention of water entry from any source.
    - (16) Marine light in fan section.
    - (17) Provide access door on drive side of fan section.
    - (18) Openings other than lockable access doors or louvers shall have security screens secured to the cabinet.
    - (19) Factory wiring inside of air handling equipment shall be copper only, conform to the latest edition of NEC and be encased in rigid or flexible metal conduit.

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(20) Plastic, Fiberglass or similar composition "space-age material" drive gears are not allowed

3. Fan Section
  - a. DWDI, centrifugal, Backward-inclined (preferred) or Forward Curve only, AMCA certified.
  - b. Fan housing: Die-formed streamlined inlets. Minimum 14 gauge scroll and 12 gauge sides
  - c. Bearings: roller split pillow block with a minimum AFBMA L-10 life of 200,000 hours
  - d. Select fans not to exceed 1500 rpm. Optimize Peak Static Efficiency.
  - e. Motor, sheaves and drive belts shall be sized to eliminate belt squeal on start-up
  - f. Mount fan and motor on a structural steel base on 2 inch spring isolators mounted on structural steel frame welded to cabinet frame. One inch may be considered for smaller fans.
  - g. Motors shall be high efficiency.
  - h. Fan guards with perforated facing and tachometer openings for motor and fan shafts.
  - i. Acceptable manufacturers of fans:
    - (1) Chicago Blower
    - (2) Blower Buffalo Forge
    - (3) New York
    - (4) Trane
    - (5) Twin City
4. Coil Sections
  - a. Aluminum or copper fins 0.0075-inch minimum thickness, bonded to seamless 5/8-inch OD copper tubes 0.024-inch minimum wall thickness. 12 fins per inch, maximum.
  - b. Coils removable from the AHU by means of doors or removable panels.
  - c. Arrange for counter-flow of air and liquid. Supply at the bottom and return at the top, drainable without air purging.
  - d. Factory fabricated frame independent of the unit casing. Any one coil shall be removeable without disturbing the other coil.
  - e. 12 inches +/- space between heating and cooling coils.
  - f. Sealing strips between each coil frame and the casing to eliminate air bypass and moisture carryover.
5. Filter Section:
  - a. Filter the entire outside air/return air mixture.
  - b. Support with galvanized steel frames.
  - c. Standard replaceable 2 inch pleated elements 24 inches x 24 inches or 20 inches x 20 inches. Farr 30/30 or acceptable alternate. Clean pressure drop: Not greater than 0.1 inch water at 300 feet per minute (fpm) face velocity.
  - d. Air velocity through filters and coil sections shall not exceed 550 fpm measured across net area.

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6. Air Mixing/Economizer Section:
    - a. Include an outside air damper, exhaust air damper and a return air damper each sized for the full rated flow of the unit.
    - b. Louvers or weather hoods with bird screen on all air openings, AMCA certified with air velocity through free area not exceeding 700 fpm
    - c. Dampers: The standards in Section 23 33 00 apply here.
    - d. Damper arrangement shall eliminate the possibility of thermal stratification within the unit.
  7. Piping:
    - a. Coil piping, pumps, valves etc. shall be within cabinet extensions or vestibules not in ceiling space below units.
    - b. Piping shall be accessible through full access hinged door of same construction as cabinet.
    - c. No Piping shall be exposed outside insulated cabinet. Cabinet Extensions to enclose piping are acceptable.
  8. Acceptable manufacturers of outdoor air handling units provided they conform to the above requirements. The engineer is responsible for insuring that listed equipment meets specifications:
    - a. Buffalo Forge
    - b. Carrier 39NX
    - c. Haakon
    - d. Miller-Picking
    - e. Trane T-Series Climate Changer
    - f. Temtrol
    - g. York
  9. Other manufacturers may be considered upon the recommendation of the Engineer and review of the District Engineer. Recommendations by the Engineer shall be accompanied by an equipment analysis and a list of installations in the Denver area.
- Indoor Air Handling Units
    1. Components:
      - a. Supply and return fans. Return fan shall discharge into exhaust and return dampers.
      - b. Hot water heating coil and Chilled water or DX cooling coil.
      - c. Filter section
      - d. Air Mixing Section for full economizer capability with:
        - (1) Outside Air Damper (OAD), Return Air Damper (RAD) and Exhaust Air Damper (EAD).
        - (2) No Minimum Outside Air (MOA) damper is required.
      - e. Controls: Acceptable factory mounted controls are Johnson Control. Unit Manufacturers controls are not acceptable.
      - f. Guards on rotating equipment.

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2. Design and Construction:

a. Cabinet

- (1) Panels shall withstand a positive or negative 4 inches wc static pressure without visible distortion.
- (2) Insulate the walls top and bottom to a minimum of R-6 with insulation conforming to NFPA 90 requirements.
- (3) Design the unit to be removable in sections such that alterations of the building structure are not required for replacement.
- (4) Provide draft gauge connections in each filter section.
- (5) Provide insulated and gasketed access doors or panels in each section.
- (6) Provide all bearings and lubrication points in accessible locations
- (7) Floor panels shall be capable of bearing a 200 lb load placed on a one square foot with a deflection not to exceed 1 inch per 200 inches span. Turn up sides of floor panels in drain pan section a minimum of 2 inches and seal.
- (8) Drain in each fan and coil section - 2 inches floor drain with a side outlet.
- (9) Supply and return fan shall be horizontal configuration for ductwork connections. No down blast discharge.
- (10) Marine light in fan section
- (11) Access door on drive side of fan section.
- (12) Factory wiring inside of air handling equipment shall be copper only, conform to the latest edition of NEC and be encased in rigid or flexible metal conduit
- (13) Plastic, Fiberglass or similar composition "space-age material" drive gears are not allowed.

3. Fan Section – See “Fan Section for Outdoor Air Handling Units” Above.

4. Coil Sections– See “Coil Sections for Outdoor Air Handling Units” Above.

5. Filter Section - See “Filter Section for Outdoor Air Handling Units” Above.

6. Air Mixing /Economizer Section

a. Outside air damper, exhaust air damper and return air damper each sized for the full rated flow of the unit.

b. Construct for easy attachment of control actuators and external ductwork.

7. Dampers: The standards in Section 23 33 00 apply here.

- Mount rooftop units on concrete pads. Wood or steel curbs filled with acoustic bat and gyp board sound attenuation treatment may be considered.
- Do not make duct penetrations through the roof within the limits of the mounting pad or curb. Supply fan shall discharge horizontally into a duct with inside clear area that matches the free area dimensions of unit supply opening. Run duct a minimum of three diameters before transitions or turning down into the building. Return air duct arrangement to be similar to Supply.
- Support equipment from the building structure only in accordance with structural drawings. No equipment may be hung or suspended from ceilings.
- Provide new filters and clean coils, plenums and fans of foreign matter and debris before turning equipment over to the District.

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- Locate air-handling equipment so all doors, exterior panels and coil-pull provisions are easily accessible for maintenance.
- Exhaust Fans
  1. Rooftop or sidewall mushroom type
  2. Belt drive for units > 1/4 HP
  3. 850 Max rpm.

END SECTION 23 75 00

**23 80 00 Decentralized HVAC Equipment - January 27, 2005**

- Work in this section is open to any product or material meeting the requirements of this Technical Guideline.
- Packaged Rooftop Air Conditioning Units
  1. Units shall be supplied with controls by Johnson Control Co.; Manufacturers controls are not acceptable except for B. below and integral safety controls.
  2. For small units which will not accommodate Temperature Controls Contractor control components the manufacturers packaged controls may be used. See Section 25, “DX Air Conditioning Unit (ACU)”.
  3. Units shall include:
    - a. Mixed air sensor
    - b. Package safety controls
    - c. Terminal interface strip for connection by Section 25
    - d. Package Controls - Damper operators shall be 0-10vDC, 4-20MA or 24v incremental Control.

END SECTION 23 80 00

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**23 82 00 Convection Heating and Cooling Units - January 27, 2005**

- Work in this section is restricted to specific manufacturers that have been previously approved by Jefferson County School District, R-1 Facilities Services Department.
- Finned-tube (Baseboard) Radiation
  1. Cabinets or enclosures: 16 gauge or maximum security steel with closed ends to resist abuse and vandalism. Slope the top to discourage the storage of materials.
  2. Design perforations to discourage vandalizing the fin tube or controls with sharp instruments.
  3. Cabinet paint: Baked on enamel or prime coating of a color selected by the Architect.
  4. Fin tubes:  $\frac{3}{4}$  inch, 1 inch or  $1\frac{1}{4}$  inches copper with a safe working pressure of 200 psi at 250° F and 0.016 inches thick or heavier aluminum fins spaced no closer than 48 per foot.
  5. Acceptable manufacturers are Standard, Sterling, or Vulcan.
- Unit Ventilators. Use only to replace in kind or when it is impossible to use an alternate HVAC system. Consult with Jefferson County School District, R-1 Engineer. Unit ventilators shall include:
  1. 100% outside air or return air economizer damper(s). Cabinet heaters are return air recirculation only.
  2. Readily accessible manually switched two-speed fan motor. Cabinet heater motors may be single speed.
  3. Interior components accessible only through tamper resistant access panels or doors. Tamper resistant hardware shall be operable using standard tools.
  4. Fin tube element or coil:  $\frac{5}{8}$  inch OD copper tube(s), .029 inch wall with fin spacing not exceeding 12 per inch.
  5. NC to satisfy criteria as defined HVAC Acoustic Criteria.
  6. Cabinet extensions sized as necessary to accommodate mechanical or electrical control devices, and all valves, vents, etc.
  7. International is not an acceptable manufacturer because of difficulty in obtaining parts.
- Classroom unit ventilators with self-contained refrigeration compressors are not permitted.
- Approved manufacturers are:
  1. Airedale
  2. American Air Filter
  3. Carrier
  4. Magic Aire
  5. Nesbitt
  6. Trane
- Unit mounted controls shall be:
  1. Manufactured by Johnson Controls.
  2. Shall include automatic reset freeze stats.
- Water control valves: Brass or bronze, 24 volt electric or pneumatic actuated, 150 psi threaded or soldered, Honeywell, Powers, Johnson Controls, Belimo or Barber Coleman.

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- Unit Ventilators – The Engineer shall include in the design scaled drawing details for location of valves, strainers, etc. Where there is cabinetry adjacent to the UV consider locating the valves within the cabinets instead of inside extensions of the UV cabinet. If there is more than one unit ventilator to be installed, complete the installation of one as a prototype for approval by the District Engineer. Access to elements of the piping within the cabinet is critical to maintenance but often overlooked by the installer.
- Cabinet Unit Heaters located at entries. Install in the occupied space beyond air locks or vestibules. Do not install in vestibules or air locks.
- Heating Water Piping:
  1. Consider reverse return
  2. Two-way control valve, balancing valve and two isolation valves for each heating terminal unit or fin tube zone to permit removal of one terminal unit or fin tube zone without shutting down the system.
  3. Three-way control valve, strainer w/ drain at the end of each branch to keep the lines close to the service temperature and protect the pump from dead head shut off, or another engineer designed method to accomplish the same purpose.
  4. Locate valves and/or other controls above the ceiling or inside the cabinet behind tamper resistant access panels or doors.
  5. Conceal piping behind architectural facades.
  6. Provide each terminal unit with brass P/T taps in the supply and the return.

END SECTION 23 82 00