

DIVISION 15 - MECHANICAL SYSTEMS

A. GENERAL

1. **General Procedures:** This section contains general guidelines for design and installation of plumbing and mechanical systems. Design Team and Contractors shall fully coordinate these requirements with other Specification sections including but not limited to Divisions 1, 2, 6, 11, and 16.

Terms used herein shall have the following connotation:

- a. Will, provide, shall, and must: an absolute requirement.
- b. Preferred or desired: indicates Owner's preference if other conditions are about equal.

Any variance from these guidelines must be approved by CSSD #11 Project Manager (COTR) or other authorized representative from the District Facilities Department.

Asbestos shall not be used in any part of the mechanical systems, including insulation or boiler gaskets. Solder containing lead shall not be used anywhere in the building. Contractor does not need to assume responsibility for performing asbestos abatement or testing but shall advise Owner if presence of asbestos is anticipated in any locations where penetrations will be made. CSSD #11 employs an environmentalist certified for Asbestos removal who will review shop drawings and pipe routing schematics prior to any coring operations to determine if abatement will be required in any location. If required, abatement will be performed by or contracted separately by Owner. Contractor shall read the Asbestos Notification Letter provided in the Construction Documents and shall demonstrate acknowledgement of receipt upon execution of contract.

Functions and educational requirements as pertaining to mechanical systems are described under General Requirements and Room Requirements listed herein. The design engineer shall review these sections carefully to establish intent and scope of educational function for each area.

The following design criteria and recommendations summarize the various engineering aspects of planning, design, installation, and maintenance which are to be considered in achieving the following objectives:

- a. Maximum safety
- b. Performance and reliability
- c. Energy efficiency
- d. Ease of maintenance
- e. Cost (First cost, operating cost, and life-cycle cost)

These criteria, coupled with specified educational and functional requirements, form the basic guidelines for mechanical planning. They are not intended to restrict the design team in the application of other concepts that are consistent with the educational and functional needs and the objectives listed above. Design Consultants and Contractors are encouraged to offer suggestions for alternate products or solutions when applicable for review and approval by the District.

2. **Mechanical Design Criteria:** Functions and educational requirements as pertaining to mechanical systems are described under General Requirements and Room Requirements listed herein. The design engineer shall review these sections carefully to establish an intent and scope of educational function for each area.

3. Mechanical Design and Installations shall comply with the most recent published and locally adopted requirements of the following:
 - a. International Energy Conservation Code
 - b. International Plumbing Code
 - c. International Mechanical Code
 - d. Colorado Department of Labor and Employment regulations
 - e. International Energy Code
 - f. International Building Code
 - g. Colorado State Boiler Code
 - h. Colorado Department of Health Regulations
 - i. NFPA 5000 Standards
 - j. International Fire Code
 - k. International Fuel & Gas Code
 - l. City of Colorado Springs Fire Department
 - m. State & regional codes or standards that supersede international codes as applicable; including Fire, utility regulations, etc.
4. Access: Provide access to all valves and equipment, including filters. Provide access doors in ducts on both upstream and downstream sides of heating coils to allow for cleaning of coils. Whenever possible, locate equipment in hallways for maintenance access. Arrange piping and ductwork to not block required access to equipment for servicing and maintenance. Whenever possible, locate serviceable equipment (terminal heating, VAV, etc) in corridors and areas where maintenance activities do not affect classroom or office functions.
5. Remote Metering: Make provision for communication from the gas service meter to remote readers. Coordinate with utility company and Owner for requirements. Provide for meter to be read through building automation system (BAS).

B. COMMISSIONING

1. This section is to be completed in a future date.

C. VIBRATION ISOLATION

1. Provide vibration isolation for motor driven equipment, connecting piping, and/or ductwork in accordance with manufacturer's recommendations and ASHRAE guidelines.
2. Whenever possible, locate air handling equipment over hallways, restrooms, storage areas and other similar areas to minimize vibration in occupied areas.
3. Mechanical equipment that creates vibrations should not be located above or directly adjacent to any auditorium or performance space.

D. MECHANICAL INSULATION

1. Insulation shall be standard brands with proper flame-spread ratings, having no asbestos content. Flame spread rating shall not exceed 25 and smoke developed rating shall not exceed 50. Insulation shall meet the requirements of NFPA 90 for fire resistance.
2. Choose insulation type and thickness based on the International Energy Conservation Code to maintain operating economy; to prevent heat gain or loss into unoccupied areas; to prevent condensation damage; and to prevent freezing. Provide vapor barrier on insulation of cold pipes and ducts.

3. Stem extensions shall be used on all isolation valves to prevent tearing of insulation when manipulating
4. Exposed ducting that requires insulation and is installed inside a structure is required to be internally insulated. External duct insulation will not be allowed without written approval by District 11.
5. Insulation will typically be required as follows:
 - a. Heating ducts: External duct insulation preferred.
 - b. Cooling ducts: External duct insulation preferred.
 - c. Evaporative systems shall have only exterior insulation.
 - d. Fresh-air ducts: External duct insulation preferred.
 - e. All heating piping.
 - f. All hot water and condensate vessels.
 - g. All domestic hot water supply and recirculation lines.
 - h. Domestic cold water lines.
 - i. All chilled water lines.
 - j. Refrigeration piping.
 - k. Condensate piping.
 - l. Above ground rainwater piping and roof drain basins where required.
 - m. Handicap accessible fixtures per code.
 - n. Provide jacket or shell on exposed insulation.

E. FIRE PROTECTION

1. New buildings and additions to buildings with existing fire sprinkler systems shall be fully fire-sprinkled in accordance with IFC, NFPA, and CSFD requirements.
2. The design of the fire protection system shall be performed by or under the direct supervision of an experienced fire sprinkler design professional having NICET III or higher level certification. Said professional shall be experienced in fire protection, thoroughly familiar with and experienced in this type of installation. Colorado registered Professional Engineers who are “Members” in the national organization of the Society of Fire Protection Engineers (SFPE) are preferred.
3. System Design Engineer and Contractor shall have five (5) years minimum experience on projects equal to or greater in size of subject project.
4. The entire fire protection system including design, calculation, fabrication, installation, and testing shall be provided by a single source Contractor that has the capability to perform all of the work required under this section.
5. Contractor shall have capability and certifications for providing full service maintenance, testing, and inspection programs in accordance with NFPA standards and shall have an established office within 100 miles of the District which maintains a full complement of spare parts, tools, and equipment necessary for repairs and maintenance of sprinkler system.
6. Avoid design and placement of main lines, branch lines, or heads near combustion air inlets or other areas that may be subject to freezing. Contractor shall be responsible for advising Owner and/or Architect of any conditions that may require dry pipe systems, antifreeze systems, or provision of heating systems to prevent freezing of wet pipe sprinkler systems.
7. Fire sprinkler piping shall be clearly labeled as such and shall be routed above drop ceilings in corridors when possible. Efforts should be made to avoid or minimize routing of main lines through classrooms and stairwells. Any piping crossing corridors or stairwells shall be above ceiling or enclosed in a soffit constructed of metal framing and gypsum board. If it is impossible to conceal sprinkler piping above ceilings or in soffits, any exposed piping and fittings must be painted. Sprinkler piping may be routed through existing mechanical tunnels or unfinished basement areas if necessary.
8. Fire sprinkler mains should be located along the perimeter of classroom walls when possible. Sprinkler heads should be located such that they will not conflict with existing ceiling grid assemblies. Sprinkler

heads do not need to be centered in ceiling tiles but must be a minimum of 4” away from grid mains or tees. Any exceptions must be stated in proposal and must be pre-approved by CSSD #11 Project Manager in writing prior to installation. Contractor shall indicate head placement on reflected ceiling plan as part of shop drawing submittal.

9. System shall be designed and installed to avoid conflicts with structural elements, existing windows, transfer grilles, clocks, speakers, outlets, ceiling fans, lighting fixtures, conduit runs, data cabling, existing and new mechanical equipment, maintenance access panels, and all other existing conditions. Coordinate all fire sprinkler work with the work of other trades.
10. Modifications to the existing fire alarm panel and enunciator shall be performed under this contract as required for interface with new sprinkler system.
11. System design shall include fire sprinkler risers and standpipes to each floor of the building as required by the IFC and CSFD. Each floor shall have a separate control valve and zone.
12. Shop drawings shall be submitted to CSSD #11 and/or Architect for review prior to submission to CSFD. Contractor shall prepare and submit necessary drawings and specifications to CSFD and follow through with CSFD review and approval process to include facilitating any required plan and specification modifications. Before work commences, the contractor shall provide the CSSD #11 Project Manager with copies of all approved drawings.
13. Contractor shall be responsible for verifying current flow rates, available pressure, and other information necessary to design a fire suppression system from the City of Colorado Springs Utilities and/or Fire Departments. If flow test is required, testing method shall be in accordance with CSFD standards. Contractor to notify representatives from CSFD and CSSD #11 Project Manager when flow test is scheduled and shall provide an opportunity for testing to be witnessed by representatives from CSFD or CSSD #11.
14. Contractor shall verify adequacy of existing underground fire service line and City water connection for use as water supply for new fire suppression system and shall include cost of any modifications (if required) in their proposal.
15. If required, Contractor shall include the complete installation of a booster pump for the Fire Suppression system. Contractors shall include all construction permit, inspection, and plan review fees.
16. If required, Contractor shall provide and install a surface mounted KNOX BOX conforming to CSFD standards to store keys for emergency building access. Location of installation to be mutually acceptable by CSSD #11 Project Manager and CSFD.
17. CPVC piping shall not be used for any portion of this project. All piping shall be USA manufactured schedule 7 or greater for mains and branch lines. All piping to have corrosion ratio of 1. Threaded or cut groove pipes are subject to limitations of NFPA 13. Grooved coupling fittings are acceptable, however, threaded fittings are preferred in architecturally exposed or sensitive areas. All pipe joining, fittings, and supports shall comply with NFPA 13 requirements. Grooved couplings, fittings, and gaskets used throughout the system shall be supplied from the same manufacturer and shall be approved for the specific installation. Segmentally welded piping shall not be used in any condition unless pre-approved by CSSD #11 Project Manager and authority having jurisdiction. Face bushings and hexagonal bushings shall not be permitted. The use of toggle bolts for suspension shall not be permitted. Hanger components shall be installed straight and true. Hangers shall be attached to the supporting structure by means of approved beam clamps, all thread, mounting plates, brackets, clips, bolts, or concrete anchors.
18. System shall be designed utilizing Viking or equal “quick response” sprinkler heads. System may be designed with sprinkler heads providing standard coverage or extended coverage as permitted by applicable codes and deemed appropriate for efficiency of system design. Design shall specify and Contractor shall install sprinkler heads of the following type/color for specific functional areas of building unless otherwise noted and approved:
 - a. Classrooms, offices, restrooms, or suspended ACT ceilings in corridors: Semi-recessed brass

- heads with white or ivory escutcheons.
 - b. Corridors with sidewall applications: 2-pc type 401 sidewall heads white or ivory in color.
 - c. Auditoriums: Semi-recessed heads with escutcheons – attempt to match ceiling color.
 - d. Locker rooms and Low Ceiling Areas: Fully concealed heads.
19. System shall be designed such that all sprinkler heads are a minimum of nine (9) feet above finish floor when possible. System designer to make specific note on shop drawings of any heads that may be located less than 9' above finish floor. Sprinklers subject to damage in all areas, rooms, closets, etc. and/or any sprinkler heads lower than 9' above finish floor shall be provided with caged guards unless requirement is waived in writing by CSSD #11 Project Manager.
 20. The two (2) inch main drain, sub-system drains, and inspector's test connection drains shall be provided with the appropriate size valve per applicable NFPA standards or manufacturer's recommendation. Drain line shall be extended to outside of building to a pervious surface.
 21. Fire protection system shall be designed and installed to facilitate ease of maintenance and repair or replacement of equipment components. Connect equipment for ease of disconnection and to allow minimum interference with other installations.
 22. Field changes in piping layout, pipe size, or any other deviation from approved shop drawings shall not be made without review and approval by CSSD #11 Project Manager.
 23. Contractor shall include all City of Colorado Springs submittals and fees, including but not limited to the Plan Review Fee, Inspection Fees, Recording Fees, etc.
 24. Contractor shall include in their proposal all "Fire Watch" costs during execution of project if deemed necessary by CSFD.
 25. Contractor shall comply with all current OSHA standards for work in confined space areas using the proper required safety equipment and procedures.
 26. Contractor shall include cleanup (removing existing corrosion) and repair of existing Fire Service.
 27. Contractor shall be responsible for provision and removal of any equipment or scaffolding necessary to complete project. Contractor shall further be responsible for getting equipment or scaffolding into areas of building where needed and restoring any surfaces altered or damaged to make such provision including but not limited to removal and replacement of auditorium seats if required.
 28. Contractor shall keep work area clean and dispose of construction debris, as required on a daily basis, in order to facilitate a safe and efficient construction operation. Contractor shall provide dumpsters for Contractor use. Contractor is not permitted to utilize CSSD #11 dumpsters for any construction debris. Contractor shall include final cleaning of all disturbed areas within the building.
 29. Where core drilling or hammer drilling is required for penetrations, Contractor shall not be permitted to use water to avoid potential damage to surrounding areas and/or school property. Vacuums should be utilized to eliminate or minimize dust and debris while coring. Proper air respirators are to be used as required by OSHA to prevent potential inhalation of hazardous particulates. All penetrations through walls, floors, and ceilings shall be created with pilot holes with final size drilling to be performed from both sides of walls, ceilings, or floors in order to minimize blowouts from drilling operations.
 30. Cutting of pipes using heat/ignition generating devices shall not be conducted inside any portion of existing buildings without written approval from the CSSD #11 Project Manager. Welding of pipes on site is prohibited by NFPA-13 and only shop welding shall be allowed.
 31. Patch any holes or surface damage to adjacent surfaces caused by contractor work. Paint all patches to match existing surrounding conditions. Contractor shall include a total of two (2) square foot of wall patching and painting at every penetration (one (1) square foot per side). Additionally, Contractor shall include two (2) square feet of patching and painting at all ceiling penetrations resulting from Hangers. Contractor shall provide unit pricing for one (1) square foot of patching and painting of walls and/or ceilings above and beyond base scope of work.
 32. Contractor shall utilize professional forces to accomplish all painting, cutting, patching and sealing of all surfaces needing to be penetrated to complete Contractor work. Fire rated assemblies shall be fire safe /

caulked as required.

33. Contractor to provide and install all necessary blocking or backing required for Contractor's work.
34. Contractor shall furnish all task lighting as required to properly complete the work.
35. Contractors shall include all necessary components for a complete installation including provision of shunt trip if required. Contractors shall include all components for tie-in to existing elevators and/or dumbwaiters when applicable.
36. Contractor will verify material to be penetrated, drilled, cut or removed will be asbestos free to avoid contamination or exposure. If any area contains Asbestos Containing Materials (ACM) an abatement and disposal will be completed within EPA guidelines prior to any work being performed. Any replacement material/products will be asbestos free.

F. PLUMBING

1. General.

- a. Provide for servicing of lines and equipment including adequate cleanout access.
- b. Coordinate with Owner and Architect for occupant load to determine number and size of fixtures.
- c. Coordinate with Owner to determine and provide requirements necessary for Food Service operations.
- d. Avoid locating domestic water lines under or near combustion air inlets or other locations subject to freezing.

2. Utility Connections.

- a. The Design Team and/or Contractors shall be responsible for determining requirements for local utility providers including submittal documents, taps, fees and licenses, meters, pressures, etc. Design Team and/or Contractor will determine required meter locations, requirements for separate taps or combined taps, and other specific requirements of all local utility providers for each project and coordinate with Owner for final approval prior to installation.
- b. The Owner will pay applicable water and wastewater development fees as required by municipality for new construction or site development. Contractors shall coordinate and pay for physical tap fees and inspections unless noted otherwise in contract documents.
- c. Water meter pit and meter for domestic (potable) water shall normally be separate from meter pit and meter for irrigation water. Provide service valves in each meter pit. Do not increase tap size for irrigation needs. Provide for digital metering of water consumption.
- d. Make direct contact with utility companies to determine piping, valve, pressure reduction and meter requirements. Determine water pressure available at the site prior to design.
- e. Local utility provider charges for work on the property shall be included in the construction Contract, when possible. Other charges will be reviewed with the Owner and further negotiated by the Owner.
- f. Storm drainage systems that rely on mechanical pumping systems shall not be permitted.

5. Piping.

a. Domestic Water System

- i. All underground piping including services shall be type "K" copper. Joints under slabs shall not be permitted. Minimum cover shall be 5'-0" outside of the building foundation.
- ii. Protect domestic water supply from freezing. Exercise care to avoid outdoor air intakes, combustion air dampers, garage doorways, or other external freeze exposures.
- iii. All main water service and irrigation lines shall enter the building through heated mechanical rooms. No pit or tunnel installations will be permitted for new construction.

- iv. Backflow preventers installed on main domestic water service lines shall be a minimum of 3" and shall have an additional 1-1/2" bypass backflow device. If service size warrants a larger backflow preventer, bypass device shall be 1/2 the size of the main backflow device. All backflow devices shall be manufactured by Febco and shall be installed in a horizontal position in accordance with the IPC and Colorado Cross-Connection Control Manual. Approved Febco backflow preventers include models 825-Y, 825YA, 880, 880V, 860, 765, 850, 805, 870, and 876-V depending on application. Models 805 and 825 are only approved for sizing from 3/4" – 2".
 - v. Pressure reducing valves shall be Watts ACV CFM 115-74 or Cla-Val model 90-01/690-01 or approved equal. Watts ACV CFM 115-74 is the preferred option.
 - vi. Piping within building shall be Type L copper with lead free solder joints. Galvanized steel piping is not permitted. All piping to be above grade or in accessible trench. Avoid placement of piping in exterior walls. Make sure that any piping above ceilings is on room side of insulation and adequately protected from freezing.
 - vii. Provide isolation valves at all main branches and for all fixture groups. All unions for the isolated equipment to go after valve on supply and before valve on return. Balancing valves shall not be used as isolation valves.
 - viii. Drain valves shall be ball valves with hose end adapters with cap & chain.
 - ix. Provide brass or brass by copper dielectric fittings where any dissimilar metals join. Avoid the use of dielectric unions in hydronic heating systems. Only brass or brass by copper dielectric unions are approved.
 - x. Provide shock absorber for all piping serving flush valves, solenoid valves, and other quick-closing valves. Provide isolation valves at each shock absorber for servicing.
 - xi. Domestic hot water
 - 1. Boilers and tanks shall be sized as required for storage and recovery rates. Tanks shall be stainless steel or glass lined and carry a 5-year warranty. Stainless steel is the preferred choice. Provide separate loop with equal to or greater than 180 degree water to the kitchen dishwasher rinse cycle and temper to 140 degrees for kitchen sinks. Design separate building loop; and deliver 110 degree water to the rest of the building. Provide tempering valves at fixtures in accordance with State standards and health department regulations.
 - 2. Instantaneous gas-fired water heaters may be considered for energy efficiency.
 - 3. Use brass nipples and unions on water heaters.
 - xii. Provide pumped recirculation system.
 - xiii. Install piping to allow for expansion and contraction without stressing piping joints or connected equipment. Mechanical expansion devices shall not be used without District approval.
- b. Waste and Vent Piping
- i. Soil pipe and soil-pipe fittings - bell and spigot or no-hub as approved by code.
 - ii. Acid-resistive waste and vent lines may be required for lab service areas. When acid waste neutralizing tanks are needed, they shall be installed in a location that is readily accessible for replacement of neutralizing media.
 - iii. Waste lines above grade up to and including 2-1/2" to be cast iron or PVC where approved by code. All exposed waste lines from fixtures shall be chrome-plated brass.
 - iv. Vent piping above ground 3" and over to be cast iron or PVC where permitted by code.

- v. Vent piping above grade up to and including 2-½" to be same material as waste lines. Vent piping in return air plenums shall be metal. Vent pipe should project one foot above roof with vandal-proof cast iron vent cap such as Zurn or Smith. Provide increase in size for vent through roof in accordance with code, minimum size 3". Vent piping penetrating roof areas shall be designed to maintain integrity of the roof assembly.
 - vi. Contractor shall install sanitary sewer service, including necessary manholes, on school property. Cleanouts to be provided at 50' on center. Minimum cover 4'-0". Designs should satisfy local utility regulations.
 - vii. Ensure that all cleanouts are accessible. In exterior sewer lines, cleanouts shall be at maximum 100 foot intervals, with manhole access at street. At the 5-foot sewer stub-out from the building, provide 2 cleanouts, one going in each direction.
 - viii. Ensure that kitchen floor drains are located near work areas. Coordinate drain locations with kitchen designer.
 - ix. For eye wash and shower stations, ensure that drain is located properly and that floor system is constructed to provide positive drainage. Locate drain piping discharge to prevent water from reaching wall and guide toward drain.
 - x. Group toilet, shower, locker, and kitchen area drains shall ensure that drain is located properly and that floor system is constructed to provide positive drainage. Locate drain piping discharge to prevent water from reaching wall and guide toward drain.
- c. Tests for Domestic Water and Drainage System Piping:
- i. The Project Manager or other authorized representative from the District shall be notified when all tests are scheduled and shall have the opportunity to be present for and witness all tests and documentations.
 - ii. All hot and cold domestic water lines shall be capped or plugged and tested with 100# hydrostatic test. They shall be proved tight before any piping is covered or concealed in any part of the building construction.
 - iii. All soil, waste, storm, and vent cast iron sewer piping occurring inside the buildings shall be hydrostatically tested at 10 PSI and all the joints inspected while under pressure.
 - iv. All soil, waste, storm and vent piping which occurs outside the building area will be tested to a minimum of 10 feet of head pressure. Each joint shall be water tight after 15 minutes.
- e. Gas Piping:
- i. Gas piping shall be installed in strict accordance with the NFPA 54 and IFGC, latest edition.
 - ii. Shut-off valves shall be installed in the main supply to each appliance.
 - iii. Electrically operated emergency shut off solenoid valves shall be installed in the supply to any room supplied with gas so that the entire gas supply may be stopped to the area. This valve will be controlled by a key operated switch located adjacent to the exit.
 - iv. Dielectric fittings shall be installed at the meter if the project contains underground gas piping. Cathodic protection of the underground piping may be necessary and should be investigated with the specific soil analysis available for the project site.
 - v. All underground gas piping outside of buildings should be polyethylene pipe. Fittings and all joints shall extend not less than 6 inches past and end of the fitting onto the pipe section. All testing of pipe and fittings shall be done prior to wrapping the fittings. Follow manufacturer's recommendations as to priming, tape widths, etc.
 - vi. Gas piping should not be routed on roof unless specifically approved by CSSD #11 Project Manager (COTR). If approved, gas piping runs across roofs should be mounted firmly to

- d. Stainless steel sinks for counter top installation shall be self-rimming type. Specify minimum 18 gauge sinks, fully undercoated with sound deadening material. Factory punching shall be specified to accommodate specified fittings.
- e. Service Sink - Floor-type preferred in all schools, terrazzo or molded stone floor service sink with rim guard and strainer; exposed double faucet with integral stops, hose and spout, bucket hook, and vacuum breaker. Mount faucet trim 24" above floor. Faucet shall be T&S Brass, Delta, or Fiat.
- f. Commercial Kitchen Sinks – obtain specifications for commercial kitchen sinks and faucets from CSSD #11 Food Services Department and/or CSSD #11 COTR.
- g. Garbage Disposals – For non-commercial applications garbage disposals shall be In-Sink-Erator model #CNTR 333 3/4HP continuous feed with polished sink flange and 360 degree stainless steel impellers. For commercial applications provide In-Sink-Erator model #SS-75.
- h. Drinking Fountains - Fountain for general usage. Shall be of the one-or two-bubbler type, wall-hung or recessed, anti-squirt bubblers with automatic volume regulators, self-closing valves, and cast-brass trap with cleanout. Set 24" floor to rim in elementary schools; 30" floor to rim in middle and high schools. There shall be no bubblers or drinking facilities in toilet rooms, science rooms, or art rooms. Furnish with screwdriver stops. All drinking fountains shall be handicapped-accessible. Provide at least one refrigerated water cooler per floor, one in the cafeteria area, and one in the lobby area. Fountains shall be box-type with attention given to proper support and vandal resistance. Elkay bottle filler type are also permitted.
- i. Toilet Room Hose Bibbs - In each group toilet room, furnish a lockable box-type chrome, vacuum breaker hose bibb installed under a lavatory on the hot water supply.
- j. Bubblers shall not be allowed in art or science room sinks.
- k. Floor Drains - to be cast iron with removable grids compatible in appearance with the area involved. Provide floor drains in all toilet rooms, including consideration of individual faculty toilet rooms.
 - i. Traps may be integral or provided in waste lines. Floor drains to receive flashing shall be specified with flashing flanges.
 - ii. Drains above grade to be flashed with 4# sheet lead 24" x 24".
 - iii. Provide floor sinks or drain trenches in Boiler Room, for draining mechanical equipment, with minimum 3" waste line.
 - iv. Provide floor drain at air compressors for condensate drain on dryers, within 2 feet of unit.
 - v. In rooms with ceramic tile floors specify square top drains for neat installation.
 - vi. Provide specialty traps and interceptors in Art rooms where applicable.
- l. Roof Drains - to be cast iron with gravel stop; weep holes, low dome with a flashing clamp. Call for 30" x 30" flashing. Roof drain type and flashing shall be coordinated with roofing system being provided or roof assembly compatible with flashing seal.
- m. Roof Flashings - All plumbing pipes passing through the roof shall be flashed around the pipe and over and down inside the pipe at least 1". The base of the flashing shall be a minimum of 24" x 24" on the roof. Roof drain type and flashing shall be coordinated with roofing system being provided.
- n. Grease Traps - are to be installed for all kitchens where required by Code. Install outside building is required.
- o. Provide for sand and oil interceptors in auto shops and parking garages.

G. MECHANICAL IDENTIFICATION

1. All heating and cooling supply and return, domestic hot water and gas piping, where exposed to view and above accessible ceilings shall be identified by color coding as follows:

- a. Color bands of identification may be painted on, or use colored tape for banding the pipe. The tape shall be guaranteed. National Emblem Company tape wrapped one and one-half times around the pipe may be used in lieu of paint. Apply at walls, floors, ceilings, and 50-foot intervals.
- b. Directional flow arrows shall be included with the color code, painted or taped on the pipe or insulation using a stencil.
- c. All color coding shall be in accordance with the latest issue of the ASME (ANSI) standard A13.1 recommendations, based on the "contents" of the piping.
- d. Nameplate requirements. Nameplate information shall be permanently affixed to each piece of equipment.
- e. All mechanical equipment shall be identified in the field by name and number utilizing permanently affixed labels or painted stencils at least 3" high and located in an easily viewed place. This shall apply to all air handling, exhaust, boiler, chiller, pump, and other major equipment components.
- f. Stamped valve tags preferred.

H. HEATING, VENTILATING, AND AIR CONDITIONING – GENERAL

1. The purpose of this section is to provide general design guidelines and considerations for HVAC systems. Architects, Engineers, and/or Contractors shall be responsible for design and installation of mechanical systems that meet all applicable codes and that meet or exceed the guideline specifications outlined herein. Owner performs ongoing service and maintenance on all mechanical equipment and has pre-approved the following equipment manufactures for HVAC system components:
 - a. Furnaces: Trane, Rheem, Carrier, or Approved Equal
 - b. Unit Heaters: Modine, Reznor, or Approved Equal
 - c. Packaged Units: Trane, Rheem, Carrier, or Approved Equal
 - d. Multi-zone Units: Seasons Four, General, or Approved Equal
2. System Types.
 - a. Mechanical or indirect evaporative cooling may be used on designated projects. Kitchens may utilize direct evaporative units.
 - b. Air-side or water-side economizers shall be required for all systems.
 - c. All systems should provide positive ventilation. Ventilation shall be provided to comply with the requirements of ASHRAE Standard 62. Air flow and sizing of HVAC equipment and duct work shall be based on quantities required for ventilation not just for heating.
 - d. Heat source should be a central hot water system. Direct fired heat exchangers should not be used without the permission of the School District. For new construction, the District prefers "Condensing" boiler plants. Such plants operate most efficiently with high delta-T return temperatures to the boiler loop. Designers should be careful to appropriately size coils to extract the maximum heat per the boiler manufacturer's recommendations. For existing building with over 160 degree supply heating water, the District prefers cast iron sectional boilers. Domestic water pre-heat and other considerations should be made to utilize return water heat.
 - e. Basic heating, cooling, and ventilating equipment may be of the central station unitary type.
 - f. Supplemental heating may be unit heaters, cabinet heaters, radiation, etc.
 - g. Electric heat shall not be used, unless by approval of Owner.
 - h. When air conditioning is required, consider using Geo Exchange, or indirect evaporative pre-cooling and ice storage. Air-cooled chillers are preferred over water-cooled chillers. Chilled water is preferred over all other types. Identified sub-loads for seasonal employees (summer) may consider DX for offices and similar small areas. The higher of IECC or Energy-Star rated equipment is preferred where appropriate.

- i. Direct evaporative cooling systems are unacceptable, except for kitchens.
 - j. The District encourages innovation and investigation and will consider alternative technologies.
 - k. Mechanical designs should be coordinated with the District Energy Manager. Design team and Contractors shall collaborate with District Energy Manager and Assistant Mechanical Engineer as required to determine and specify mechanical systems which shall have the lowest life cycle cost and placing high consideration on maintenance.
 - l. The district requires rated premium-efficiency motors, and encourages VFD use to match motors with actual loads. 10hp or larger motors are to utilize VFD's.
 - m. VRF is excluded from use in District 11 without prior approval from the Capital Program Manager, Assistant Mechanical Engineer, and Mechanical Shop supervisor. This will require agreement from the three parties.
3. General Design Considerations.
- a. Adequate space must be given to accessibility and servicing of equipment, including filter changing, equipment replacement, and major repairs. All equipment must be installed so that it can be serviced and repaired as recommended by the manufacturer (e.g., access panels must open completely, filters must be replaceable without bending, etc.).
 - b. The District encourages Schematic Design consideration of resource efficient alternates – GSHP, ERV, Chillers, Cooling towers, ice storage, VAV, High efficiency motors, VFD, high SEER equipment (Energy Star standards), etc.
 - c. Coordinate with the District Assistant Mechanical Engineer, Energy Manager, and Energy Program Standards in developing designs.
 - d. Specify equipment that has low routine maintenance; e.g., exterior grease fittings, etc.
 - e. All 3-phase motors 1 HP or larger shall have phase protection.
 - f. All 10-HP and larger motors shall include a VFD technology..
 - g. Unit ventilators, unit heaters and cabinet unit heaters shall have direct drive motors. Consider location of units with respect to air distribution, noise, and service access.
 - h. Consideration must be given to equipment noise and vibration isolation, especially when equipment is mounted above grade. Consideration must also be given to locating equipment away from quiet areas and classrooms.
 - i. Provide sufficient isolation zone valves and unions to allow parts of the domestic water or hydronic heating/cooling system to be serviced without disabling other parts of the system. This shall include each piece of equipment, such as pumps, unit heaters, radiation units, coils, heat exchangers, etc. Valves and valve locations should be identified in plan schematics rather than just referred to in specifications.
 - j. No system shall have control voltage exceeding 120 volts (24 volt preferred).
 - k. Indirect evaporative coolers used with air handling units shall have access doors for pad removal as large as the pads which are to be serviced. Water tank, pad rack, or any area downstream from pads shall be of a rust-resistant metal such as galvanized, stainless, etc. Consideration should be given to electrostatic type powder coatings. Indirect evaporative cooler systems must be specified with water treatment and treatment monitoring systems to prevent water and air quality problems.
 - l. No actuator valves are to be installed in tunnel spaces that serve univents, fan coils, fin tube, ect. This includes isolation valves. Keep them above the floor for ease of maintenance.
 - m. All new and replacement boiler plants are to include 30% Glycol.
4. Zoning. The heating and A/C systems shall be zoned according to direction and severity of exposure and occupancy and use of space. In addition, the following areas shall have individual air handling control:

- a. Individual classrooms (VAV)
- b. Office and combined office/conference areas (VAV, DX)
- c. Media Center (VAV)
- d. Entries
- e. Cafeteria (VAV, Co2)
- f. Auditorium (Co2)
- g. Gymnasium (Co2)
- h. P.E. Locker Rooms
- i. Large Music areas (Co2)
- j. IT closets
- k. Computer Labs
- l. Large electrical rooms
- m. Other areas subject to special uses and occupancy

I. CHEMICAL WATER TREATMENT

1. Provide chemical water treatment for:
 - a. Hot water heating systems
 - b. Chilled water systems
 - c. Condenser water systems (cooling towers)
 - d. Steam systems (only when existing systems are modified)
2. Owner performs chemical treatment maintenance. Contact Owner's Treatment Provider for specification requirements.
3. Glycol concentration: 30%. Use propylene glycol only. Consult with Assistant Mechanical Engineer regarding alternatives for ethylene glycol before use.

J. HEAT GENERATION

1. Heating Piping.
 - a. Black steel with cast iron screwed fittings for 2" and under, black steel with welded fittings above 2". Weld-O-Lets and Thread-O-Lets may be used for take offs, mitered tees not allowed. Type "L" copper with 95/5 solder joints may be used between sections of fin tube and may be allowed as a Contractor's option for piping less than 2". If dielectric unions are used only brass or brass by copper are acceptable. If they are used, provide isolation valves on each side of union. Steam condensate lines shall be schedule 80 welded black steel.
 - b. Piping shall not be installed under slabs unless in an accessible trench.
 - c. Piping shall not be installed in exterior walls.
 - d. Piping above ceilings shall be on the room side of the building insulation and shall not be installed adjacent to exterior walls or in soffit without special precautions against freezing.
 - e. Radiant slabs shall not be used without special permission, and shall not be used in structural floors.
 - f. Provide for drains, isolation valves, air vents, etc., as required for maintenance of system. Use manual air vents unless automatic vents are absolutely necessary.
 - g. All equipment; pumps, coils, sections of radiation, etc., shall be provided with shut-off valves.
 - h. Provide auto flow valves for system balancing and balancing valves in fixed-flow systems. Where practical, provide Venturi flow meters, etc. for flow measurement in main lines and distribution zones of building.

- i. Valves shall be provided for main heating lines from Boiler Room into quadrants, or some reasonable division, to permit partial draining of boiler water, for repairs, without the necessity for replacing all the boiler water treatment and/or glycol. Allow for piping expansion and contraction without stressing pipe, joints, or connected equipment. Mechanical expansion compensation devices shall not be used without District approval. Use bottom take-offs for branch piping wherever possible to avoid trapping air. Maximum velocity 5 feet per second.
- j. Zone valves shall be Belimo, Invensys, or Approved Equal.
- k. Automatic shut-off valves on gas trains to boilers shall be Honeywell or ITT.
- l. All piping components shall be stored in protected areas where dirt and debris is prevented from contaminating the pipes. Keep coils wrapped and sealed until installed in place to prevent contamination.

2. Boiler Plants.

- a. Boiler rooms should be on the ground floor with direct access to outdoor vehicle traffic areas for equipment access and maintenance. Doors to boiler rooms shall be wide enough to allow for replacement of equipment without disassembly or demolition. Space above boiler room shall not be used for human occupancy. If boilers are to be mounted on structural floors special consideration must be given to the weight of the boilers and structural support in access path to the outdoors for servicing and replacement of boilers in the future. Boilers shall be installed on concrete pads.
- b. Controls should be provided for automatic shutdown of boiler when outside air temperature warrants, and should be integrated into the DDC control system.
- c. Allow space in the boiler room for make-up water chemical treatment. Top of chemical post feeders shall not be more than 36" A.F.F. Include bypass chemical feeder and reduced pressure backflow prevention in contract. Backflow preventers shall be no more than 5 feet above floor level. Specify initial testing and certification of backflow preventers to be included in contract. A resilient seat spring-loaded check valve shall be installed directly ahead of backflow preventer. Pressure reducing valves for makeup systems to be located downstream of backflow preventers. Glycol feeders shall be included for monitoring on the Building Automation System.
- d. Boiler types:
 - i. All boilers shall have automatic flue dampers where Code permits.
 - ii. Condensing Boilers are required for new construction projects.

Approved boilers include:

<u>Non Condensing</u>	<u>Condensing</u>
a. Weil-McLain 88 series	a. Lochinvar Crest, Armor, Knight
b. Smith 28 or 19 Series	b. Viesman

Approved Burners include

- a: Reillo with Siemens controls and Massimo Multi-burner control system or equal.
- iii. Induced draft fans shall not be used unless otherwise approved by Districts' Assistant Mechanical Engineer.
- iv. Do not use small package water tube boilers unless approval is received in writing. Coordinate with Districts' Assistant Mechanical Engineer.

- e. All boilers shall meet ASME Code requirements and shall have AGA approval where applicable. All installations shall comply with the State Boiler Code.
- f. Boiler Startup. Boiler startup shall be by Manufacturer's Representative, and shall be scheduled with, coordinated with and witnessed by the Owner.
- g. Glycol testing levels, chemical tests, and boiler startup reports shall be presented to the Owner as a part of the O&M documentation.
- h. Boiler Controls:
 - i. Up to 400,000 BTUH sea level input rating shall have UL approved control system. 400,000 to 1,500,000 BTUH sea level input rating shall have FM approved controls. Over 1,500,000 BTUH sea level input rating shall have FIA approved controls, intermittent auto pilots, and electronic flame supervision.
 - ii. All boilers shall have high temperature (or pressure) and low water cutoffs with DDC and local alarm indicating lights and manual reset.
 - iii. All boilers shall provide a DDC interface for temperature reset.
- i. Boiler trim for water boilers shall include manual reset low water cutoff, manual reset high temperature limit, pressure gauge, thermometer, separate operating aqua stat, pre-wired control panel, and ASME relief valves.
- j. Steam boilers are not permitted unless specifically permitted as a replacement for existing systems by the District's Assistant Mechanical Engineer.
- k. Pipe gas vents outdoors, not to burner.
- l. Automatic shut-off valves on gas trains to boilers shall be Honeywell or ITT.
- m. Provide operating instructions on control panel.
- n. Provide blowdown on low water cutoff (and water column).
- o. Fuel: Natural gas
- p. Combustion air shall be provided as required by the IMC. Combustion air openings shall be provided with automatic dampers that open when boiler fires. A boiler circuit proving switch shall be wired in, to prove damper is open before allowing boiler to fire, per IMC. Mechanical or plumbing equipment that could freeze shall not be located near the outside air intakes.
- q. Provide boiler room ventilation for temperature control. Do not use exhaust fans, supply fans may be used. Avoid freeze conditions including location of piping near ventilation openings.
- r. Boilers shall be rated for altitude of facility where they will be installed. Typically, multiple boilers shall be provided. Consult with District's Assistant Mechanical Engineer to determine whether multiple boilers shall be required.
- s. Size total boiler plant gross capacity at 150% of heating load at minus 5 F plus 20% pickup factor. Provide load calculations on mechanical equipment schedules. Multiple boilers are required for redundancy. Suggested loads are 50%, for each boiler. Three boilers is the preferred standard for redundancy, where space allows.
- t. Provide boilers rated for up to 50lb working pressure.
- u. Provide thermometer on return piping directly before boiler.
- v. Reference boiler reset controls section in specifications.

3. Pumps.

- a. Use lead-standby parallel pumping on all main pump circuits. Provide standby pump with one automatic change over. Provide DDC alarm on standby pumps.
- b. Pumps shall be Energy-Star rated high efficiency pumps.
- c. Approved Manufacturer's include:

- i. Grundfos/Paco
 - ii. Taco
 - iii. Approved Equal
 - d. Pumps shall be located to pump away from boiler. Provide primary pumps as required by the manufacturer.
 - e. Provide strainers and check valves in pump discharge.
 - f. Mechanical seal pumps will be normally used. Grundfos is preferred.
 - g. Call for gauges at intake and discharge of each pump, with isolation valves.
 - h. Utilize primary/secondary pumping where appropriate for flexibility and efficiency of operation.
 - i. Provide two heating water pumps each at 100% with automatic lead/lag sequencing.
 - j. Prefer variable-speed pumps for energy use optimization.
 - k. Pumps with integrated VFD'S are not permitted.
4. Equipment Room Miscellaneous Items.
- a. Use ASME rated expansion tanks with diaphragm rated for glycol service.
 - b. Use ASME rated relief and safety valves, to be sized to Insurance Company requirements.
 - c. Provide adequate space for accessibility to tanks and for tank replacement.

K. REFRIGERATION

1. Mechanical Cooling.

- a. Mechanical cooling shall be provided for all new construction projects and shall be provided as requested for renovation, addition, or upgrade projects. The general system shall be similar to requirements of Heating and Ventilating systems.
- b. Systems shall be designed so that no refrigeration is required when outside temperature is below 55 degrees.
- c. Systems shall not be capable of simultaneous heating and cooling per the IECC. Heating-cooling changeover shall be automatic.
- d. Routine maintenance is a primary factor in system choice up to 50 tons; e.g., air cooled condensers. Operating costs are a primary factor in system choice over 100 tons, e.g., water cooled central chillers. Mechanical consultants should perform a comparative costs and benefits analysis of this, and discuss with Owner before selecting system. On water cooled systems, consider indoor sump for cooling tower freeze protection. On water systems, consider flat plate heat exchangers.
- e. Computer labs shall be mechanically cooled. Separate or split cooling systems are preferred for computer spaces.
- f. Administrative offices and media center areas shall be mechanically cooled, and shall have separate air handling systems.
- g. Cooling towers are preferred to provide "free cooling" when chillers are in use. Sub-meter water supply to cooling towers via BAS for separation from wastewater charges.

L. AIR DISTRIBUTION

1. Ventilation.

All occupied spaces within the building shall be provided with exhaust fans whenever any space requires exhaust air only, the make-up air should be provided from other areas of the building. Provide access for maintenance and replacement of all ventilation equipment.

- a. The air systems, supply, return, and exhaust shall be designed and balanced so that the building will have a slight positive pressure at all times.
 - b. Ventilation requirements should conform to the approved IMC, ASHRAE Standard 62, and Colorado Revised Statutes. Those requirements will be considered as minimum. Consideration should be given in special areas to increasing ventilation requirements, e.g.: science rooms, computer labs, art rooms, copy centers, welding shops, locker rooms.
 - c. The fresh-air requirement may be reduced to minimum code requirements when operating on the mechanical cooling cycle.
 - d. Carbon dioxide sensors are preferred to monitor for fresh air, maintaining an indoor Carbon Dioxide level no greater than 700 ppm greater than outdoor air for gymnasiums, cafeterias, and auditoriums.
 - e. Use prudent design precautions to prevent placing outside air intakes in areas that will not provide fresh outside air, e.g., bus loading areas, kitchen exhaust, etc.
 - f. Kitchen shall be exhausted by a kitchen hood. The kitchen ventilation system must comply with the requirements of IMC. Direct-fire hoods are not permitted in kitchen areas.
 - g. Air exhausted from toilet rooms, kitchens, teachers work areas, rest rooms, copy rooms, shower rooms, locker rooms, and science laboratories shall not be recirculated at any time to other areas.
 - h. All fans shall be mounted with vibration isolation. Flexible connectors shall be included between all fans and connecting ductwork, if required.
 - i. In areas where noise must be kept at a minimum, such as classrooms, offices, and most other occupied areas, exhaust fans shall be sound attenuated. Sound is a consideration in selection of backdraft dampers.
 - j. Provide dust collecting systems for shops in school buildings. Verify requirements with Owner. Recirculating systems are preferred.
 - k. All heating and ventilating equipment requiring filters shall be furnished with throw-away 2" pleated type. Contractor shall provide and install temporary filters as needed for testing and operation of equipment during construction. Upon project completion, Contractor shall provide and install new filters in all equipment and shall further provide one additional complete set of replacement filters for Owner's use upon completion of project.
 - l. Exhaust hoods for kitchen and shop areas shall have air volumes (CFM determined by the capture velocities) as recommended by ASHRAE.
 - m. Copy rooms should have separate exhaust zones.
 - n. Provide slightly negative ventilation system for automotive shops, as compared with adjacent areas. Engine exhaust system should be considered.
 - o. Provide slightly negative ventilation for finishing room of wood, metallurgy and plastic shops as compared with adjacent areas.
 - p. Provide for filters as required for shop equipment.
 - q. Provide for two 1-inch flex hose connections, direct to exterior, for gasoline engine exhaust in middle school technical arts shop.
 - r. Investigate requirements for special exhaust systems.
 - s. Provide for natural cooling and ventilation of kitchen dry storage room. Normal heat requirements of these rooms are low. Do not locate heat sources such as refrigeration compressors in these rooms.
 - t. When possible direct drive exhaust fans are preferred
2. Ductwork.

- a. Sheet metal ductwork shall be fabricated and installed in accordance with the recommendations of the latest ASHRAE guide and SMACNA Manuals. Provide insulation of ductwork to reduce heat loss.
- b. Do not call for or permit non-metallic duct, under any circumstances. Boots may be used on return grilles.
- c. Adequately sized access doors shall be provided in all air handling units and ducts for coil and filter removal, motor and fan lubrication, etc. Access doors shall be provided in the ductwork of sufficient size to service fire dampers, filters, etc. Provide access doors at both upstream and downstream side of each heating or A/C coil.
- d. Where ducts pass through walls or partitions, the openings shall clear the metal of the duct by 1". Provide for support sleeves through masonry floors, walls, and ceilings. Where walls or floors are fire and/or smoke rated provide fire rating of penetration where it is necessary to make a change in the elevation of a duct, the change should be made as near a 30 angle as possible.
- e. Show locations and sizes of access panels on drawings.
- f. Range hood exhaust ducts shall be welded throughout with approved fire block insulation or 1-hour separation, in accordance with current NFPA standards.
- g. Exposed ductwork on roof is not permitted without Owner's specific approval.
- h. Air ducts in auditorium or other performance areas should be oversized to reduce air volume noise.
- i. Ceiling grid suspension wires may not be secured to ductwork.

3. Ductwork Insulation.

- a. External duct insulation is preferred to duct lining when possible.
- b. Do not call for any internal duct lining of supply ducts for direct evaporative cooling.
- c. For acoustical isolation and sound attenuation, provide sound attenuators specifically designed for the application.
- d. Design and installation consideration shall be given to occupancy areas with special acoustical needs including, but not limited to, band and music rooms, conference rooms, auditoriums, lecture halls, executive offices, air transfer from cafeteria to kitchen, etc. Provide appropriate sound attenuation for these areas.
- e. Avoid locating mechanical equipment directly above or adjacent to designated quiet areas.

4. Air Devices.

- a. Grilles and registers shall not have removable cores unless job conditions warrant their use.
- b. All supply devices shall have foam rubber or plastic gaskets around their outer frames or borders to prevent air leakage.
- c. Supply grilles shall be of the double deflection adjustable blade type. Mesh supply diffusers are not allowed. The supply registers shall also have removable key operated opposed blade volume dampers for flow control.
- d. Exhaust and return grilles and registers shall be of the fixed-blade type. These devices shall be positioned so they cannot be "seen through." The exhaust or return registers shall also have removable key-operated opposed blade volume dampers for flow control.
- e. Provide fire and/or smoke dampers as required by IBC. They shall be U.L. labeled dampers or equal and bear labels of compliance with fire and/or smoke rating.
- f. Provide heavy-duty solid bar grille or register in high activity areas such as gymnasium.
- g. Ceiling diffusers shall be of the adjustable pattern type, with throw-patterns designed in response to space layouts. Provide volume dampers for balancing in all duct systems.
- h. Air extractors and/or distribution grids shall be used where air outlets are mounted direct on the ductwork. Where branch or take-off collars are short, air extractors shall be employed for better distribution across the outlet face.

- i. Call for dampers having springs, pulleys, cables, and motor mounted outside of duct, for servicing, such as Prefco Products. Do not specify dampers requiring dismantling to service.
- j. Use most efficient air distribution layout and devices consistent with building design.
- k. All 90 elbows up to 18" wide and all 45 elbows shall consist of an inside radius of not less than ½ width of the duct or shall be furnished with single blade duct vanes with 2¼" blade spacing.
- l. Ninety degree (90) elbows larger than 8" in either dimension shall be equipped with airfoil type duct vanes having an inside radius of 4½" and an outside radius of 2¼" and shall consist of Tuttle & Bailey Type D, Elgin Manufacturing Corporation vane runners or equal, 2¼" blade spacing.
- m. Shop fabricated duct vanes shall conform to the latest details of the SMACNA Sheet Metal and Air Conditioning Contractor's Manual.
- n. VFD's should be required for supply and return air for all equipment servicing auditoriums or other performance spaces.
- o. Stainless steel or aluminum diffusers are to be used for all pool and locker room spaces.

M. AIR FILTERS

1. Provide all new filters as 2" pleated filters, MERV-8 (or 11 for LEED) at startup.
2. Remove construction filters and replace with new 2" pleated filters BEFORE test and balance contractor performs TAB activities.
3. Provide one (1) full replacement set of filters to Owner upon project completion.
4. Equipment shall not be operated for any reason without filters in place.

N. CONTROLS

1. General.
 - a. The System. The District has an established District-wide Building Automation System installed by Long Building Intelligence (719) 592-9249. All new buildings, additions, upgrades, replacements, and other renovations shall be designed for integration into the District's BAS system. The installed system is "BACNET" standard. New controls systems must be compatible with existing installations. Separate software, gateway devices, drivers or routers are not acceptable.
 - b. The temperature control system shall be an extension of the existing DDC system with Belimo or Schneider Electric actuators. Krueger pneumatic actuators are not permissible.
 - c. Barber Coleman thermostats and low limits are not allowed.
 - d. The system shall be placed into operation and adjusted under operating conditions, being carefully coordinated with other related Subcontractors. See section on "Testing, Adjusting and Balancing."
 - e. Require that the Architect or mechanical consultant deliver a copy of the Temperature Control submittal, including drawings of system layout, connections to central School District system, and detailed sequence of operations, to School District Facilities Department for review and written approval prior to release of approved submittal.
 - f. Pneumatic systems are not permitted for new installations but may be considered for renovation projects subject to review and acceptance by District COTR. All controls shall be DDC.
 - g. Pump and Boiler Controls:
 - i. Boilers shall use factory controls with DDC temperature reset and switch-over control. DDC system shall automatically control building pumps. The heating pump shall restart automatically after a power failure.
 - ii. Boiler pumps are permitted to be controlled by the boiler management system (BMS)

- iii. Rated premium-quality motors are required. VFD's are preferred, and shall be Yasakawa or approved equal.
 - iv. The system supply water temperature shall automatically be varied inversely with changes in outside temperature. The schedule shall be adjustable, and shall be controlled by the existing District DDC system.
 - v. Systems shall be provided with standby pumps that shall have pump controls and circuits arranged for automatic lead-standby selection of pumps, and alarm circuit on standby pump.
-
- h. Unit ventilators shall have ASHRAE II control cycle valve control.
 - i. Heating and ventilating units shall have cycle similar to ASHRAE II unit ventilator cycle. Check for exhaust interlocks in kitchens, shops, science rooms etc.
 - j. Multi-zone and dual duct units shall normally have mixed air and minimum outside air controlled by District DDC system.
 - k. Provide all unit controls based on the specific use of the area. In general, the simplest controls that will perform the intended function are preferred.
 - l. Freeze protection shall be provided for all systems handling outside air. Consider the use of face and bypass control for any systems designed for 100% outdoor air (i.e.: make up air units).
 - m. Outside air dampers shall close any time the fans are off and during warm up of area serviced, per District DDC controls.
 - n. Provide for night time setback heating controlled by District DDC system, with OSA dampers closed at all times units are in night-cycle mode.
 - o. Thermostats – Wall mounted thermostats or DDC sensors shall include adjustable temperature features and override capability (one per zone, mapped for building engineer use and control).
 - p. Controls Zones - DDC: The building will minimally be divided into the following dedicated air handling zones for operation. No listed space is to be served by more than 1 unit unless approved by Owner.
 - i. Auditorium
 - ii. Gymnasium
 - iii. Weight rooms and locker rooms
 - iv. Administration Area
 - v. Designated conference rooms, meeting rooms, or lecture halls
 - vi. Classrooms to be divided into zones as required by building orientation.
 - vii. Media Center
 - viii. Music wings or other specialty academic areas
 - ix. Kitchen
 - x. Cafeteria
-
- q. Exhaust Fans:
 - i. Exhaust fans for group toilets shall be controlled with air handlers on District DDC system. Small exhaust fans for individual toilet rooms may be switched on with the lights.
 - ii. Kitchen exhaust fans shall have local manual start with hard-wire interlock to makeup air unit.
 - iii. Fire Protection: Provide fan shutdown in accordance with latest editions of IBC and NFPA. Where ionization type detectors are used, provide for connection to building fire alarm system or smoke detector in the zone.
 - iv. Relief exhaust fans shall be controlled off building static pressure sensor. Fans shall be OFF during night cycle when outdoor air dampers are closed.

- r. Entry Heaters:
- s. Provide 24-volt line voltage control circuit unless otherwise noted.
- t. Use of electric heaters is discouraged if other cost-effective solutions are available.

2. Controls Clarification(s)

- a. New controls shall be integrated into the Districts existing Tridium N4 Supervisor.
- b. Graphics, Trending, and alarming will be configured to match existing format on the Tridium Supervisor.
- c. All new DDC controllers shall be BACnet and fully programmable. Configurable controllers are not allowed.
- d. Any and all user ID's and Passwords for admin and programing level access to any component or software platform shall be provided to the owner. District controls specialist will provide the standard passwords as needed.
- e. A N4 JACE shall be installed in each building to allow connection to the District's supervisor.
- f. All JACE controllers shall be provided with open an open license.
- g. Open software license requirement: The Niagara Compatibility Statement (NiCS) for all Niagara software shall allow open access and be set as follows: accept.station.in="*" accept.station.out="*" accept.wb.out="*" accept.wb.in="*". Controls contractor shall provide the NiCS as part of the submittal process to insure the owner has full functionality of all software without the reliance on the controls contractor.
- h. All JACEs shall be provided with a one year maintenance license (Tridium part# SMA-8xxx-1YR)
- i. All new controls conduit shall be blue in color to allow for easy identification.

O. TESTING, ADJUSTING, AND BALANCING

1. Testing and Start-Up - General.

- a. Testing of mechanical systems shall be conducted by the Manufacturer and the Contractor in the presence of the Design Consultant(s) and/or the Owner's Representative(s). Contractor shall notify design team and Owner of scheduled start up's at least 72 hours in advance.
- b. Boiler plants and all associated hydronic loops shall be thoroughly flushed to ensure that all construction debris is removed from the system prior to initial operation of the boiler and pumping plant. Flushing shall first be conducted with all terminal valves in a closed position to prevent contamination of coils or other peripheral equipment; then flushed thoroughly with all valves open. Flushing shall continue until little debris is detected at the lowest flush point. Follow Manufacturers specifications for initial fill and operation of the boiler plant.
- c. Fill and vent the heating system, add trisodium-chloride boiler cleaning compound and operate system at maximum design conditions (200 degree Fahrenheit minimum) with pump running, valves open, and with heating unit fans "off" for a period of 24 hours prior to hydrostatic testing. Pump screens must be in place at startup to divert and capture any remaining construction debris from the system. After system has been completely flushed with fresh water, replace start up screens with standard strainers.
- d. Fill and vent the chilled water system with clean tap water. Operate system at maximum design conditions with pumps running and valves open for a period of 24 hours prior to hydrostatic testing. Pump screens must be in place to divert and capture any remaining construction debris from the system. Drain and fill with glycol mixture.
- e. Pneumatic control system shall be tested under 50 psi air pressure for 24 consecutive hours during which time the pressure drop shall not exceed 5 psi.

- f. Provide for such items as thermometer wells, pressure test cocks, flow meters, access doors, etc., as required to allow tests, adjustments, and balancing to take place.
- g. All heating system piping (except compressed air for pneumatic control system) will be tested hydrostatically to 125 psi for at least six consecutive hours during which time the pressure shall remain constant without pumping. Any system components or equipment which cannot withstand test pressure shall be isolated or removed from the system. Welded piping shall be subjected to a "hammer test" and "soap suds" test while under pressure.
- h. Test and adjust boiler burner controls.
- i. Drain system completely; flush and refill, adding specified boiler water treatment.
- j. Provide Factory boiler field combustion tests for maximum and firing rates which include the following information:
 - i. Stack temperature
 - ii. Gas pressure and gas cubic feet per hour
 - iii. Percent CO₂ and CO
 - iv. Presence of CO in flue gas or high stack temperature will require corrective action by the Contractor
 - v. Thermal efficiency

2. Testing and Balancing Certification Reports

Testing, adjusting, and balancing of new mechanical systems, upgraded systems, or replacement systems shall be provided by a third-party independent agency as approved by Owner. Qualified TAB firms include:

- a. Griffith Engineering Services (303) 688-5054
- b. JPG Engineering (303) 688-9044
- c. Jedi Balancing (720) 839-5333
- d. Midwest of Colorado Springs (719) 599-0168
- e. Other pre-approved District Contractor

Test and Balance Contractor shall coordinate with Design Team, Owner's Representatives, Contractor, and Commissioning Agent as applicable and shall be required to provide a certified TAB report specific to the specified and installed mechanical system upon completion of system installation but not later than 45 calendar days following completion of a project unless otherwise approved.

P. CONTRACT CLOSEOUT REQUIREMENTS

Refer to Division One (1) of the D-11 Design and Construction Standards and to the project-specific Request for Proposal (RFP) or other form of Contract Solicitation issued by CSSD #11 for specific requirements for preparation and provision of Operation and Maintenance Manuals, Project Record Documents, Warranties, and other required contract closeout documentation.

<<<<END OF DIVISION 15>>>>