MARICOPA COMMUNITY COLLEGES®

CAPITAL DEVELOPMENT PROJECTS MANUAL

Part IV:
MECHANICAL, PLUMBING AND ELECTRICAL SPECIFICATIONS AND OPERATIONS GUIDELINES

Revised to issue as separate MP&E 4/10

01800 *(01 75 00)* **Commissioning Guidelines**

A. General

A.1. Introduction. This section may not apply to some projects, so the Design Consultant must verify the applicability and scope of the procedures and services outlined herein.

A.2. Definition. Commissioning is a systematic process of assuring that building systems perform in accordance with the design intent and the owner's operational needs. It is a designed process of documentation, training, adjustment, testing and verification, performed specifically to ensure that the facility operates as intended, and which occurs during design, construction and through the first year of operation.

A.3. Goals and Objectives. There are six major goals to be achieved by the commissioning process. They can be summarized as follows:

A.3.1. To provide safe and healthy facilities by minimizing building systems deficiencies relative to air quality and environmental comfort.

A.3.2. To improve energy efficiency by improving systems performance.

A.3.3. To reduce operating and maintenance costs by fine tuning and increasing the life of building systems.

A.3.4. To facilitate the preparation and training of the operations and maintenance staff by developing participatory and collaborative testing and operational development processes.

A.3.5. To improve the systems technical documentation relative to operation, maintenance, troubleshooting and renovation(s) of facilities.

A.3.6. To aid in meeting the facility users' needs by developing a facility that operates as it was intended.

A.4. Single-Party Commissioning. The type of commissioning services to be retained by the College will be the single-party commissioning approach, where a commissioning team, as defined in D.2, is assigned to perform various commissioning functions as detailed in D.2. Single-party commissioning adds a new process to the traditional Owner-Design Consultant-Contractor team, but it does not require significant changes in the functions of the traditional team members.

B. Process

B.1. Commissioning is a designed process. It differs from traditional Construction Administration services offered by most Design Consultants and/or consulting engineers. It is a preplanned series of activities designed to meet specific goals. It is not a thorough punch list or solutions to problems that arise during start-up or balancing procedures. It is an all-encompassing series of activities developed to avoid conflicts and verify intended performances in a proactive way.

B.2. Documentation is critical to this process, since it makes its results available to future operators and designers seeking to modify or renovate the facility. Obviously, effective staff training is essential to the success of the process.

B.3. Commissioned systems must be adjusted to suit the actual operating conditions. Set points and other design parameters may need to be adjusted to fit occupancy conditions which differ

from those envisioned during design. In all cases, the most significant tool is the proper development and execution of testing procedures.

B. Testing

C.1. Stages. There are four basic stages of testing which provide an objective demonstration of the proper operation of the components and systems in a facility:

- Static Testing.
- Component (point-to-point) Testing.
- System Functional Performance Testing.
- Intersystem Functional Performance Testing.

Completion of the first two stages is sometimes called pre-functional performance testing. It is the phase that ensures that system and intersystem performance testing can proceed without undue interruption.

Static testing verifies the strength and integrity of installed materials and equipment. Component testing verifies that each component functions as it is intended. System functional testing verifies that each system produces the required effect in accordance with its design capacity and sequence of operation. Finally, intersystem testing verifies that the whole facility functions in accordance with the design intent and the users' needs.

D. Responsibilities

D.1. Responsibilities of the Design Consultant. It is the responsibility of the Design Consultant and his design engineers to develop the necessary tests and testing procedures to be followed during the Commissioning process. These tests must be designed in accordance with the stages stipulated in C.1. above and must include the expected and/or acceptable test result(s) parameters. These parameters must contemplate year-round conditions and full building occupancy implications.

D.2. Commissioning Team Structure and Responsibilities. The Commissioning Team shall be structured as follows:

- Representative(s) of the Design Consultant's firm.
- Representative(s) of the pertinent design/consulting engineers' firm(s).
- The District's Facilities Planning and Development Project Manager.
- The College's Facilities Manager.
- The College's Operations and Maintenance pertinent system(s) supervisor(s).
- Other specialized consultant(s) as may be required.

The design/consulting engineers and the College's Operations and Maintenance supervisors may vary from systems to system as required, but the representative from the Design Consultant, the PM and the Facilities Manager shall remain constant throughout the process.

The following items constitute the basic responsibilities of the Commissioning Team throughout the design and construction processes:

D.2.1. Provide the necessary documentation and information so that work can be done effectively and expeditiously.

D.2.2. Coordinate all activities with the remainder of the design team, contractor(s), and owner's representatives.

D.2.3. Assess and document the deficiencies, problems and inefficiencies found during testing and inspection.

D.2.4. Generate facility deficiency reports.

D.2.5. Determine the party (ies) responsible for resolution of the deficiency (ies) and follow up with pertinent action to resolve the deficiency (ies).

D.2.6. Produce the Commissioning Manual complete with all appropriate testing procedures, results, adjustments, corrections, modifications and any or all pertinent project and/or systems documentation. The Commissioning Manual shall be coordinated and produced by the Design Consultant's office with input from all other commissioning team members.

E. Scope and Functions of the Commissioning Team per Project Phase

The following constitutes a general breakdown of the commissioning scope and functions of the Commissioning Team relative to each project phase. It is noteworthy that these functions are project specific and must be verified with the PM and the Facilities Manager on a case-by-case basis.

E.1. Programming.

E.1.1. Attend Engineering Criteria meeting(s).

E.1.2. Review Project Program draft for compliance and functional issues.

E.1.3. Study and propose alternatives to programmed systems and components.

E.1.4. Review regulatory surveys reports and their applicability.

E.2. Schematic Design

E.2.1. Participate in any and all design charette sessions concerning selection and definition of building systems.

E.2.2. Review and comment on 100% Schematic Design submittal.

E.3. Design Development

E.3.1. Collaborate with the design team in outlining detailed quality control/testing procedures and desired results for performance verification.

E.3.2. Consult with the design team in the selection and specification of all commissioned building systems.

E.3.3. Review and comment on 100% Design Development submittal.

E.4. Construction Documents

E.4.1. Review proposed testing procedures and required results.

E.4.2. Participate in controls meeting(s).

E.4.3. Review and comment on 50% Construction Documents submittal.

E.4.4. Include provisions in the specifications that allow time for point to point testing.

E.4.5. Review and comment on 100% Construction Documents submittal (Bid Documents) and assist in the preparation of any addenda items that may pertain to the commissioning aspects of the project.

E.5. Construction Award

E.5.1. Verify that the aspects pertaining to the commissioning procedures are addressed and properly covered in the Construction Contract.

E.5.2. Ensure that the Construction Schedule allows for adequate testing and correction of deficiencies.

E.5.3. Ensure that the commissioning functions, testing and inspections are included in the construction schedule and process flow.

E.6. Construction Administration

E.6.1. Inspect the installation of all major systems.

E.6.2. Procure and/or conduct all testing and inspections as developed by the design team for compliance with desired results.

E.6.3. Match the systems' operating parameters to the actual usage conditions.

E.6.4. Verify and document compliance with all engineering/design criteria.

E.6.5. Check the coordination of all integrated systems and confirm their operational integrity.

E.6.6. Assist the General Contractor in the training of Operations and Maintenance staff. Maintenance staff must observe all startup and testing of equipment and systems. Following acceptance of the project, the Operations and Maintenance staff will perform routine maintenance in accordance with the operating manuals with the first scheduled maintenance measured from the date of turnover.

E.6.7. Review "as-built" drawings and request corrections and/or additions.

E.6.8. Review all Operations and Maintenance manuals prior to their distribution during the Project Closeout and ensure compliance with the College's requirements.

E.6.9. Develop a preventive maintenance program for all commissioned building systems.

E.6.10. Recommend and inspect surplus materials quantities, packaging, labeling and delivery.

F. Commissioning Systems Testing and/or Areas of Involvement

The following constitutes a general listing of all possible areas of involvement and or testing which may be incorporated into the commissioning scope. Note that most projects will not require all areas listed below to be included within the commissioning responsibilities. The subjects which are applicable to specific jobs must be verified on a case-by-case basis.

F.1. Department-Specific Systems.
(To be defined on a project-by-project or case-by-case basis).

F.2. Site/Utilities

F.2.1. Steam.

F.2.2. High-voltage electric service.

F.2.3. Domestic/Reclaimed water.

F.2.4. Chilled water.

F.2.5. Natural gas.

F.2.6. Compressed air.

F.2.7. Telephone, Fiber Optics and Data services.

F.3. Architectural/General Building Systems.

F.4. Structural items

F.5. Vertical Transportation

F.6. Plumbing

F.6.1. Piping.

F.6.2. Valves.

F.6.3. Pumps.

F.6.4. Fixtures.

F.7. HVAC

F.7.1. Motors and pumps

F.7.2. Water heaters and Boilers.

F.7.3. Cooling towers.

F.7.4. Cooling package and fan coil units.

F.7.5. Condensate drains.

F.7.6. Filters.

F.7.7. Convenience outlets and safety controls.

F.7.8. Evaporative cooling units.

F.7.9. Ductwork.

F.8. Electrical

F.8.1. Conduits

F.8.2. Wiring and circuitry.

F.8.3. Power generation.

F.8.4. Electric service and distribution.

F.8.5. Interior, exterior and emergency lighting.

F.8.6. Fire Alarm system.

F.8.7. Security system.

F.8.8. Telecommunication and television systems.

F.9. Controls and EMS.

G. Jobsite Services

In projects where a jobsite Commissioning Team representative is required, the Design Consultant's specifications must require the following services to be made available to the Commissioning Team representative:

- Intermittent access to telephone services (for local calls only).
- Intermittent access to facsimile (FAX) machine for (local faxes only).
- Intermittent use of desk and secure desk storage space.
- Access to sanitary facilities.
- Use of on-site duplicating equipment.

In addition, the Project Specifications shall indicate that the General Contractor and any Subcontractors shall provide the Commissioning Team with names, telephone number(s) and addresses of all Sub-subcontractors, product and materials manufacturers and distributors and any other specialized trades as may be requested by the Commissioning Team.

DIVISION 15- MECHANICAL and PLUMBING

All designs shall incorporate the energy conservation standards required by A.R.S. Section 34-451 will comply with all requirements of ASHRAE/IESNA 90.1-2004 Energy Standards, including all issued amendments and updates.

1. All buried gas lines and all other underground utilities except copper pipe, shall have a separate copper tracer wire and non-metallic warning tape installed above the utility line. The tracer wire shall be traced for continuity prior to backfill, immediately upon completion of backfill and compaction and once again during final utility location/as-built at the end of the project. This also will include landscape irrigation mains to the points of the valves.

Where connecting to existing chilled water lines and/or valves, the contractor must do a field verification of supply or return. **Do not** depend on as-built information, MCCCD personnel, or existing designations that may be found.

When any new chilled water pipe or air handling equipment is installed, provide strainers at the supply side, prior to entering any equipment (valves, devices, coils, etc.). Demonstrate that the strainer basket can be removed and cleaned during walk through. See water flush requirements for the start up and final sieve size.

No victaulic coupling systems will be allowed, the only exception is mechanical equipment that is outfitted from the factory with this type of coupling system. All pressurized water lines shall be

screw or welded pipe joints. Where unions or flanges are indicated, only flanges shall be allowed. Flanges shall be provided with complete flange insulation kits.
Gas lines running through occupied areas or plenum areas shall be soldered joints.

Chilled water piping shall only be of the welded type. The only locations grooved connections shall be allowed is at AHU coils and/or chiller end bells. Long radius elbows shall be used in all chilled water and hot water piping cases. If short/standard radius elbows need to be substituted, both engineer and owner shall be notified in writing and both parties must sign off where exceptions are to be allowed. This includes changes made by engineer as well.

Piping as it relates to chiller servicing, shall be installed in such a manner for ease of access to end sections for chiller end barrel servicing.

Access to mechanical equipment

1. Access to all mechanical equipment shall be free and clear of permanent obstructions, and shall comply with all applicable codes.
2. Minimum clearances around equipment shall be denoted with dashed lines on the floor plans. Final floor plans reviews must take place by the engineer after equipment submittals have been received. For items such as chillers, VAV boxes, AHUs, if final footprint deviation is desired by the mechanical contractor, the engineer of record shall inform the owner in writing, prior to final equipment footprint acceptance. Shop drawings shall be submitted for approval by MCCCD and Engineer prior to start of equipment installation. Mechanical shop drawings shall be reviewed by electrical engineer and electrical contractor prior to rough-in (in an effort to solve conflicts, and make for a better installation). For retrofit work, when equipment is being submitted as a substitute, it shall be the responsibility of the contractor to submit scaled shop drawings indicating dimensional equipment, air, power, and water (chilled, hot, and condensate drain) point of connections. In the case of right hand or left hand electric reheat and controls access configurations on VAV boxes, this option must be coordinated upfront and confirmed by the engineer.

Coil selection criteria size/design guidelines:

In order to increase the efficiency of the central plant and allow extended operation of the plate and frame heat exchanger during the winter months, we request that all consulting/design engineers select air handling unit (AHU) cooling coils for a 52 deg F chilled water supply temperature. With the 52 deg F chilled water supply, we are expecting the airside of the AHU to provide the CFM required at 59 deg F supply air. If the AHU is constant volume, the fan shall be selected to deliver the increased CFM.

Also, AHUs will be supplied during the cooling season (when plant and frame heat exchanger is not operating) with chilled water at 45 deg F. This allows the cooling coils to be sized somewhat larger and to operate a longer period of time on the plate and frame heat exchanger.

In addition, to reduce the impact of expansion in the present chilled water piping distribution system, we recommend all coils to be selected for a minimum of 14 deg F temperature rise. Selected coils must be checked at partial load conditions to assure stable operation.

Chilled Water Line Flush & Pretreatment procedures

The following procedure should be used in conjunction with the piping flushing procedure provided by the mechanical contractor. Typically, the mechanical contractor's procedure does not detail the different system flushing/pretreatment/sterilization/treatment steps with enough detail. **Other concerns are that within 1-3 days of the pressure testing the initial steps of**

flushing should be completed and, once approved by MCCCD District personnel, the system be opened (by campus) to the central utility to prevent fouling of campus with stagnant water.

Chemical samples will be run prior to system certification. Specifically, a microbiological analysis of the chilled loop and mineral/metals analysis of the open & chilled loop will be completed.

Flush valves (return and supply) shall be sized for meeting, and strategically placed to meet, the requirements of adequate flushing and cleaning both building service pipes and coil branch pipes.

Minimum Flushing, Cleaning and water treatment procedures for chilled water closed loop systems by MCCCD. If the consultant has a more stringent procedure, that procedure shall apply with approval MCCCD.

(The following processes are based on strategically installed devices (i.e. flush valves, recirculation/crossover connections, recirculation barrel, recirculation pump, separate fresh water source, etc.) allowing for the procedure to be followed and expected results to be achieved.)

Directly following the successful pressure testing of new pipes

Flushing:
Provide all equipment (temporary and permanent) as necessary to:

1.) Flush building service pipes and coil branch pipes:
- Flushing may be feed and bleed or fill and drain until the system pH is no greater than 0.5 units above city. Example, city pH 7.5, final flush pH 8.0 or less.

2.) Once flushing has been completed, remove the Rock wool/startup strainer element from the strainer, replace with operating strainer element.

Cleaning:
It takes minimum of 48 hours (and possibly 72 hours or more if substantial fouling exists) of water circulation to clean piping. The alkaline polymer cleaner shall be added, over time, until M Alkalinity equals 3000 ppm or greater monitored at the drain or recirculation barrel.

The system cleaning and treatment is complete when the water is clear, and treated to a minimum 200-ppm Nitrite (as NO2), and 20 ppm Molybdenum (as Mo). Starting and ending sample test data shall be recorded, signed by testing agent and included in startup documentation. At this time the district will unlock and open the chilled water main isolation valves and the system shall be considered turned over to the District, this level of treatment is desired and the system should be sterile.

When higher pH levels are indicated; iron, oil, and grease are generally occurring at higher levels as well. This hasn't been a condition of the water supplied to the valley as of yet, but these changes may occur at anytime without warning. All necessary cleaning is inclusive to the contract.

Flushing pump must have capability to meet flow demands to adequately flush new system piping.

If condenser supply and returns are to be cleaned, a tower bypass must be installed. Justification; Cleaning will damage galvanized surfaces and discolor stainless steel red.

Recirculation/Bypass line/cleaning loop connection sizing shall be adequate to manage 20-25% of loop flow (generally sized at no smaller than ½ the service line size)?

Systems Acceptance to Campus Hydronic System

Only after a successful pressure test and the Plant operator/MCCCD District personnel have approved and accepted the test results will the system valves connecting the building to the central utility be unlocked and opened (by campus personnel). However, this does not grant contractor use of chilled water for temporary cooling during construction. De-lamination of countertop material and/or wood veneers are most often due to poor installation or material rather than temperatures. Should it be necessary to obtain specific indoor temperatures during construction, the contractor is to provide written justification and specification for such conditioned air and also provide material data sheets that substantiate these requirements before conditioned air shall be provided by campus utility.

AHU

- Coil piping best practices, device placement per manufacturers' requirements.
- Coil piping device installation constraints (i.e. P/T (Pressure/Temperature) fittings, Strainers, temperature control valves, flow control valves, full port ball valves, etc.). Straight pipe diameters upstream and downstream of device applies to flow control valves, and temperature control valves (must refer to manufacturer's installation guides). Strainer servicing access and Strainer accessories specific sizes, flange removal, element removal. Installation of probes associated with P/T fittings. Location/Placement of P/T fittings shall be such to be placed equal distances on both sides of device (coil, strainer, or control valve). Placement of P/T fittings shall be inline and not at the end of a 'TEE'. If pipe diameter is too small to accommodate the probe properly then an extension 'neck' shall be added to the fitting. Extensions stems shall be added to ball valve handles to appropriately insulate the surrounding valve and piping.
- Piping configuration ensuring equal pressurization (equal water delivery) to stacked coils.
- Piping of all condensate drains to a distilled water reservoir (if water conservation is desired for local source of water, requires additional discussion.)
- Filter Door(s), Servicing Door(s) and coil pull access shall be scaled and provided and detailed on construction drawings.
- Condensate drain piping coordinated with dropped floor drains.
- Coil pull direction needs to be denoted on plans, ensure unit has capability for coil pull.

Pump installation and alignment

Ensure specifications addresses alignment checks and procedures (must refer to manufacturer's installation and alignment guides (both angular and parallel). Initial alignment takes place after horizontal and vertical leveling, alignment re-check after grout has set, and after motor rotation verification, couple the motor to the pump, but before starting it is extremely important to check the coupling and shaft alignment (motor and pump shafts)), visual attest by customer/engineer, and that a signed alignment report, by alignment technician and site representative, becomes part of the record documents recording alignment tolerances.

Pump/motor coupling alignment shall be performed with a calibrated dial indicator or calibrated laser alignment tool, in the presence of campus HVAC personnel. An alignment report shall be provided to the campus HVAC personnel. The report shall include T.I.R. (Total Indicator Runout) readings. Final alignment shall be within the tolerances allowed, based on the coupling and, by the coupling manufacturer.

General Notes:

Mains pipes (Serve entire campus)
Building Service pipes (Serve individual buildings)
Coil branch pipes (Serve Coil(s) at each AHU)

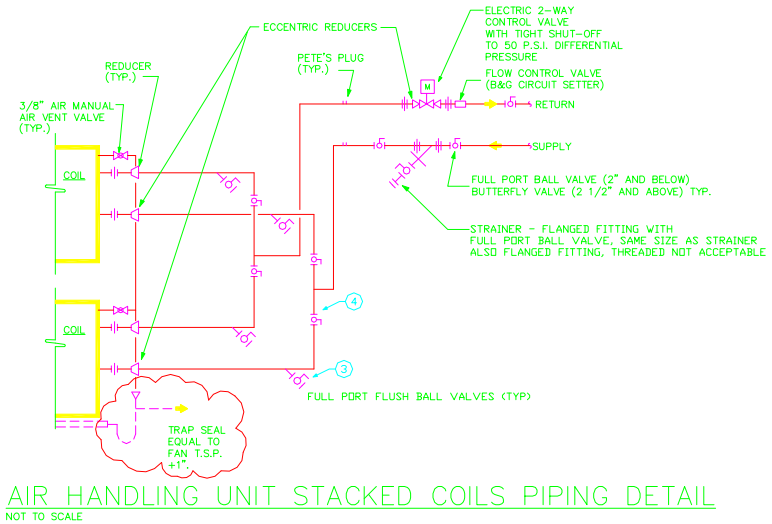
Prime and paint the condenser water piping, cooling tower structural steel, and other exposed metals to ensure long life and a neater appearance. Consider color-coding the lines, especially on complex piping systems.

Where piping serves multiple towers, arrange the piping so that supply and return connections to each cell and each connection point are symmetrical and, thus, self-balancing.

For multi-cell towers, include isolation valves in the equalization connections between cells, in addition to the supply and return lines, so that individual cells can be taken out of service for cleaning without shutting down the entire system. Strainers for tower sump shall be serviceable without affecting the operation of any other tower or central plant equipment.

MCCCD will require SCR control on all electric heat unless prior approval through FP&D. MCCCD, with FP&D approval, may allow staged heat on smaller units but will be limited to 3kw per stage, 3 stages maximum (9kw total).

Air Handling Unit Stacked Coils Piping Detail – FOR REFERENCE ONLY



The following information applies only to equipment associated with AHU coils

1. For stacked coil applications install chilled water piping in such a manner to provide equal pressure drops to all coils per Unit. Pay special attention to piping configuration.

2. All elbows shall be long radius. (reduced system pressure drops)

3. At the coil side of long radius Elbows (prior to coil connections) add 'Y's' with 'full port ball valve size at ½ line size of coil service lines' labeled on detail as 'full port flush ball valves'. (Uses: initial coil flushing and future means to back flush individual coils, lower for coil draining purposes.)

4. Each individual coil shall have full port isolation valves (2 each coil) on the house side of the flush valve 'Y's'. (isolation per coil)

5. All 'Y' strainers shall be flanged type (or outfitted with flanges). 'Y' strainer 'Service Flange' threaded opening shall be same size as 'service lines tied to inlet and outlet of strainer'. Outfit Service flange with 'service line full sized connecting nipple' between flange and full port service ball valve (diameter reduction shall not be allowed here). Connecting nipple shall be long enough to allow for proper insulating method. Valve stem shall be outfitted with extension section to handle, to allow for proper insulating method. Install insulation to allow for element servicing, without need for insulation repair. In cases where a single strainer is installed serving multiple AHUs drawings may indicate a single Strainer with line piped to drain. In these instances, continue the drain line full size to the drain. In cases where the strainer service ball valve is not required to be piped to a drain, finish the Outlet side of service ball valve with reduced pipe size down stream of ball valve to ¾" hose-end connector with cap. ('Y' strainer detail)

6. Ensure that the Full port ball valve shown down stream of strainer is installed directly after the strainer.(Clouded) (Plumber recommended for flushing.)

7. PETE's plugs belong on 'both' sides of strainer (2), and 'both' sides of control valve(2), and at equal distances from both sides of both coils(4). All Pressure and temperature fittings shall be installed 'in-line' of pipe. Symmetrical locations shall be selected to provide uniform pressure drop readings (representative of equal pressure drops on both sides of the coil). Pressure and Temperature fittings installed in 2" and smaller lines shall utilize an extension neck, to accommodate probe installation. Where it is necessary to accommodate access for free and clear installation of probes, pressure measuring stems, thermometers, etc., lines (i.e. CHWS, CHWR, HWS and HWR, etc.) shall be installed in an offset manner, installation shall provide easy access and clearance to the probe ports, for pressure stem and temperature stem insertion. (PETE's plug placement)

8. Install temperature control valve with flanges on both sides of actuator and valve assembly(on the outside of reducers and expanders, pipe is at full size), across strainer, and at coil P.O.C.'s. Flanges shall be placed to the outside of both the reducers and expanders, where pipe is full size. Reducers/expanders shall be installed directly adjacent to the entering and leaving sides of the temperature control valve. At flanges **utilize dielectric isolation where dissimilar metals exist (is there better language to use).**

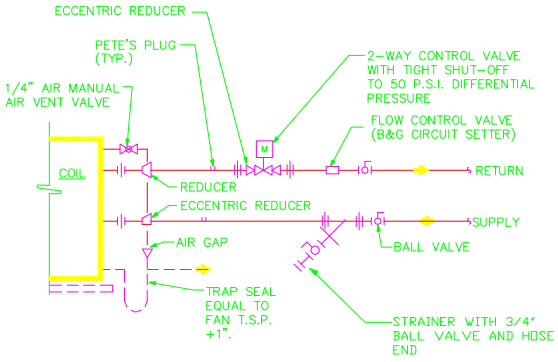
   Flanges shall be provided with complete flange insulation kits including:
   - One 1/8" thick steel washer for each bolt.
   - One insulating washer for each bolt.
   - One full length insulating sleeve for each bolt.
   - One type "E" gasket, phenolic retainer/nitrile sealing element.

   Reducers/expanders at the coil P.O.C. shall be coupled to flanges within 1.5 pipe diameters of the reducers. Supply side reducers shall be of the eccentric type. Chilled water control valve furnished by controls contractor, installed by mechanical contractor. ?)

9. Install flow control valve per manufacturer application guidelines or a minimum of five pipe diameters down stream from any fitting and a minimum of 10 pipe diameters downstream from a pump, a minimum of 2 pipe diameters down stream from the balancing

valve shall be free of any fittings, whichever application is more restrictive. Installation shall provide easy access to the probe metering ports, drain ports, and handwheel.(flow control valve installation details)

10. Trap seal detail with note applies to all coil condensate traps. (Clouded)



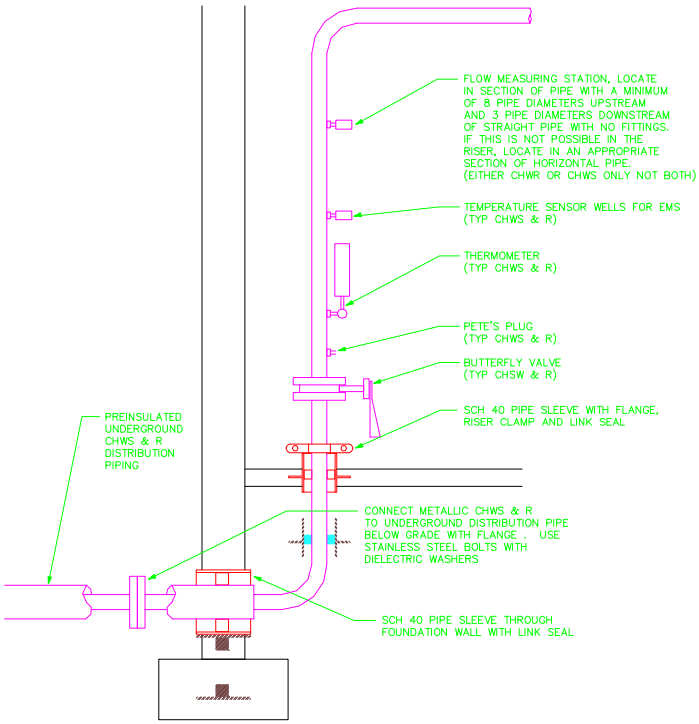
AIR HANDLING UNIT

Coil Piping Diagram (2-Way Coil Valves) – FOR REFERENCE ONLY
Above ceiling installations of AHU/FCU/SZU:

1. Location of AHU/FCU/SZU shall not be less than 6 inches from the bottom of unit to top of drop in or hard lid ceiling.

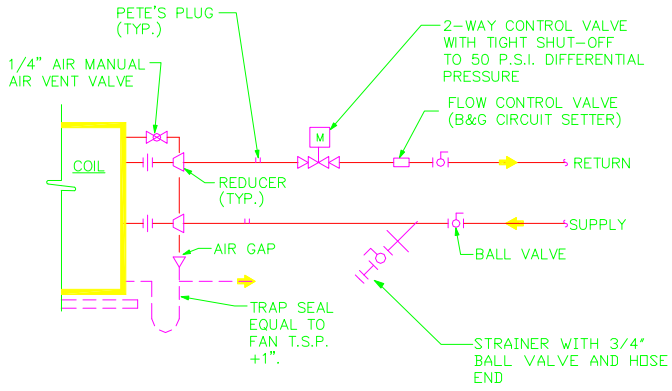
2. Install secondary seamless condensate overflow pan to extend a minimum of 3" beyond the bottom of AHU/FCU/SZU etc., in all directions (down and to the sides). The seamless pan shall extend beneath the primary condensate drain trap and extend 3" around the sides and end of the trap. The seamless pan shall extend beneath the coil P.O.C. flanges and extend 4" beyond the outside of the flanges. Secondary overflow lines shall be outfitted with float switches that shall be hardwire interlocked to interrupt fan control circuit operation. (SEE EZ trap: Inline condensate overflow switch model #EZT 225 or equivalent) (For above ceiling installations. To prevent ceiling failures. Note: The fan motors are monitored through the EMS system for failure when expected to be operating.)

3. Primary condensate drain lines shall be insulated continuously to prevent condensation from forming on the outside of condensate. In all cases Hangers shall be installed on the outside of the insulation to allow for continuous insulation.



Building Chilled Water Pipe Entry Detail Notes

1. Add Temperature sensor wells, flow sensor insertion kit, regardless of installing the sensors per this job. (On a per building basis).



AIR HANDLING UNIT

Air Handling Unit Detail

Refer to the following for all applications:

- Manual vents can be sized for 3/8" (allows for slow filling of the coil, to allow for proper refilling). Pipe the vent line with ball valves to appropriate drain or on down streamside of condensate trap with applicable air gap. If coil is not outfitted with manual vent, provide as part of the 'upper' piping on each coil. (Exception: For above ceiling applications, collect all vents/drains install hose connection and cap, insulate accordingly.)

DETAIL NOT SHOWN – To be provided by Mechanical Contractor.

- **Break Lines that indicate where the building lines tie in at System lines. Detail to include: 1.) In ground building isolation valves. 2.) A means to cross-connect both pipes (down stream of the In ground building isolation valves) with valved taps (qty. 2) that are ½ size of pipe. Valves are to be full port, installed below grade, and capped after use. This is to provide a means of flushing entire building at point of connection to central utility.**

All exposed chilled water lines, valve bodies, strainers, taps, wells and other POCs shall be fully insulated including end caps or exposed surfaces

DIVISION 16- ELECTRICAL

All designs shall incorporate the energy conservation standards required by A.R.S. Section 34-451 will comply with all requirements of ASHRAE/IESNA 90.1-2004 Energy Standards, including all issued amendments and updates. All designs shall incorporate the Lighting standards for state and community college buildings required by A.R.S. Section 34-47

1. All other non-metallic underground utilities shall have a tracer wire and warning tape installed above the utility line. The tracer wire shall be traced for continuity prior to backfill, immediately upon completion of backfill and compaction and once again during final utility location/as-built at the end of the project.

For economy of operation, building service sections shall be 480v (exception GCC main campus). All associated equipment shall be 480/277/240/120 voltage using step-down transformers as appropriate. Design of 208V systems MUST be approved by FP&D. Fire alarm tie-in to Building Management System (BMS) system

No electrical conduit should be run horizontally within either concrete slab on grade or elevated slabs (fully formed or on metal decking). For slabs on grade, provide at least 1" cover within the ABC. To the greatest extent possible, distribute power and data conduit at all partitions from overhead, then vertically down, with minimum horizontal runs, in order to allow wall relocation or demolition without interruption or damage to these systems.

The fire alarm contractor shall provide three (3) normally open, form-c dry contacts for tie-in to BMS system. The three contacts shall be programmed and labeled for 'fire panel alarm', 'supervisory' and 'panel trouble' indication. The supervisory indication shall include necessary programming and wiring to include tamper switch. Flow switch shall be programmed and wired as an alarm condition. The fire alarm contractor shall provide one (1) evacuation input (preferred as a separate zone or discrete address) for BMS system interface. The fire alarm contractor shall provide, j-box with terminal blocks, and land FACP labeled wiring to the associated terminals. BMS contractor shall provide properly labeled cables and terminate them to the associated terminals provided and labeled by the fire alarm contractor. The fire alarm contractor shall coordinate terminations with the BMS contractor. Final connections shall be made by the Fire Alarm contractor in the J-box and the fire panel.

Occupancy Sensors shall be provided to control lighting. Where occupancy sensors are provided in all classrooms, conference rooms and workrooms The sensors shall be supplied with auxiliary contacts for connection to BMS system for temperature control. In all areas were occupancy sensors are provided, evaluation for utilizing the auxiliary contact for security applications is required. (As a reference Go to:
http://www.wattstopper.com/products/productline_list.html?catindx=1)

Outdoor lighting Detail and narrative

All outdoor lighting circuits shall be controlled through normally closed sets of contacts. All outdoor lighting shall fail to the 'ON' state when coil is de-energized. All outdoor lighting circuits shall be circuited to allow for controlling 1/3 of the defined lighting: dusk to dawn. The intent is to allow for the majority of lighting to be controlled 'off' through programming when desired.

Outdoor lighting control:

All outdoor lighting shall be controlled through the BMS system. Three states of operation shall be available through the BMS (Sensor, On, and Off). Two states shall be available at the Lighting circuit point of interface via standard wall switch (Off = 'Lights On' and Auto = follows BMS command).

DIVISION 17- SPECIAL SYSTEMS

VAV boxes with electric reheat.

Ensure that all forms of electric reheat are provided with airflow proving switch interlock (fan interlock device shall not be considered as a substitute). Ensure that all airflow proving switches are installed integral from the electric reheat/heater manufacturer, and are not field adjustable.

Ensure that the specification addresses electric reheat commissioning procedures. Written testing report shall indicate that the reheat shall be activated through automatic means (BMS). These means shall be activated by the (BMS) controller and at no time shall any reheat be activated by mechanical means other than through the (BMS) controller. Both controls contractor and test & balance contractor are to submit report results independent of each other and final review and inconsistencies resolution shall be by the engineer. Final reports shall be part of the record documents recording heating temperature maximum differential (ΔT) by the controls contractor and amp draws as recorded by the balancing contractor.

The engineer shall review each reheat/heater application, based on the vendor selection guide, for adequate minimum and maximum CFM flow and pressure conditions which shall be adequate to produce defined ΔT's at these applicable conditions.

RESPONSIBILITY MATRIX				
WORK	**FURNISH**	**INSTALL**	**Low Volt. WIRING/TUBE**	**LINE POWER**
BMS low voltage and communication wiring	BMS	BMS	BMS	N/A
VAV box nodes	BMS	15	BMS	16
BMS conduits and raceway	BMS	BMS	BMS	BMS
Automatic dampers	15	15	N/A	N/A
Automatic damper actuators	BMS	15	BMS	BMS
Manual valves	15	15	N/A	N/A
Automatic valves Note: Pneumatic 2 position Actuators shall be upsized one size.	BMS	15	BMS	N/A
VAV boxes	15	15	N/A	N/A
Pipe insertion devices and taps including thermowells, flow and pressure stations.	BMS	15	BMS	BMS
BMS Current Switches.	BMS	BMS	BMS	N/A
BMS Control Relays	BMS	BMS	BMS	N/A
Air Flow Measuring Stations	BMS	15	BMS	16
Air Handler Unit Controls	BMS	BMS	BMS	16
Fan Coil Unit Controls	BMS	BMS	BMS	16
BMS interface with Chiller controls	BMS	BMS	BMS	BMS
Chiller controls interface with BMS	15	15	BMS	16
Classroom unit controls interface with BMS	15	15	BMS	16
All BMS Nodes, equipment, housings, enclosures and panels.	BMS	BMS	BMS	BMS

Smoke Detectors	16	16	16	16
Fire/Smoke Dampers	15	15	16	16
Fire Dampers	15	15	N/A	N/A
Chiller Flow Switches	15	15	BMS	N/A
Boiler wiring	15	15	15	15
Water treatment system	15	15	15	16
Variable Speed Drives (VFD)	BMS	16	BMS	16
Refrigerant monitors	15	BMS	BMS	16
Computer Room A/C Unit field-mounted controls	15	15	BMS	16
Fire Alarm shutdown relay interlock wiring	16	16	16	16
Fire Alarm smoke control relay interlock wiring	16	16	16	16
Fireman's Smoke Control Override Panel	16	16	16	16
Fan Coil Unit controls	BMS	BMS	BMS	16
Unit Heater controls	BMS	BMS	BMS	16
Packaged RTU space mounted controls	15	BMS	BMS	16
Packaged RTU factory-mounted controls	15	15	BMS	16
Packaged RTU field-mounted controls	BMS	BMS	BMS	16
Cooling Tower Vibration Switches	15	15	16	16
Cooling Tower Level Control Devices	15	15	16	16
Cooling Tower makeup water control devices	15	15	16	16
Packaged Split systems interface wiring between indoor fan section and outdoor condenser/compressor section	15	15	15	16
Packaged A/C units where N2 Thermostat identified for application	BMS	15	15***	16
Starters, HOA switches	16	16	N/A	16
Control damper actuators	BMS	BMS	BMS	16

***Interface wiring by division 15, N2 bus wiring by BMS. Mechanical shall select Thermostat per application.

Smoke detector shutdown wiring

It shall be the responsibility of the Fire Alarm contractor to provide adequate 'shutdown interface devices' necessary to Shut down all AHU equipment as initiated by associated detection devices or fire alarm control panel as indicated by Plans and specifications. These 'shutdown interface devices' shall include relays with the number of isolated contacts necessary to isolate the controlling circuits, including motor starters or VFD drives which may employ their own self-contained isolated control power.

It shall be the responsibility of the Electrical contractor to provide the wiring between the 'shutdown interface devices' and the motor starter, combination motor starter, VFD and like devices. It shall be the responsibility of the Fire Alarm contractor to technically assist the Electrical contractor in final terminations of the 'shutdown interlock wiring'.

It shall be the responsibility of the Controls contractor to verify/confirm that the wiring provided by the Electrical contractor is free and clear of any voltages prior to terminating the 'shutdown interlock wiring'. It is the responsibility of the controls contractor to confirm that when load wiring is disconnected from common AHU associated VFDs, that the disconnected VFD control section is also confirmed to be de-energized. Any discrepancies shall be reported to the general contractor for resolution.

It shall be the responsibility of the Fire Alarm contractor to assist the electrical contractor, as necessary, to correct any/all of the shutdown wiring circuit problems.

It shall be the Fire Alarm contractors responsibility to confirm that when either the Supply Air or Return Air duct detectors activate that the VFD(s) (or motor starter('s) shut down (simultaneously, where 2 are included with a single AHU.)) All fire alarm functional features shall be observed by a district representative prior to final Authority Having Jurisdiction (AHJ) inspection. Scheduling of the 'district observed; fire alarm functional features testing' by the fire alarm contractor (in coordination with the general contractor) shall occur a minimum of 5 working days prior to final inspection by AHJ.

Fire Alarm system interface to BMS system and Supervisory signal interface to BMS

It shall be the responsibility of the Fire Alarm contractor to provide dry contacts to monitor General Fire Alarm, General Fire Trouble and General Supervisory conditions.

It shall be the responsibility of the Fire Alarm contractor to provide (supervised dry contact closure) input terminals necessary to initiate, via contact dry closure, a general Alarm from a remote BMS location. It shall be the responsibility of the controls contractor to provide a relay with dry contacts necessary to provide remote evacuation.

It shall be the responsibility of the Electrical contractor to provide an interface J-box for the FACP and the BMS interface wiring. It shall be the responsibility of the Electrical contractor to provide wiring between the FACP and interface J-box. The interface J-Box shall contain a terminal strip to facilitate the landing of both Fire Alarm wiring and BMS monitoring cables. It shall be the responsibility of the Fire Alarm contractor to clearly label the terminals of the terminal strip.

It shall be the BMS/controls contractor's responsibility for the wiring and terminations between the interface J-Box w/ terminal strip and the BMS controller.

It shall be the BMS/controls contractor's responsibility to verify/confirm that the wiring provided by the Electrical contractor is free and clear of any voltages prior to terminating the 'BMS monitoring cables'.

It shall be the responsibility of the Fire Alarm contractor to technically assist the Controls contractor with final terminations of the 'BMS monitoring/controls cables'.

Control Valves

Control valves shall be Johnson Controls CV-1000 type, weather exposed valve applications shall be specifically reviewed, at a minimum, exposed valve and valve operator shall be rated for local climatology, sufficiently protected from elements and warrantied for not less than 5 years – parts.

Sequence of operations

The following is a partial list of standardized sequence of operations that have been developed with the BMS contractor throughout the years and should be a good starting point for any new system. The engineer is required to work with BMS contractor when designing mechanical systems, as standardized sequences and drawing diagrams have already been developed. The engineer continues to be responsible for system operating constraints outside of those listed herewith.

Name
VAV Air Handler with Return Fan w/o Heat
Multizone Air Handler w/o RF w/o Heat
VAV AHU with Relief Fan and preheat
Zone Controller
VAV Air Handler w/ Modulating Heat and Zone Reheat without Return Fan Sequence
Single Zone AHU with Modulating Heat
Single Zone Air Handler
Fan Coil w/ Heating & Cooling Valves
Fancoil Sequence
Fan Coil w/ Cooling and Staged Heating
VAV VFD Air Handler with Supply and Return fans and Baseload Heating
Heat Pump - Single Stage
VAV AHU with Supply Fan VFD, no heat (return fan tracking)
VAV AHU with Supply Fan VFD and Intake Air Flow control
VAV AHU with Supply Fan VFD No Heat
VAV AHU with Supply Fan VFD and EF VFDs No Heat
VAV AHU with Supply Fan VFD Reheat
VAV AHU with Supply and Exhaust fan VFDs and Reheat
VAV AHU with Supply Fan VFD and Staged Heat
VAV AHU with Supply Fan and Return fan VFDs and Modulating Heat (RF tracking)
Single Zone AHU w/ Cooling & Heating Valves
Single Zone AHU w/ Dehumidification
Single Zone AHU w/ Cooling Valve and Staged Heating
Multizone AHU w/ Hot Deck and SF VFD
Multizone AHU w/ Cold Deck and Bypass
Multizone AHU w/ Hot Deck and SF VFD and Humidity
Multizone AHU w/ Hot and Cold Decks
Multi Zone AHU with Modulating Preheat and SF-VFD
VAV with Modulating Heat
VAV w/ Staged Heat
VAV w/ Staged Heat & Parallel Fan
VAV w/ Staged Heat & Series Fan
VAV w/ Modulating Heat
VAV w/ Modulating Heat & Parallel Fan
IDF Room AC Unit w/ Multi Zones and Compressor
Zone Controller No Heat
Zone w/ Hot & Cold Decks Mod Heating and GEX.
Lighting and Fire
Boiler Control
Makeup AHU with Cooling Valve and DX Coil
PHOENIX CONTROL VALVE W/ STAGED HEAT & GENERAL EXHAUST
Zone controller with dehumidification control

Refer to ANSI/ASA S12.60-2002, for details on acoustical performance criteria for learning spaces, definitions, requirements and guidelines for noise isolation. Except where a programmed space may require a lower noise level. The more stringent level will be required.

MCCCD is not necessarily a 24-hour a day, 7 day a week operation. Areas that require cooling during off hours or extended shutdown may need independent systems for cooling. This will be evaluated on a site-by-site or system-by-system basis and shall be reviewed and require FP&D approval.

If the manufacturer supplies minimum heating CFM set point that the heating safety switch will engage, this CFM level must be provided on the mechanical schedule as a separate column.

High performance Supply Air diffusers are preferred. Engineer is to provide what level Air Diffusion Performance Index (ADPI) the system will be designed to. Manufacturers certified performance levels must be included in the diffuser submittals.