Commissioning Humidifiers

Harry B. Koons III

Director of Commissioning Services

Precis Commissioning, Inc

AIA Quality Assurance

The Building Commissioning Association is a Registered Provider with The American Institute of Architects Continuing Education Systems (AIA/CES). Credit(s) earned on completion of this program will be reported to AIA/CES for AIA members. Certificates of the Completion for both AIA members and non-AIA members are available upon request.

This program is registered with AIA/CES for continuing professional education. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the AIA of any material of construction or any method or manner of handling, using, distributing, or dealing in any material or product.

Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Course Description

Kxp lglilfdwlrq lv nh| wr p rvw KYDF v|vwhp v vhuylqj krvslwdov/ oderudwrulhv/ vfkrrov/ p dqxidfwxulqj/ dqg skdup dfhxwlfdoidflolwlhv1

Wkhvh v|vwhp v qhhg wr eh ghvljqhg/ lqvwdoohg/ vwduwhg/ dqg frp p lvvlrqhg wr hqvxuh wkdwwkh| surylgh wkh uhtxluhg p rlvwxuh/ duh xqghu frqwurc/ kdyh wkh uhtxluhg vdihwlhv/ dqg z loo shuirup ryhu wkh olih ri wkh KYDF v|vwhp 1

Xqiruwxqdwho|/ hyhu| |hdu/ z h vhh lvvxhv z lwk kxp lglilhuv qrw shuirup lqj dv uhtxluhg/ kxp lglilhuv wkdwduh p lg0vl}hg/ lqfruhfwo| lqvwdoohg/ p lvvlqj wkh uhtxluhg frqwurov/ dqg/ p rvw lp sruwdqwo|/ p lvvlqj wkh uhtxluhg vdihwlhv wr hqvxuh wkh v|vwhp fdq rshudwh z lwkrxwfdxvlqj lvvxhv lq wkh gxfwz run rudwwkh vsdfh dnyhd1Wklv lv iruqhz /uhqrydwlrq/ dqg uhwurilwsurmhfw1

Wklv frxuvh z loo jlyh wkh dwwhqghh d edvlf xqghuvwdqglqj ri kxp lglilhu vhdnfwlrq/ lqvwdoodwlrq/ rshudwlrq/ hvvhqwdolwhp v wr orrn iru/ srvvleoh lvvxhv/ dqg vroxwlrqv wr wkrvh lvvxhv1

Learning Objectives

1. Review what a humidifier is, why you need it and the design considerations in selecting a humidifier.

2. Compare the different types of humidifiers and when to use one vs another.

3. Describe the components of humidifiers and the installation requirements and operation of humidifiers.

4. Review the possible issues and solutions with humidifiers and maintenance requirements.

What is a humidifier?

- A means to deliver moisture into an air stream or space to increase the humidity levels to the required design level.
- A standalone or integrated system that will work with the supply air system to provide for space humidity.
- A standalone system that is in a space and will deliver moist air to the space.

When do I need a humidifier?

- Humidification is normally provided when required to maintain humidity levels for a product or process.
- It should be noted that ASHRAE Standard 55 requires systems designed to control humidity must be able to maintain a dew-point temperature of 16.8°C (62.2°F). There are no longer any established lower humidity limits for thermal comfort; as such, Standard 55 does not specify a minimum humidity level.
- Note that comfort factors like dry skin, eyes, or noses, manufacturing or storage requirements and static electricity generation may require a specified and documented low humidity level.

Design Considerations

- The humidity levels are listed as part of the A/E design package, but space humidity is generally between 25% RH to 50% RH.
- Higher RH requirements may require the use of primary and secondary humidifiers, as the delivery of very moist air from the equipment may lead to moisture in the duct system and tripping of smoke detectors.
- Interestingly, ASHRAE guideline 36 does not address humidification control.
- Double check that the high humidity level is not just a dehumidification requirement, but is in fact a humidification requirement.

Design Considerations

The building construction.

- Some things that are reviewed for design will be the type of building materials used, use of vapor barriers, glass area, exhaust requirements, roof, and enclosure construction.

The humidification load.

- Space or System RH requirements can be dictated by a product or process and may include comfort requirements.

The energy source for generation.

- Gas, steam, or electric can be used.

The humidification system location.

- The system location is important as longer systems will require higher delivery pressures (for generation steam) and more traps. The steam delivered for local generators is low pressure (5 PSI) and is really atmospheric at the distribution tubes. Proper trapping and drainage is required for clean dry steam. Identifying the required utilities and the runs for the utilities may also impact where systems are located. Access for installation and maintenance must be considered.

Design Considerations

The controls system.

- Whether using a BAS or local controls provided by the vendor, the control system must be able to provide for a steady steam output, should not hunt, should not provide for too much steam, and should provide for operational feedback and alarming.

How should they be sized?

- The engineer or vendor should provide the calculation for the required humidification based on the system type and load requirements. It should be noted that the worst case (most humidity required) may not be in the dead of winter. Most suppliers provide software to help with those calculations.

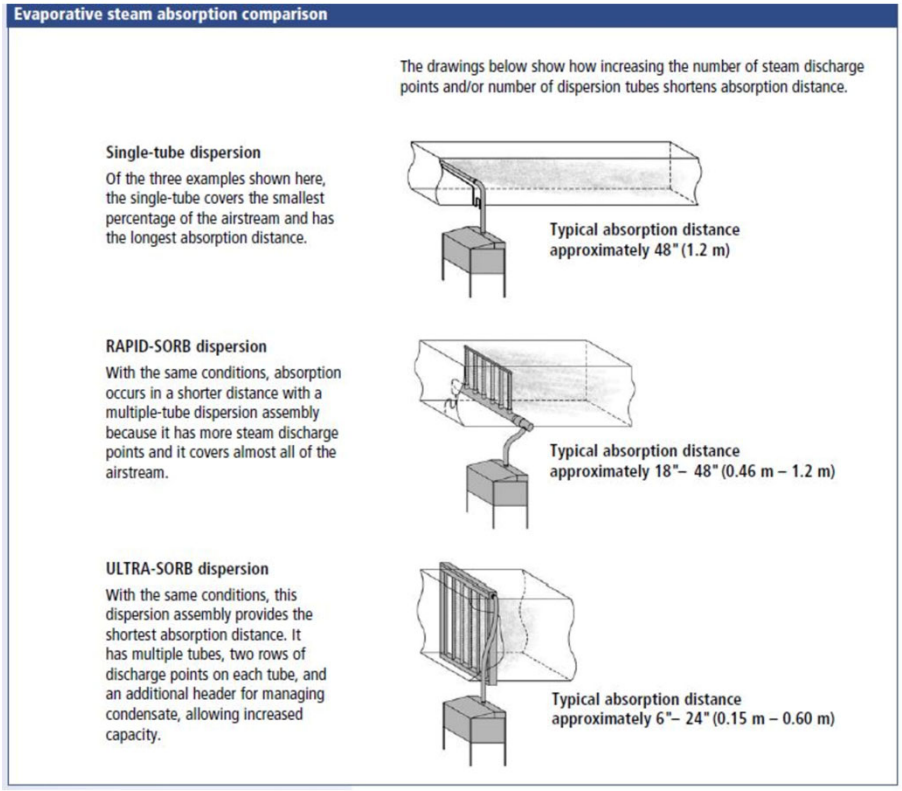
The steam condensate load at start-up.

- The steam condensate load at start-up may be many times higher than while running. The A/E should confirm the traps and piping is sized for the maximum load.

What is absorption distance and why is important?

- Absorption distance is the distance required to allow the injected steam to be absorbed into the air stream. Having this distance calculated by the A/E, or better yet by the vendor is very important as duct design and sensor location is based on knowing the actual absorption distance. Note that duct changes, duct elbows, turning vanes and sensor installation should not occur within or close to this distance.

Absorption Distance



From Dri-Steem

Design Considerations

What type of water should be use for humidifiers?

- Soft water is recommended for most applications for humidification. This will provide for long term quality water and will not introduce unwanted chemicals or calcium to the system.
- Deionized (DI) water can be used where pure steam is a requirement. This may be needed in some research, production, and healthcare facilities. If using DI water, the vendor should provide a unit designed to use DI water and normally will provide a float for level control as DI water will not provide a good source for electronic level control. This may also include reverse-osmosis (RO)/DI water.
- Pharmaceutical facilities may require the use of Pure Steam or at least chemical-free steam.

Design Considerations

What type of water should be use for humidifiers?

- Plant steam direct injection - feasibility for this should be evaluated at the start of the design. Boiler systems have chemical treatments which may impact the quality of the humidification and may lead to possible health issues if amines are used. The most common are clohexylamine, morpholine, and DEAE. These chemicals have been found to irritate eyes and skin and aggravate respiratory disorders such as asthma. A better application would be a steam-to-steam heat exchanger where plant system is used to heat a humidifier that uses soft water or DI water.
- Generally, domestic water should not be used for humidification. This will lead to calcium buildup and poorly-performing humidifiers. I have seen a site that was on well water that clogged the humidifiers in a matter of weeks.

What types of humidifiers are there?

Adiabatic systems

- Adiabatic systems use heat from the surrounding air to change water into vapor for humidification (evaporation). These systems are used where local humidification is required.
- Foggers and ultrasonic humidifiers are typical adiabatic systems.

Isothermal systems

- Isothermal systems use heat from an external source to create humidity.
- Electricity, natural gas, hot water, and boiler steam are isothermal heat sources used to boil water into steam for humidification.

Adiabatic system

ADIABATIC HUMIDIFIER

From Dri-Steem

Isothermal system

STEAM-TO-STEAM HUMIDIFIER

From Dri-Steem

Key System Components:

Steam generator

- Boilers (gas, oil, or electric) and heat exchangers are used to generate steam. May also be a stand-alone unit in a room (hot or cold mist). These should be sized for the design steam load or have a capacity above the design steam load.

Steam Piping

- This piping supplies the steam to the humidification distribution tubes. The piping should be pitched, should be provided with drains and traps, and should be insulated. Strainers should be provided per the design.

Steam Separator

- Used in some applications to provide dry steam to the dispersion tubes. Not all systems require these units.

Steam Distribution Tubes (Header)

- Used to introduce steam into an air stream. May have a steam jacket, insulation, or be bare metal.

Steam Condensate Piping

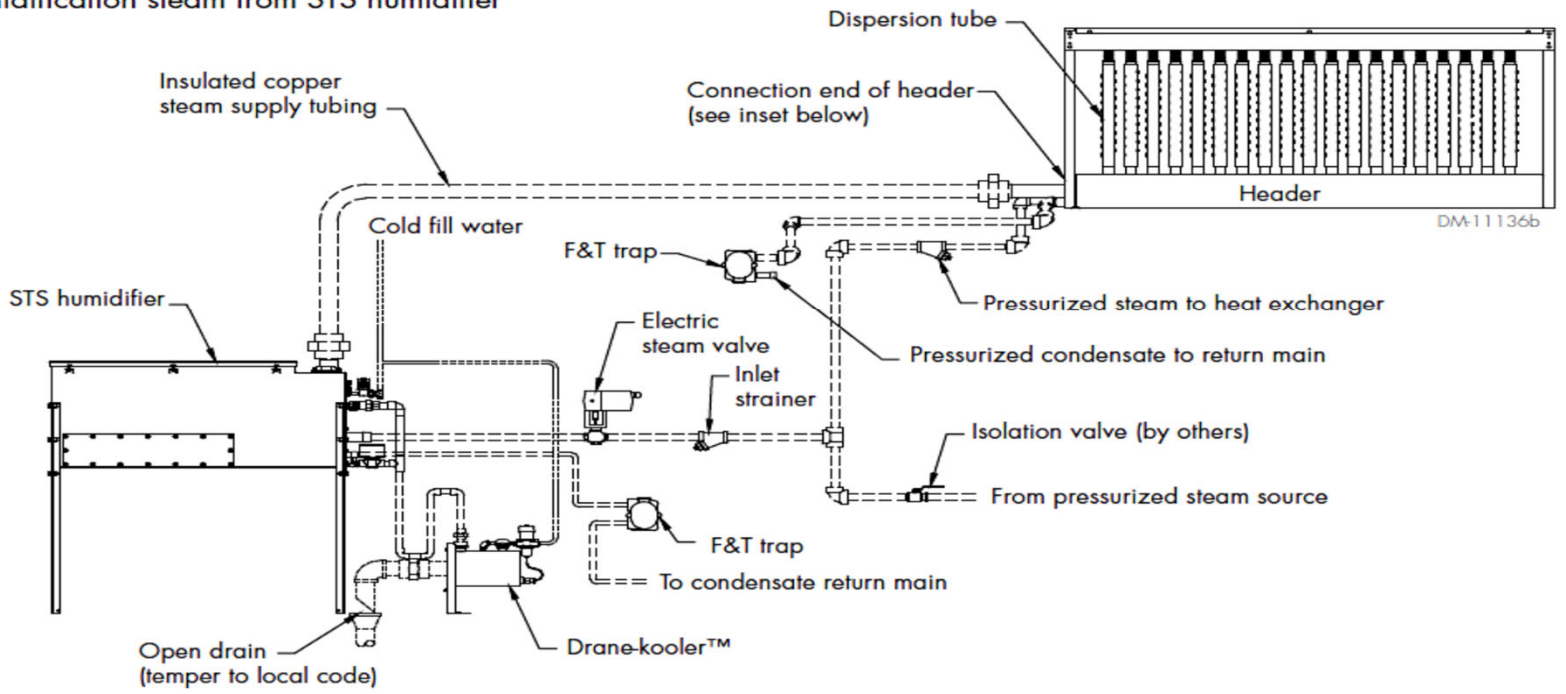
- Used to removed wet steam from the system and drain condensed steam from the piping system.

Condensate Cooling

- Steam condensate should be cooled to lower than 140F for safety reasons and 120F for systems that may have PVC or CPVC drain piping.

Key System Components:

Steam to heat exchanger from pressurized steam source, humidification steam from STS humidifier



From Dri-Steem

Where and how should humidifiers be installed?

Each type and manufacturer will have different requirements for installation of their steam generators, piping, and distribution tubes. The A/E should check that the design documents and details are for the Basis of Design manufacturer. Should a different type or manufacturer be submitted by the MC, they will be required to assure the installation meets the vendor's IO&M and can achieve the design requirements.

In room

- Foggers (cool mist) and ultrasonic humidifiers are generally installed in-room. These units have onboard controls and are not normally tied to a BAS. They are mounted in the space and provide for direct steam into the space. Many systems will come with optional DI water treatment. Spaces like cigar storage rooms, baking proofing rooms, and wineries use this type of system. They can be installed in pharmaceutical or data centers but I have not seen that application.

In duct

- Generally installed after the AHU-to-Discharge air duct connection. This type of installation should be done in a section of stainless-steel duct which includes an access panel, viewing glass and may include a pitched duct section after the distribution tube that's provided with a drain line.
- Note the location of control and safety sensors should be based on duct layout, system requirements and humidifier absorption distance.

Where and how should humidifiers be installed?

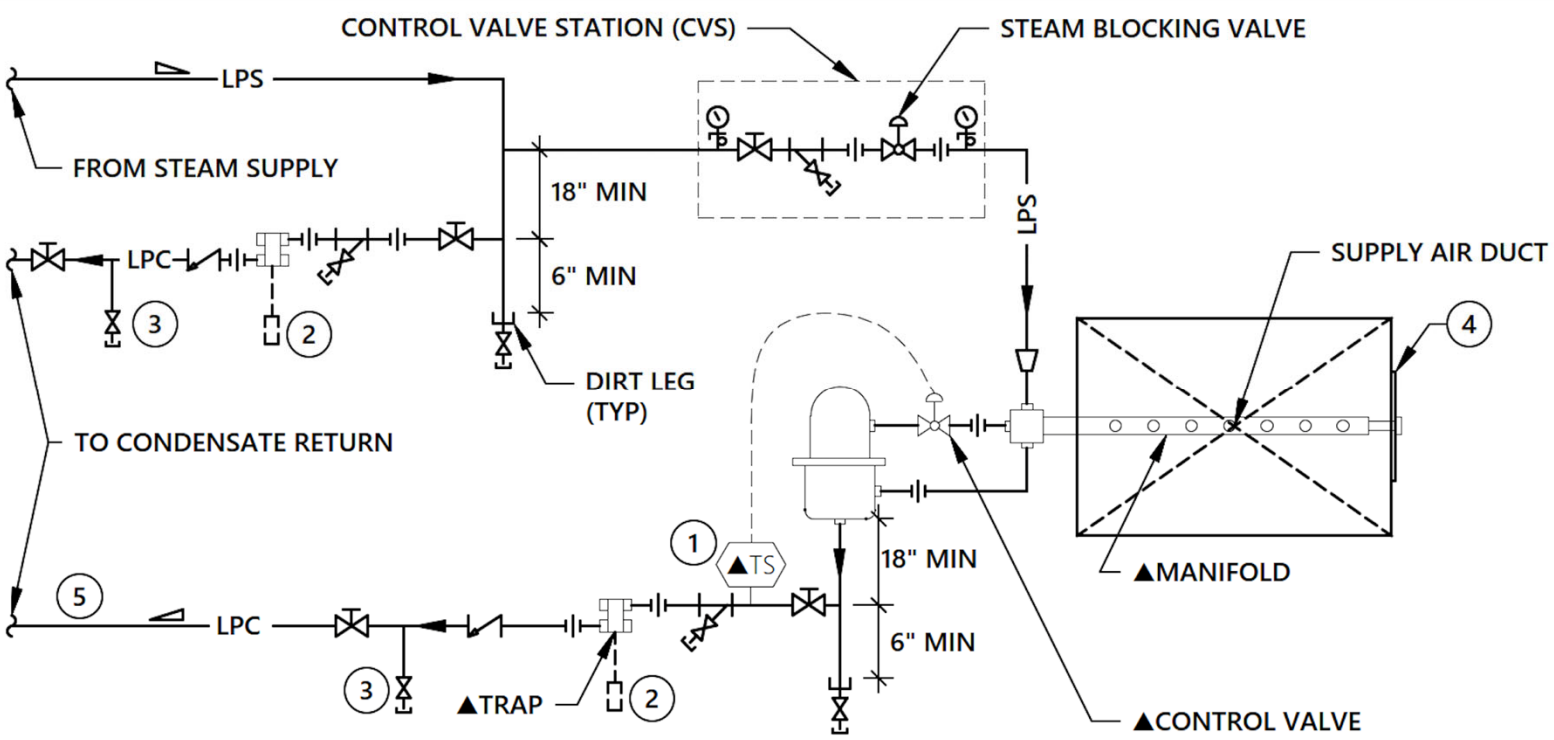
In AHU

- Installed in the AHU, either after both the heat and cooling coils or between the heating and cooling coils. The first installation is the cleanest the second utilizes the cooling coil as a mist eliminator. Note the location of control and safety sensors should be based on duct layout, system requirements and humidifier absorption distance.

Trim humidifiers after VAV/CV Boxes

- Installed after the local VAV/CV box and is used to bring an individual space to a set-point which is higher than general humidification needs. Like a critical care space or pharmaceutical manufacturing space. May include a room or return air sensor. This will require additional control logic and sensors to support tight control of the humidifiers.

Where and how should humidifiers be installed?



Control Logic

- There is a difference in controls between a constant volume system and a VAV system. The VAV controls will require multiple sensors, duct and space and a tight P&ID logic.
- The BAS or vendor PID loop should be very, very slow. A ramp and soak control logic can also be used where the valve is opened a small percentage and a time delay is used to see the control feedback, actual RH and will only open the valve if the humidity set point has not been reached.
- In some cases, local vendor provided controls are used. These are hard to check through commissioning and the vendor will be required to test and tune the controls to meet the design and assure that there are no excursions. Cx follow-up should be completed where possible.

Sensors

Humidity sensor or a combination temperature and humidity sensor.

- This can be a room sensor, duct mounted sensor, or both. The location should be part of the design and in a duct mounted system the sensor should be located in the return duct as this gives the most uniform mixture of dry and humid air.
- It should be noted that the feedback time on a return duct application will require the control vendor to carefully tune the control loop so the system does not hunt or over humidify.

High Limit Switch

- (Yes a switch). If it trips the blocking valve should close and an alarm should be sent out. If this trips a manual reset is required. I do not recommend using auto-reset high limit switches. They can just cause a cycle of trips and restarts without knowing or fixing the real issue.

High Limit Sensor

- (BAS backdown control). This can be used to throttle back the control valve if the humidity gets too high but should not replace a safety switch.

Air flow switch

- No airflow means the unit should not run. This should be tied back to the blocking valve.

Humidity Unit-mounted Temperature Sensor

- This will only allow the steam to flow if the piping system is at the vendor's required temperature (Not on all types).

Valves

Steam Control Valve

- The Steam Control Valve is used to control how much steam flows to the system. The turn down of the valve should be considered. If the valve does not have linear performance hunting may occur.

Blocking Valve

- The blocking valve is used to positively shut off steam to the distribution system. This should be closed when the system is off, has reached a “High Limit” or if there is some form of system failure, like a loss of the AHU. It also stops jacket heating from raising the duct air temperature when the unit is disabled.

Steam Traps

- The type and location of steam traps will be based on the vendor's requirements and system installation. Deep seal traps and F&T traps are normally used, but other traps like thermodynamic traps may be specified.
- The trap location and piping should be designed to allow for the required liquid head and free flow of condensate.
- The trap location should be accessible as trap maintenance is important.
- The trap operation should be checked by the installer and start-up vendor prior to any commissioning activities.

Additional Items

Check Valves

- Check valves may be required after the traps and the type and location of the check valve should match the vendor's requirements. If any system pressure or back-pressure could be expected, then they must be installed.

Heat Trace

- Heat Tracing could be for the supply water service, steam and condensate piping/traps based on the vendor recommendation or standard engineering practice. This may include heating and insulating piping within a vendor provided skid, if installed when freezing temperatures could occur. The system should be tested to confirm all controls are completed, all sensors are in place, and the system(s) are fully operational.

Natural Gas System

- The natural gas service to the gas fired generator should include a pressure reducing valve, pipe dirt-leg and a local isolation valve. Verify the downstream gas pressure has been set to meet the generators service requirements.

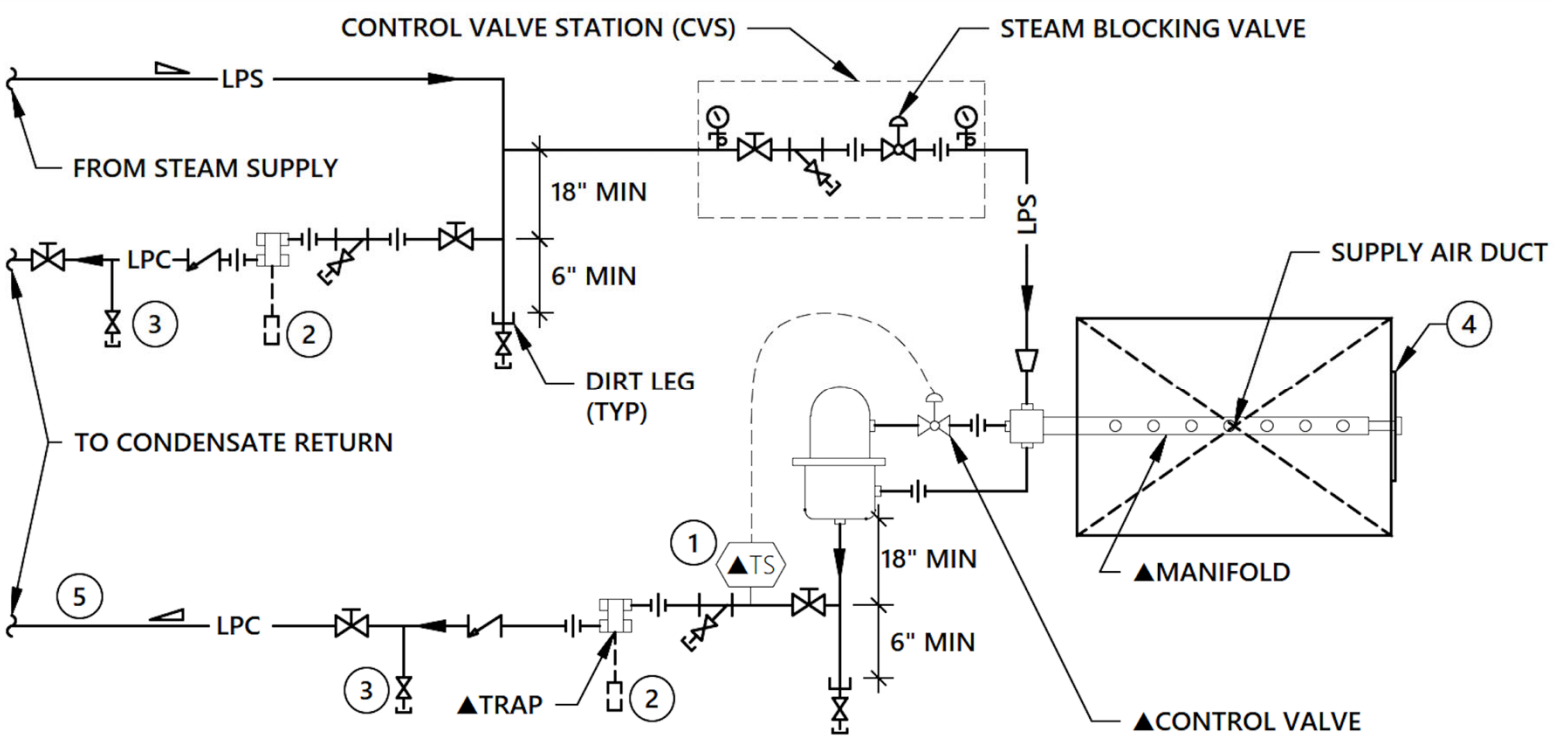
Cx Design Checks

- The design review should include checks for the system, distribution tubes, valves, piping, and traps. Double check both the details and when possible, the vendor's IO&M documents. Each vendor will have specific details on installation for their systems.
- The design review should include checks for the ductwork (S.S and drains), access doors and sight windows. Double check both the details and when possible, the vendor's IO&M documents.
- The design review should include checks for the sensors and sensor locations. A check of the vendors information, BAS submittals and fire alarm submittals should be done.

Cx Installation Checks

- The installation review should include checks for the system, distribution tubes, valves, and traps. Double check both the details and, when possible, the vendor's IO&M documents. Each vendor will have specific details on installation for their systems.
- The installation review should include checks for the ductwork (S.S and drains), access doors and sight windows. Double check both the details and, when possible, the vendor's IO&M documents.
- The installation review should include checks for the sensors and sensor locations. A check of the vendors information, BAS submittals and fire alarm submittals should be done.

Cx Installation Checks



Cx Installation Checks

- The installation review should include pipe size, pipe pitch and insulation checks.
- A check for device calibration should be made
- The installation review should include a check of the BAS graphics, BAS Point-to-Points and a review of the BAS SOO and Logic.
- If vendor controls are used a check of the controls should be completed with the installer and start-up tech.

Cx Installation Checks

From Dri-Steem

Cx Tests (Functional)

- Complete a full building power loss test. How does this impact the humidifiers and controls?
- Complete an AHU power loss test. How does this impact the humidifiers and controls?
- Complete a loss of communications test. How does this impact the humidifiers and controls?
- Re-Review the BAS set-points, alarm values, and trending. Test the normal control logic and assure the system is responding to changes in space/duct humidity and the controls are stable, not hunting and not reaching the high limit.
- Review the logic, how the system is being controlled, PID values, steps, and response.
- Test the safety circuit(s), flow switches and high-limit switches.

Cx Tests (Functional)

- Test the control of ganged humidifier generators and any lead-lag functions.
- Verify the AHU and humidifier are both controlled, and that the humidifier cannot run without the controls calling for the AHU to run. Even if the safeties circuits are open, don't use the AHU off command to lock out the humidifier in a shutdown. It should be commanded off via the controls.
- Verify the auto-drain function of any steam generator is operational.
- Verify the drainage, is the system draining? Are the traps operational? Use an IR gun.

Possible Issues.

- **Hunting and lack of stable control.** Reaching the high limit or using the high limit as a normal control function.
- **Smoke detector trips.** Duct smoke detectors should be located at a minimum of 10 feet downstream from humidifiers or 3 times the absorption distance (whichever is greater).
- **Undersized humidifiers.** Hard to verify unless the outside air conditions are at a design day. Note the maximum humidification requirement is not the dead of winter.
- **Poorly installed humidifier.** The location of the humidifier should consider the absorption distance as well as any changes in the ductwork. Humidifiers near elbows or sharp duct transitions will have wetting issues.
- **Mixing of no pressure, low pressure and/or medium pressure condensate.** This can lead to back-pressure and system hammering.

Possible Issues.

- **Incorrectly installed humidifier tubes.** The steam injection ports should face the incoming air steam. Some vendors do have 90-degree ports, but the ports should never face away from the air stream.
- **AHU humidifiers too low.** Unit mounted units should be installed as high as possible in the casing. This allows for more room for drains, traps, accessories, and piping pitch. Blank off plates and sealing should be provided.
- **Incorrect piping, pitched incorrectly, incorrect traps.** This includes generation and distribution.
- **Missing control sensors.** High Limit Switches are missed in many cases.

Possible Issues.

- **Incorrect position of control sensors.**
- **Incorrect drainage, no drain cooler.**
- Missing piping or distribution tube insulation.
- **Missing water feed to quench coolers or additional feed requirement listed in the IO&M documents.** Sometimes the A/E drawing and details do no show all the required piping as it may be listed as part of the vendors package when it is not.

Fixes

The Cx Provider is not responsible for addressing issues that can't be fixed during commissioning. There are times when field fixes can help with problems and when the project team agrees on using them, they can be installed.

- Installing a mist eliminator
- Blocking off injection ports

Maintenance

Sensor calibration.

- The control sensors for humidification can drift making for inaccurate control and possibly leading to operational issues. Calibration should be completed at least once a year or twice a year where tight humidity requirements exist.

System Inspection.

- For system that operate throughout the year this should be done every 6 months.
- This may also be completed in the fall prior to system start up.
- Checks for damage, defects, leaks, faulty traps, bad seals, corrosion, or biological buildup should be completed.

Questions

Harry B. Koons III, Precis Commissioning Inc.