
IDEA2021
Powering the Future: District Energy/CHP/Microgrids
Sept. 27-29 | Austin Convention Center | Austin, Texas

CHP and Building Chilled Water and Steam Energy Monitoring Lessons Learned

John Beaudry P.E.

Jacobs

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INTERNATIONAL DISTRICT ENERGY ASSOCIATION

Steam and Chilled Water Requirements

- Measure energy for steam and chilled water to County, City, and Federal buildings.
  - 19 buildings
- Billing on a monthly basis.
- Flow and energy reporting required for CA Greenhouse gas reporting.
- Flow reporting for Air permits.
- Minimal Maintenance.

Energy Monitoring – Chilled Water Flow Problems

- Venturi differential pressure standard.
- Existing piping and installation issues.
- Measurement for billing based on flow not actual energy.
- Calibration issues.
- Circular charts used in existing facility.

Energy Monitoring — Steam Flow Problems

- Venturi differential pressure – not sized for building load.
- Existing piping and installation issues.
- Measurement for billing based in volumetric steam flow, not the based on the quality of the steam.
- Calibration issues.
- Circular charts used in existing facility.

Site Historic Alternative Flowmeters

- Ultrasonic used with issues
  - Likely maintenance issues with coupling.
  - Facility technicians weren't capable of troubleshooting.
- Averaging Pitot Tube
  - Unknown maintenance issues.

Additional Flow Challenges

- Greenhouse gas reporting requirements
  - Parasitic steam loads.
  - Fuel oil.
  - Calibration requirements for regulatory reporting.
- South Coast Air Quality Monitoring District requirements.

GHG and Air Permit Flow Challenges

- Calibration frequency based on manufacturers recommendations.
- Must be able to verify validity of flow data
  - Meters will require flow testing.
  - DP type meters may use a visual inspection and calibration of the transmitter.
  - Coriolis meters offer internal verification
- Non-resettable totalization for fuel oil.
- Cooling tower calculations based on CW flow.

Chilled Water Flow Technologies

Technology	Advantages	Disadvantages
Magnetic Flow	High turndown Linear	Straight run piping Calibration - flow lab testing Maintenance complexity

DP (Venturi, orifice)	Maintenance Simple
	    Calibration zero/span dp
	    Inspect flow element
		Straight run piping
		Minimal turndown
		Plugging of impulse lines
		Permanent pressure loss

DP (V-Cone)	High turndown
	Maintenance Simple
	    Calibration zero/span dp
	    Inspect flow element
		Plugging of impulse lines
		Permanent pressure loss

Chilled Water Flow Technologies Alternative

Technology	Advantages	Disadvantages
Ultrasonic	High turndown Linear Lower relative cost for larger lines	Straight run piping (multi path option) Calibration validation Maintenance complexity
Turbine	High turndown Linear	Straight run piping Mechanical bearings to maintain

Chilled Water Systems

- Constant volume systems have the same flow all the time with supply and return differential temperatures varying.
- Variable volume HVAC systems will change flow based on load. Low load conditions go below min flow rating of the meters.

Chilled Water Flow

- Tracked gallons of chilled water flow regardless of the differential temperature.
- Many venturi flow elements were line size. Often oversized for accurate flow.
- Installation issues – Flow not developed
  - Upstream/downstream straight run piping.
  - In/out of plane straight run piping.
  - Square root extraction.
- Maintenance Issues
  - Plugged impulse lines and meter .
  - Square root extraction missing.

Chilled Water Flow Meter Improvements

- Right sized the flow meters.
- Straight run piping issues meters were replaced with a V-cone style flow element.
- Added BTU calculation to all buildings so billing would reflect energy usage, not gallons of chilled water flow.
- Calibrated differential pressure transmitters.
- Configured controls for square root extraction.
- Provided site wide continuous energy and flow monitoring.

Steam Flow Technologies

Technology	Advantages	Disadvantages
Vortex	High turndown Linear	Straight run piping Calibration - Flow lab testing required Maintenance complexity
Multivariable Venturi	Mass flow Maintenance Simple Calibration zero/span DP Inspect flow element	Straight run piping required Minimal turndown Plugging of impulse lines Permanent pressure loss
Multivariable V-Cone	Mass flow High turndown Maintenance Simple Calibration zero/span DP Inspect flow element	Plugging of impulse lines Permanent pressure loss

Steam Flow Technologies

Technology	Advantages	Disadvantages
Multivariable Averaging Pitot Tube	Mass flow Maintenance Simple Calibration zero/span DP Inspect flow element	Straight run piping required Minimal turndown Plugging of impulse lines
Ultrasonic	High turndown Linear Lower relative cost for larger lines	Doesn't work in all steam lines Straight run piping (multi path option) Calibration validation Maintenance complexity
Multivariable Orifice	Mass flow Maintenance Simple Calibration zero/span DP Inspect flow element	Straight run piping required Minimal turndown Plugging of impulse lines Permanent pressure loss

Steam Flow

- Steam volumetric flow (not temperature or pressure compensated).
- Many venturi flow elements were line size. Often significantly oversized for accurate flow.
- Installation Issues
    - Impulse tubing installed improperly.
    - Upstream/downstream straight run piping.
    - In/out of plane straight run piping.
- Operational Issues
    - Pulsating flow.
- Maintenance Issues
    - Square root extraction missing.
- Circular charts used for calculating billing.

Steam Meter Installation Issues

- Top of impulse line leg must be equal for both meter taps or there will be a calibration offset.
  - Trained contractor on proper installation.
  - Testing to provide no flow condition to verify zero.
- Location of meters weren't providing sufficient upstream/downstream diameters.
  - Relocated other meters.
  - Changed types of meters.
- Calibrated differential pressure transmitters.
- Configured controls for square root extraction.

Flow Meter Improvements

- Right sized the flow meters were several sizes less than line size.
- Added multivariable transmitters (internal static pressure and external temperature compensation) - pounds of steam usage.
- Provided site wide continuous energy and flow monitoring.

Chilled Water and Steam - Controls Upgrades

- Provided site wide continuous flow of steam and chilled water BTU monitoring with PLC based and industrial SCADA controls.
- Upgrades tied into plant controls upgrade. New redundant server and redundant PLC system.
- Fiber installed with new chilled water piping, reducing installation cost.
- Automated billing data, environmental calculations, GHG calculations.

Chilled Water and Steam - Controls Upgrades

- Thermal monitoring using Industrial Remote I/O.
- Fiber formed a redundant ring for reliability.
- Electrical monitoring via Modbus TCP/IP interfacing with a Power Monitoring using same fiber network as Thermal monitoring.
- Historian data for critical data.
- Reports that support billing, GHG, cooling tower air permit data and other regulatory reports.

Useful References

- Flow Measurement – D W. Spitzer
- Flow Measurement Handbook- Miller
- ASME MFC-3M-2004 Measurement of Fluid Flow in Pipes Using Orifice, Nozzle, and Venturi
- ASME MFC-8M - Fluid Flow In Closed Conduits: Connections For Pressure Signal Transmissions Between Primary And Secondary Devices
- ASME PTC 19.5, Flow Measurement

Q&A

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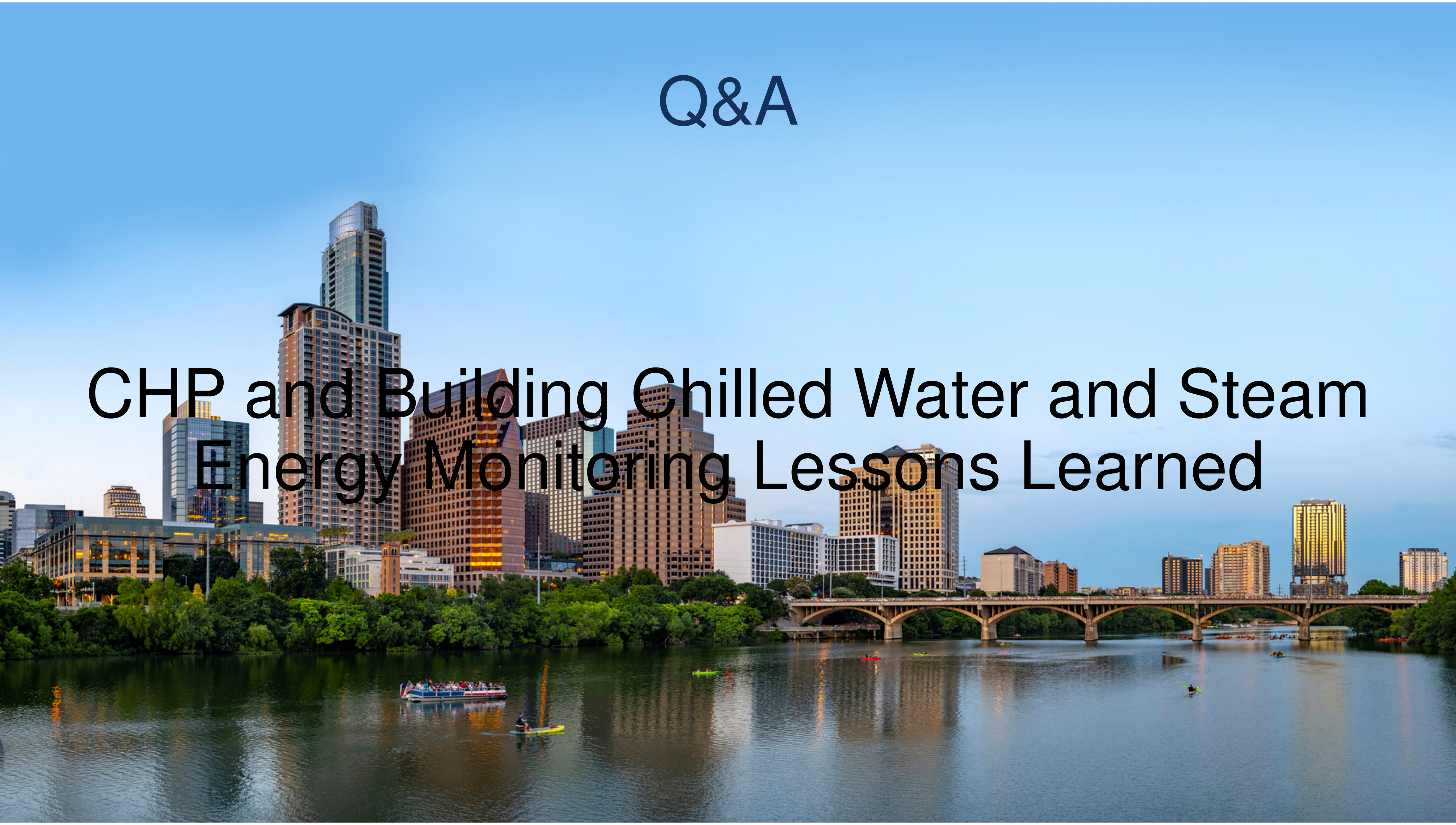

Thank You!

John Beaudry, P.E.

john.beaudry@jacobs.com

Office: (503) 736-4278

Mobile: (503) 730-4781

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