Commissioning Chilled Water Systems

BUILD. CONNECT. ACHIEVE.

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BCxA™ Building Commissioning Association

Learning Objectives

PRESENTATION OVERVIEW

- Introduction to Cx CHWS
- Cx CHWS: Basic Concepts
- Cx CHWS: Process and Field Knowledge
- Functional Testing CHWS: Best Practices
- Q&A

Cx Chilled Water Systems (CHWS)

INTRODUCTION TO Cx CHWS

Properly commissioned building systems will provide:

- Less problems inherited at the end of the project
- Improved comfort and indoor air quality
- Reduced construction and warranty issues
- Complete documentation and critical system operation data
- Better tenant and occupant satisfaction
- Reduced O & M costs and increased reliability
- Lower utility bills
- Improved net operating Income
- A benchmark for future system operating evaluation
- Fully trained operating staff

Cx Chilled Water Systems (CHWS)

INTRODUCTION TO Cx CHWS

- **AN EARLY START IS ESSENTIAL**
- **AQUIRE A FULL UNDERSTANDING OF:**
  - Current system design & approved documents
  - Operational requirements (Owner vs FM vs Designer)
  - Robust documentation (Effective use of Cx Documents)
  - Connecting the gaps
    - *Owner expectations vs User Experience*
    - *Engineer Equipment Schedule vs Controls Drawings*

Cx Chilled Water Systems (CHWS)

INTRODUCTION TO Cx CHWS

- **KNOWLEDGE OF THE Cx PROCESS**
  - Design phase
  - Construction phase
  - Acceptance phase
  - Occupancy & warranty phase
- **CERTIFICATION AND EXPERIENCE (CCP, CPMP)**

Cx Chilled Water Systems (CHWS)

Cx CHWS: BASIC CONCEPTS

- **REQUIRED KNOWLEDGE OF THE CxA**
  - Chilled Water System Design and Applications
  - Knowledge of Chillers, Boilers, and CEP Safety

Cx Chilled Water Systems (CHWS)

Cx CHWS: BASIC CONCEPTS

- **REQUIRED KNOWLEDGE OF THE CxA**
  - Knowledge of Pumps, Hydronics and Piping
  - Knowledge of AHU´s, Heat Exchangers, and Ductwork

Cx Chilled Water Systems (CHWS)

Cx CHWS: BASIC CONCEPTS

- **REQUIRED KNOWLEDGE OF THE CxA**
  - Knowledge of Condenser Water Systems *(As applicable)*
  - Knowledge of Controls & Control Loops *(Floating Setpoints)*

Cx Chilled Water Systems (CHWS)

Cx CHWS: BASIC CONCEPTS

- **IMPORTANT KNOWLEDGE & EXPERIENCE**
  - Engineering Applications, Fluid Dynamics, Psychometrics
  - Construction Installation Methods and Materials
  - Operational & Troubleshooting Skillsets
  - Knowledge of Factory Startup Procedures *(Warranty)*
  - Knowledge of Test & Balance Procedures *(Air & Water)*

Cx Chilled Water Systems (CHWS)

Cx CHWS: BASIC CONCEPTS

- **FIELD EXPERIENCE (I went to College… How do I get it?)**
  - Construction installation & management
  - Architectural & Engineering Construction Administration
  - TAB, Controls & Service Technician Work

Cx Chilled Water Systems (CHWS)

Cx CHWS: PROCESS & FIELD KNOWLEDGE

- **LAYING THE FOUNDATION FOR EFFECTIVE CX**
  - Cx CHWS requires a simple but well defined process to catch and track issues *(Good Cx will enable close out of issues timely)*
  - Timeliness of response, reports, and document delivery
  - Follow up, Follow up, and more Follow up
  - Properly Executed Cx Process = Efficient CHWS $$$
  - Poorly executed Cx Process = Failure to protect Clients

(If you fail to plan – then you plan to fail!)

Cx Chilled Water Systems (CHWS)

Cx CHWS: PROCESS & FIELD KNOWLEDGE

- **CREATING / CAPTURING ACCURATE & USEFUL DATA**
  - Detailed Startup & Prefunctional Checklists (Non-Generic)
  - Submittal Process (Define Registries)
  - Making good use of the Cx Plan (Simple language)
    - Step by step instructions (When, Where, Who & What)
    - Communication protocols
    - Ensure task items for such milestones as Start-up are clearly defined for each Team member whom is responsible

Cx Chilled Water Systems (CHWS)

Cx CHWS: PROCESS & FIELD KNOWLEDGE

- **EFFECTIVE CONSTRUCTION PHASE Cx**
  - **Installation Observations**
    - Equipment on Site = Verification Process (Timeliness)
    - Study up on the systems to be observed
    - Know typical issues (Problem Areas)
    - Focus on most common issues 1st

Cx Chilled Water Systems (CHWS)

Cx CHWS: PROCESS & FIELD KNOWLEDGE

Make up Water Pressure Regulator/Relief Valve Sizing

- (Incorrect / Under sized)

Cx Chilled Water Systems (CHWS)

Cx CHWS: PROCESS & FIELD KNOWLEDGE

- **EFFECTIVE CONSTRUCTION PHASE Cx**
  - **Coming out to the field prepared** (Know More!)
    - Consistency, Methods and Thoroughness
    - Consolidated Floor Plans (Half-Size)
    - System & Zone Maps Complete with Room Names
    - Safety Gear
    - Physically Fit
    - High Resolution Camera

Cx Chilled Water Systems (CHWS)

Cx CHWS: PROCESS & FIELD KNOWLEDGE

Safety, Fitness, and Awareness needed at all times during Cx.

CHWS are more complex and larger. There is more that can go wrong if you are not prepared to stay vigilant on the jobsite.

Cx Chilled Water Systems (CHWS)

Cx CHWS: PROCESS & FIELD KNOWLEDGE

- **TYPICAL AND CRITICAL FIELD ISSUES**
  - **Protection of System Inlets & Outlets**
    - AHU SA/RA/OA/EA Openings, Coil Connections, Pump inlets, Motor openings, Cooling Towers & Basins, Ductwork & Piping
  - **Protection of Staged equipment & during prep and assembly**
  - **Improper use of equipment during construction**

Cx Chilled Water Systems (CHWS)

Cx CHWS: PROCESS & FIELD KNOWLEDGE

- **TYPICAL AND CRITICAL FIELD ISSUES**
  - **Piping Connections**
    - Proper Welds or Joint Types
    - Piping Pressure
  - **Piping Supports & Vibration Isolation**
    - Proper Fasteners, Saddles, Die-Electric separation
    - Approved Vibration Isolation (Noisy Pipes)
    - Insulation Requirements

Cx Chilled Water Systems (CHWS)

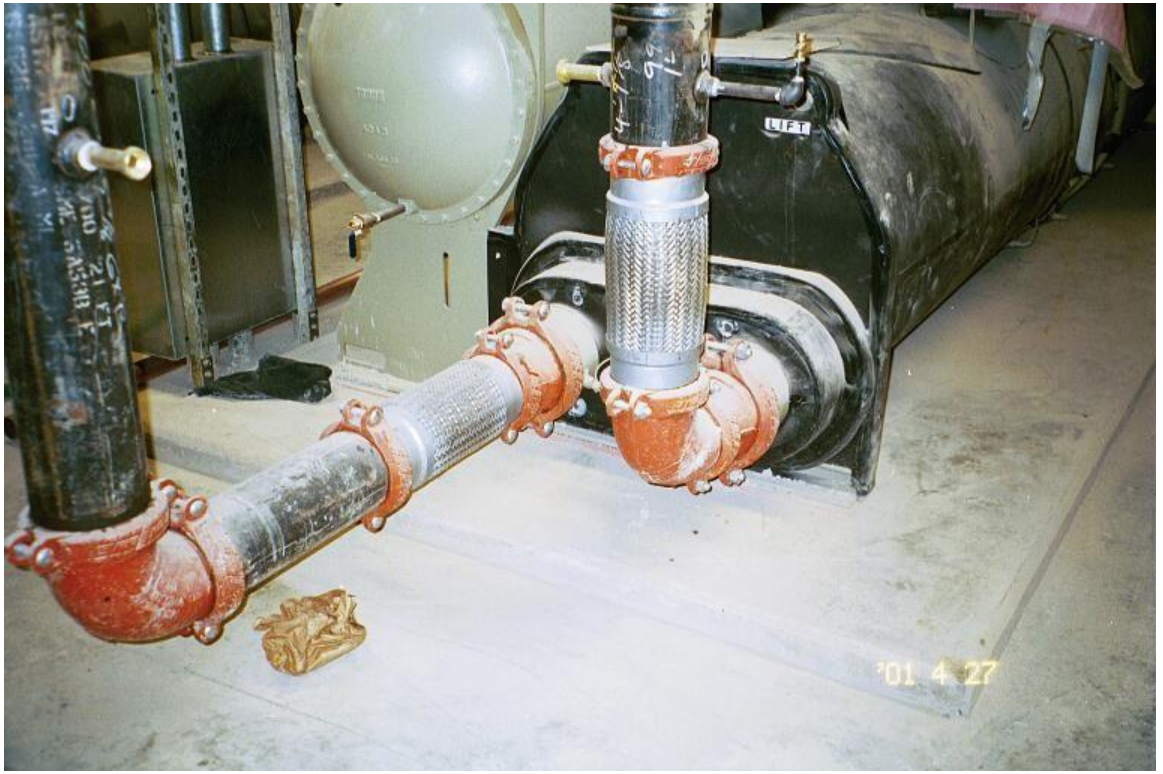
Cx CHWS: PROCESS & FIELD KNOWLEDGE

- Piping insulated and protected with sleeve for protection on exterior applications
- Clearances & Piping Supports

Cx Chilled Water Systems (CHWS)

Cx CHWS: PROCESS & FIELD KNOWLEDGE

- Improperly supported CHW Supply and Return Piping during construction. Unnecessary load on Chiller Marine Box.
- Potential for damage to chiller inlet/outlets.



Cx Chilled Water Systems (CHWS)

Cx CHWS: PROCESS & FIELD KNOWLEDGE

- **TYPICAL AND CRITICAL FIELD ISSUES**
  - **Comprehensive Flush-out Plan**
    - Develop Early (As soon as HVAC contractor is hired)
    - Ensure plans include specific step by step procedures
    - By-pass Coils during initial flushing
    - Schedule Flushing / Chemical Treatment (timeliness)
    - Flush Water Source (Cleanliness)
    - Drip Legs & Strainers (Clean out Included in Plan)
    - Dead Ends (Maintaining Flow)

Cx Chilled Water Systems (CHWS)

Cx CHWS: PROCESS & FIELD KNOWLEDGE

- **TYPICAL AND CRITICAL FIELD ISSUES**
  - **Chemical Treatment Addition Plan**
    - Develop Early (As soon as HVAC contractor is hired)
    - Ensure plans include specific step by step procedures
    - Remove By-passed Coils provide finished flushing
    - Drain system Fully, re-flushing till water is crystal clear

Cx Chilled Water Systems (CHWS)

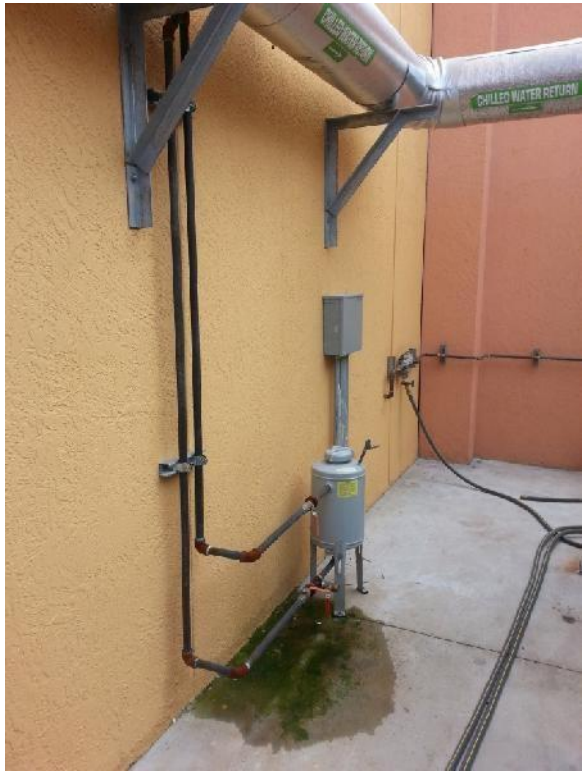
Cx CHWS: PROCESS & FIELD KNOWLEDGE

- **TYPICAL AND CRITICAL FIELD ISSUES**
  - **Chemical Treatment Addition Plan**
    - Maintaining Circulation while adding chemical treatment
    - Ensure all valves are open (included in Cx Flush Plan)
    - All feed control equipment must be in place
    - Certified Contractors & TAB

Cx Chilled Water Systems (CHWS)

Cx CHWS: PROCESS & FIELD KNOWLEDGE

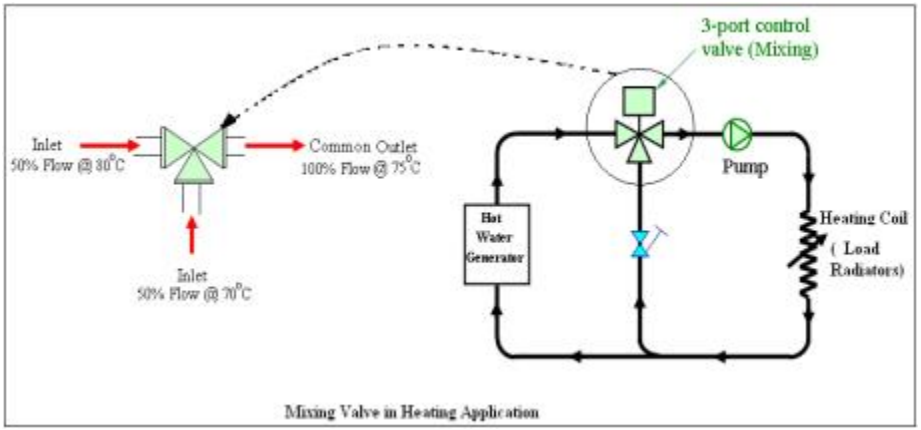
- Shot feeder supply and return lines not insulated and condensation forming/dripping 12-16 from connection at CHWS

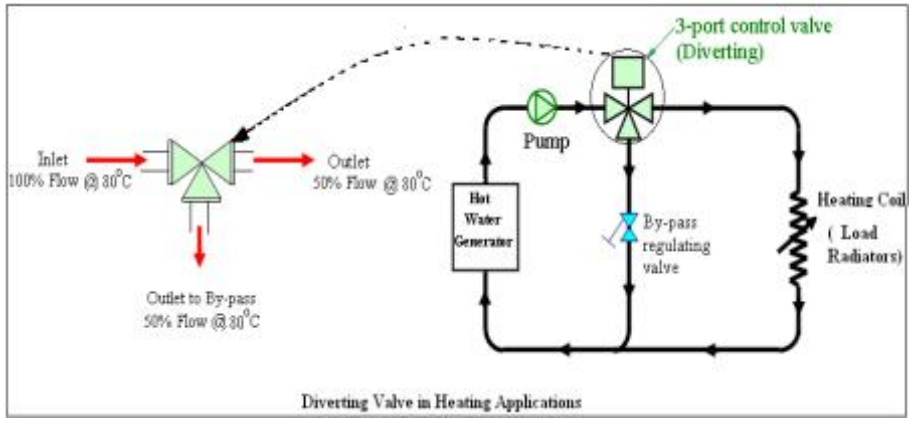


Cx Chilled Water Systems (CHWS)

Cx CHWS: PROCESS & FIELD KNOWLEDGE

- **TYPICAL AND CRITICAL FIELD ISSUES**
  - **Locations of Valves & Sensors**





- Design drawing locations vs submittals
- Test & Balance Results (Troubleshooting)
- Verification of Sensor Readings during TAB

Cx Chilled Water Systems (CHWS)

FUNCTIONAL TESTING: BEST PRACTICES

- **Overall System Level Testing**
  - Goal is for test of all components on a system level
  - Ensure individual components are working 1st
  - Using BAS sensors? What is the TAB Report Status?
  - Controls Loops (Interdependencies & Fine Tuning)
  - Tune only one system at a time – either heating, or cooling. Do not try to tune both at the same
  - Cascading upwards from sub-systems to parent systems
  - Regardless of CxA preference: No PFC – No FPT

Cx Chilled Water Systems (CHWS)

FUNCTIONAL TESTING: BEST PRACTICES

- **Energy Management Controls Systems (BAS)**
  - Cascading Controls Loops (interdependencies)
    (Proportional + Integral + Derivative = PID)

P =How far away from setpoint
I =Time away from setpoint
D =Approach/Decay speed to/from setpoint

Common Factors contributing to an unstable system:

- Too much gain (too narrow a throttling range) for a proportional system.
- The controlled variable has too much capacity to be reasonably controlled.
- Incorrect install – Often, the sensor providing feedback is located in a remote location.
- Too much lag time (delay) in the response of the system.

Cx Chilled Water Systems (CHWS)

FUNCTIONAL TESTING: BEST PRACTICES

Chiller, Boilers, Cooling Tower Testing

- Senor Locations & Readings
  - Safeties, Interlocks, Alarms
  - Unit Capacity (Part-Load vs Full Load)
  - Staging (Lead/Lag & Demand Response per AHU zone)
  - Water Temperature Reset
  - Control Accuracy and Stability (Control Loops / Hunting)

The system should not require the controlled device to operate at an extreme position – this is an indication of lost control.

Cx Chilled Water Systems (CHWS)

FUNCTIONAL TESTING: BEST PRACTICES

- **Pumping System Testing**
  - Senor Locations & Readings
  - Safeties, Interlocks, Alarms
  - Pump Capacity (Part-Load vs Full Load)
  - Actuation & Sequencing
  - Setpoints and Pressure Reset
  - Control Accuracy and Stability (Control Loops / Hunting)

Cx Chilled Water Systems (CHWS)

FUNCTIONAL TESTING: BEST PRACTICES

- **AHU System Testing**
  - Senor Locations & Readings
  - Safeties, Interlocks, Alarms (EA/RA/OA)
  - SA Temperature Control (Part-Load vs Full Load)
  - Actuation & Sequencing
  - Setpoints, Static Pressure Reset
  - CHW Valve Control and Water Temp Reset
  - Control Accuracy and Stability (Control Loops / Hunting)

Cx Chilled Water Systems (CHWS)

O&M: BEST PRACTICES

- **Training provided to facilities maintenance staff (FMS)**
  - Understanding & conveying maintenance impacts to the owner
  - Developing meaningful operational troubleshooting and system maintenance procedures
  - Teaming with the engineer of record, contractor & manufacturer to yield better results

Cx Chilled Water Systems (CHWS)

O&M: BEST PRACTICES

Typical Chiller Maintenance Tasks

- Check setpoints
- Check for fouling of evaporator and condenser tubes
- Check water quality
- Check for leaks
- Conduct oil analysis and change as necessary
- Check strainers and valves
- Check electrical connections

Cx Chilled Water Systems (CHWS)

O&M: BEST PRACTICES

Typical Cooling Tower Maintenance Tasks

- Setup a testing program/schedule for water quality
- Setup strict schedule of water treatment and blown down to prevent buildup of mineral deposits and premature erosion
- Setup a schedule for periodic cleaning
- Check condition of fill, wood frame, nozzles, water level control and degree of approach.
- Check for leaks

Cx Chilled Water Systems (CHWS)

O&M: BEST PRACTICES

Typical Pump Maintenance Tasks

- Check for Vibration
- Check Bearing temperature
- Check for unusual noise
- Check for entrapped air at impeller (Cavitation effects)
- Check flow @ design RPM and FLA
- Check for leaks

Thank You

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