What Does a Successful Turn-Over to the Building Operator look like?

Bryan W. Welsh, P.E.
President
Welsh Commissioning Group, Inc.
Learning Objectives

1. Planning activities that lead to a successful project
2. How to use project documents and specifications to help assure a successful project Turn-Over
3. Construction phase activities to support Turn-Over
4. Occupancy and Operations phase actives that contribute to a successful project turn over
Bryan Welsh – President, WCxG

BS Mechanical Engineering, Licensed PE
LEED Accredited Professional
BCA Certified Commissioning Professional
ACG Certified Commissioning Authority
25 years engineering and facility engineering experience in commercial, industrial and educational facility environment
10 years as facilities manager receiving new and remodeled facilities
Full-time commissioning provider since 1999, part time provider since 1989
Overview

- Challenges to a Successful Turn-Over
- Integrating Turn-Over into the Building Delivery Process
- Pre-Design and Design Phase Activities
- Construction Phase Activities
- Occupancy and Operations Phase, Turn-Over
Challenges to Successful Turn-Over

What Does a Successful Turn-Over to the Building Operator look like?

Well….. what doesn’t it look like?
The Owner says:

“We need an environmentally friendly swing that will accommodate multiple kids.”

The Building Delivery Process at Its Worst:

1. How the Owner explained it
2. How the Project Leader understood it
3. How the Architect envisioned it
4. The results of Value Engineering
5. What the Bid Documents show
6. How the Contractor built it
7. What it cost the Owner
8. What the Owner really needed
9. How the project was documented
10. How it got Maintained
Test Question

In a typical specification, what direction will be provided regarding operator training?

A. Nothing
B. A complete list of training requirements
C. A list of training requirements that meets the specific needs as articulated by the Owner’s staff
D. Whatever was used last time by the designer
Chemical Treatment Spec - Ground Source HP System

PART 2 - PRODUCTS

2.1 CHEMICALS
   A. Condenser Water: Environmentally safe corrosion inhibitor.

2.2 POT FEEDER
   A. Closed Loop Filter Feeders:
      1. A 5-gallon feeder, such as the Wingert FHC-DB-5HD or equivalent, shall be installed across the recirculation pump of each closed loop where the system volume is 2,000 gallons or greater. For loops less than 2,000 gallons, and 2-gallon feeder such as the Wingert FHC-DB-2HD or equivalent, can be installed if space is limited. Filter feeder shall not be installed more than 12 inches (1 foot) above the floor of the mechanical room. A 12-month supply of filter socks (6 - 12 socks) shall be supplied following the initial cleaning, flushing and treatment of system. Two (2) replacement O-rings shall also be supplied for the filter feeder lid.
      2. Chilled loop filter feeders and bypass piping shall be insulated.

3.4 INSTALLATION OF COUPON HOLDERS
   A. Provide coupon holders with isolation valves in all treated closed systems.

3.5 CHEMICAL TEST EQUIPMENT
   A. Provide complete test sets for each system. Provide test cabinet with lights for condenser and steam boiler systems. Provide complete test sets for condenser and closed system tests. Provide logbooks for each system.
Godzilla Teaches Controls

Generator 1.mpg
Recent Real Life Example:
- Leased facility
- Owner contracts for HVAC services
- Lessee – Building Manager/Operator
- Lessee – Building Automation System Manager
- Lessee – SCADA System & Utility Monitoring Manager
- The approach will depend on organizational structure
Owner Maintenance Staff Challenges

- Often don’t make use of material they are given
- Existing relationships with suppliers can undermine plans
- Complex organizational structures
- Outsourcing
- Staff Turn-Over
Commissioning – Quality Assurance

Pre-Design Phase:
- OPR Review
- BOD Review

Design Phase:
- SD & DD Review
- Cx Specs
- CD Review

Construction Phase:
- Submittal Review
- Cx Plan
- Site Observe
- Start Up
- Install Verify
- Functional Test
- Cx Report

Operation and Occupancy Phase:
- Systems Manual Review
- O&M Review
- Training Verify
- Seasonal Test
- Post-Occ Review
- Lessons Learned
- OCx MBCx
Integrating Turn-Over Into the Building Delivery Process
A Failure to Plan is a Plan to Fail

• Build Turn-Over into the total process
  • OPR
  • Specifications
  • Commissioning Plan
  • Construction Phase Activities
  • Occupancy and Operations Phase Activities
Planning

Approach Depends on Organizational Structure

• Owner & Operator – Institutional
• Complex Owner/Operator Relationships
• Leased Facility
• Core and Shell

Evaluate specific needs and best approach
Document in OPR and/or Specifications
Supporting Turn-Over in the OPR and Specs

• O&M Manual format and content
• Specific training requirements - who, how much, when, what – Don’t forget the occupant
• Warranty requirements
• Spares
• Test Kits
• Interface devices and software
• Involve the Owner’s staff
• Ongoing Commissioning sequence of operations and systems
# OPR Content

## Maintenance and Operations Information

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic Hot Water</td>
<td>SLCo Facilities Plumbers</td>
<td>Maximo</td>
<td>Pipe labeling and color code, valve tags, index posted</td>
<td>(4)</td>
</tr>
<tr>
<td>HVAC</td>
<td>SLCO Facilities HVAC</td>
<td>Maximo</td>
<td>All HVAC equipment. (1)(2)</td>
<td>(4) Chillers = Carrier, York and McQuay only</td>
</tr>
<tr>
<td>Building Automation</td>
<td>SLCo Facilities HVAC</td>
<td>Maximo</td>
<td>All controllers (2)</td>
<td>Alerton BacTalk as per (4)</td>
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<tr>
<td>Lighting and Control</td>
<td>SLCo Facilities Electricians</td>
<td>Maximo</td>
<td>Outside light controller (2)</td>
<td>(4)</td>
</tr>
<tr>
<td>PV Array</td>
<td>SLCo Facilities Electricians</td>
<td>Maximo</td>
<td>Inverters and meters</td>
<td></td>
</tr>
</tbody>
</table>

**Key Notes:**
1. All equipment to be identified with unique identifying numbers in equipment schedule and on plans.
2. Black plastic tags with white letters. **No self-adhesive allowed, permanent attachment method.**
3. Not used.
4. See county standard.

## 5. Quality Control/Testing

<table>
<thead>
<tr>
<th></th>
<th></th>
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<tbody>
<tr>
<td>Domestic Hot Water</td>
<td>County Standards Division 22 requirements and applicable codes</td>
<td>Access panels as needed</td>
</tr>
<tr>
<td>HVAC</td>
<td>Commissioning</td>
<td>Have strategic plan for VAV box locations. Owner is very concerned about access. Ceiling tile access should be avoided if possible. If not, coordinate with space contents.</td>
</tr>
<tr>
<td>Building Automation</td>
<td>Commissioning</td>
<td></td>
</tr>
<tr>
<td>Lighting and Control</td>
<td>Commissioning</td>
<td></td>
</tr>
<tr>
<td>PV Arrays</td>
<td>Commissioning</td>
<td></td>
</tr>
</tbody>
</table>

**Key Notes:**
SECTION 230553 – IDENTIFICATION FOR PIPING & EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes mechanical identification materials and devices.

B. Provide red lettering on the ceiling tiles of the locations of all fire dampers, smoke dampers and fire/smoke dampers. Size of lettering and verbiage is to conform to IBC and NFPA standards.

C. Equipment ID tags for all equipment, plumbing and mechanical shall be screwed or riveted.

1.3 SUBMITTALS

A. Product Data: For identification materials and devices.
# OPR Content

## Training Requirements

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<tbody>
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<td>Facilities plumbers</td>
<td>2 hour</td>
<td>Installing contractor</td>
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<td>No</td>
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<tr>
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<td>Factory rep on chiller and boiler</td>
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<td>(1)(4)</td>
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<td>No</td>
<td>(1)(4)</td>
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<td>SLCo Facilities electricians</td>
<td>2 hour</td>
<td>Installing contractor</td>
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<td>No</td>
<td>(4)</td>
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<tr>
<td>PV Array</td>
<td>SLCo Facilities electricians</td>
<td>2 hour</td>
<td>Installing contractor</td>
<td>No</td>
<td>No</td>
<td>(4)</td>
</tr>
</tbody>
</table>

**Key Notes:**

1. If a professionally produced technical training video, DVD or interactive DVD is available from the manufacture of this system or equipment and those videos or DVD’s are given to the owner, the videos or DVD’s could count for up to half of the training time required. The video or DVD cannot take the place of a tour of the completed installation. The “Training Modules” in Section 017900 must still be discussed.
2. Must be filmed by professional.
3. 1 week Alerton training including travel and per diem.
4. Warranties shall be provided in a separate binder and provided in Adobe PDF format.

## 7. Topics

<table>
<thead>
<tr>
<th>System</th>
<th>7. Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic Hot Water</td>
<td>Tour of installation. Training agenda to include all “Training Module” topics found in SLCo Standards -- Demonstration and Training-Section 017900 as a minimum.</td>
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<tr>
<td>HVAC</td>
<td>Tour of installation and control programming instruction. Training agenda to include all “Training Module” topics found in SLCo Standards -- Demonstration and Training-Section 017900 as a minimum. Additional emphasis shall be placed on the operation, maintenance, troubleshooting of high efficiency boilers and the chiller.</td>
</tr>
<tr>
<td>Building Automation</td>
<td>Tour of installation and control programming instruction. Training agenda to include all “Training Module” topics found in SLCo Standards -- Demonstration and Training-Section 017900 as a minimum.</td>
</tr>
<tr>
<td>Lighting and Control</td>
<td>Tour of installation. Training agenda to include all “Training Module” topics found in SLCo Standards -- Demonstration and Training-Section 017900 as a minimum.</td>
</tr>
<tr>
<td>PV Array</td>
<td>Tour of installation. Training agenda to include all “Training Module” topics found in SLCo Standards -- Demonstration and Training-Section 017900 as a minimum.</td>
</tr>
</tbody>
</table>

**Key Notes:**
3.7 AS BUILT DOCUMENTATION REQUIRED

A. 5 sets of as-built documents are required in electronic format.

3.8 TRAINING

A. Provide application engineer to instruct owner in operation of systems and equipment.

B. Provide system operator’s training to include (but not limited to) such items as the following: modification of data displays, alarm and status descriptors, requesting data, execution of commands and request of logs. Provide this training to a minimum of 3 persons.

C. Provide on-site training above as required, up to 8 hours as part of this contract.

D. Provide up to 40 hours of time to work with the commissioning agent to ensure that all systems are functioning.

E. Provide tuition for at least one individual for a one-week factory training class including costs.

HVAC INSTRUMENTATION AND CONTROLS

230900 - 14
Review Plans and Specifications for Content

Construction Document Review
Commissioning Plan Development Check List

<table>
<thead>
<tr>
<th>Section Or Sheet</th>
<th>Page Detail Note</th>
<th>Description</th>
<th>Sub. Rev.</th>
<th>Site Obs.</th>
<th>Startup</th>
<th>SRC &amp; IV</th>
<th>FPT</th>
<th>IAB</th>
<th>O&amp;M</th>
<th>Warranty</th>
<th>Training</th>
<th>Spares</th>
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Project: ___________________________ Date: _________
# Turn-Over in the Commissioning Plan

## Appendix Table of Contents

<table>
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<th>Tab</th>
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<tbody>
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<td>Commissioning Authority Qualifications</td>
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<tr>
<td>Commissioned Equipment List</td>
<td>2</td>
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<tr>
<td>Commissioning Schedule</td>
<td>3</td>
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<tr>
<td>Owner Project Requirements/Basis of Design Review Documentation</td>
<td>4</td>
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<tr>
<td>Commissioning Specifications</td>
<td>5</td>
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<tr>
<td>Construction Document Review Reports</td>
<td>6</td>
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<td>Submittal Review Reports</td>
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<td>Commissioning Meeting Minutes and Site Observations Reports</td>
<td>8</td>
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<tr>
<td>Start-Up Plan and Systems Readiness Checklists</td>
<td>9</td>
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<td>Installation Verification Checklists</td>
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<td>TAB Verification</td>
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<td>Functional Performance Test Plan</td>
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<td>Trend Log Plan</td>
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<td>Commissioning Issues List</td>
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<td>M&amp;O Review Report</td>
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<td>M&amp;O Owner Training Verification</td>
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<td>Project Closeout Checklists</td>
<td>17</td>
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<tr>
<td>Post Occupancy Review</td>
<td>18</td>
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<tr>
<td>O&amp;Ms, Training Warranties, Spares Etc.</td>
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<tr>
<td>Place Holder Preliminary Agenda</td>
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18th National Conference on Building Commissioning

A PECI EVENT
Construction Phase
Construction Phase Activities

• Discuss the Turn-Over and closeout activities at the initial commissioning coordination and subsequent meetings
• During Site Observations, mark up working plans with major changes so that As-Built Documents can be reviewed easily
• During testing make notes of any controls or sequence changes
• Request and review training agendas with Owner
• Track all Turn-Over and closeout activities
Occupancy and Operations Phase
Occupancy and Operations

- Review O&M Manuals
- Review As-Built Documents
- Verify Warranties
- Verify Spares
- Provide a Systems Manual
- Verify or provide training
- Build interactive training media
- Post Occupancy Reviews
- Ongoing Commissioning
O&M and As-Built Documents
O&M Review & As-Built Review

• Know the specification requirements regarding content, layout, etc.
• Usability - watch out for “cut sheets”
• What would you want to have?
• O&M for each system
• Use field notes for as-built review
• Review controls as-built schematics and sequences in detail
## Irrigation System O&M Manual Review

<table>
<thead>
<tr>
<th>Item</th>
<th>Sheet/Page</th>
<th>Review Comment</th>
<th>By:</th>
<th>Resolution</th>
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<tbody>
<tr>
<td>1</td>
<td>N/A</td>
<td>Specification section 02810 1.2.B.b requires supplier contact information be provided for each individual product. This information does not appear to be provided.</td>
<td>TSO</td>
<td>Record Drawings are being updated electronically known by SPVV Thomas A. Pratt</td>
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<tr>
<td>2</td>
<td>N/A</td>
<td>Specification section 02810 1.2.B.e requires a system description, sequence of operation, and a copy of the record drawings to be included in the manual. This information does not appear to be provided.</td>
<td>TSO</td>
<td></td>
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<tr>
<td>3</td>
<td>N/A</td>
<td>There appears to be no listing of recommended spare parts included in the manual. This list is required by specification section 02810 1.2.B.d.</td>
<td>TSO</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>N/A</td>
<td>There appears to be no wiring diagrams included in the manual. Wiring diagrams are required by specification section 02810 1.2.B.e.</td>
<td>TSO</td>
<td>The wiring layout is indicated on the ‘Record Drawings’ Thomas A. Pratt</td>
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<tr>
<td>5</td>
<td>N/A</td>
<td>Specification section 02810 1.2.B.f requires a copy of any inspection or test reports (e.g., mainline pressure test) to be included in the manual. No test or inspection reports appear to be included.</td>
<td>TSO</td>
<td>No inspection reports or test acknowledgements were provided other than the Substantial Completion Report for this portion of the project. Thomas A. Pratt</td>
</tr>
</tbody>
</table>
Training
Training Verification

- Know the specification requirements regarding who, how (much), what, where
- Request a training agenda
- Verify credentials, in particular the videographer
- Verify Owner reviews and approves agenda
- Witness training, provide training or collect sign-in and other documentation for review
I. INTRODUCTIONS

II. START-UP and LOG-ON
   A) Starting Envision for BACtalk
   B) User Name
   C) Password

III. NAVIGATION
   A) Floor plans
   B) Zones
   C) Quick Views
   D) Main Mechanical Systems

IV. CHANGING SETPOINTS
   A) Room Temperature Setpoint
   B) Local Temperature Adjustment Range
   C) After-Hours Override Timer

V. SCHEDULES
   A) View Schedules
   B) Adjust Schedules
      1) "Normal" Schedule
      2) "Event" Schedule
      3) "Holiday" Schedule

VI. TREND LOG
   A) View a Trend Log
   B) Set-up Trend
   C) Set-up Multiple Trends

VII. ALARMS
   A) Acknowledge an Alarm
   B) Set-up an Alarm

VIII. "TROUBLE" PROCEDURE
   A) Customer (Tenant) Complaint
   B) View Area of Trouble
   C) Is the System trying to Satisfy or Failure?
   D) If Trying, Why Can't the System Satisfy?
   E) If Failure, What Failed?
   F) Print Screen(s)
   G) Call for Service

IX. Physical Layout of Hardware
   A) Global Controller (BCM)
   B) VisualLogic Controllers (VLC)
   C) Space Sensors (Microset II)
   D) Carbon Dioxide Sensor (Multipurpose Room)

X. Questions?
# Training Agenda and Schedule

## MECHANICAL

<table>
<thead>
<tr>
<th>Component</th>
<th>Instruction Description</th>
<th>Time Frame (hrs)</th>
<th>Training Date</th>
<th>Proposed Time</th>
<th>Instructing Company</th>
<th>Instructor Name</th>
<th>Contact Info</th>
</tr>
</thead>
</table>
| Complete Piping Systems | - Building Piping Systems walk-thru  
  o Condenser Water System (locations of valves, drains, piping & risers)  
  o Steam System (locations of valves, drains, piping & heating water riser)  
  o Fuel Fill System (locations of valves, drains, piping & alarm systems)  
  o Chemical Fuel System (walk through operation)  
  o Heat Trace (walk through operation) | 2               | 6/30/06       | 7:30 - 9:30   | MacMiller         | Glen Nelson - MM Pipe Fitter       | cell 206.396.4966 |
| Complete Plumbing Systems | - Building Plumbing Systems walk-thru  
  o Domestic water, waste & Vent systems (walk-thru including equipment, valves, piping, risers and cleanouts)  
  o Roof Drains, back-flow preventers  
  o Natural Gas (piping locations and operation)  
  o Water Heater (location and operation) | 2               |              |               | Auburn Mechanical | Scott Nelson - AM Plumber          | cell 206.730.4067 |
| Complete HVAC Systems | - HVAC Systems – Description of Operation  
  o Identifies how systems function and their design intent  
  o Review of equipment maintenance and operational tasks  
  o Major Equipment – Operations and Maintenance  
  o Fluid Cooler (including pumps & VFDs)  
  o Steam-Heating Water Converter  
  o Hydronic Heat Pumps  
  o Hydronic Systems Makeup Water | 2               | 7/5/06        | 7:30 - 9:30   | MacMiller         | Ron Landsberg - MM CX Agent        | cell 206.571.2661 |
| Partially Complete Controls | Overview of Metasys System Architecture  
  o Overview of controls components and HVAC equipment under control  
  Metasys System hardware basics  
  HVACPRO Programming tool  
  NAE overview and programming  
  Scheduling  
  Trending  
  Graphics | 4               | 6/30/06       | 1:00 - 4:00   | Automated Controls | Ken Was - Controls Technician & Programmer | cell 425.864.0513 |

## ELECTRICAL

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<tr>
<th>Component</th>
<th>Instruction Description</th>
<th>Time Frame (hrs)</th>
<th>Training Date</th>
<th>Proposed Time</th>
<th>Instructing Company</th>
<th>Instructor Name</th>
<th>Contact Info</th>
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</thead>
<tbody>
<tr>
<td>Complete Fire Alarm</td>
<td>Fire Alarm</td>
<td>1</td>
<td>7/7/2006</td>
<td>12:00 - 1:00</td>
<td>JCI</td>
<td>Jim Morey &amp; Tim Morrison</td>
<td>cell 206.383.3016</td>
</tr>
<tr>
<td>Complete Electrical Infrastructure</td>
<td>Electrical Infrastructure</td>
<td>1</td>
<td>8/8/2006</td>
<td>10:00 - 11:00</td>
<td>EHS</td>
<td>Kevin Schmoll</td>
<td>cell 206.383.3016</td>
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<tr>
<td>Complete Generator</td>
<td>Generator</td>
<td>1</td>
<td>7/7/2006</td>
<td>10:00 - 11:00</td>
<td>Generac</td>
<td>Collin</td>
<td>cell 206.383.3016</td>
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<tr>
<td>Complete Security</td>
<td>Security</td>
<td>4</td>
<td>7/7/2006</td>
<td>8:00 - 12:00</td>
<td>Precision Alarm</td>
<td>Scott Rose</td>
<td>cell 206.383.3016</td>
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## Fire Sprinklers

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<th>Instruction Description</th>
<th>Time Frame (hrs)</th>
<th>Training Date</th>
<th>Proposed Time</th>
<th>Instructing Company</th>
<th>Instructor Name</th>
<th>Contact Info</th>
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<tr>
<td>Complete Fire Sprinkler</td>
<td>Fire Pump Fundamentals</td>
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<td>7/10/2006</td>
<td>10:00 - 11:00</td>
<td>Patriot Fire Protection</td>
<td>Scott Rose</td>
<td>cell 206.383.3016</td>
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18th National Conference on Building Commissioning  
A PECI EVENT
## Post Facto Training Verification

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<th>Spec Section</th>
<th>Description</th>
<th>Hrs</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>23 09 23 - 3.11</td>
<td>DDC System for HVAC</td>
<td>3 hrs</td>
<td>Training provided by applications engineer.</td>
</tr>
<tr>
<td>23 25 00 - 3.04</td>
<td>HVAC Water Treatment</td>
<td>2 hrs</td>
<td>Instruction in maintenance, testing and operation of water treatment system.</td>
</tr>
<tr>
<td>23 33 00 - 3.03</td>
<td>Air Duct Accessories</td>
<td>2 hrs</td>
<td>Demonstrate resetting of fired dampers to Owners representative</td>
</tr>
<tr>
<td>23 34 00 - 3.05</td>
<td>HVAC Fans Demonstration</td>
<td></td>
<td>Fan operation and maintenance procedures demonstrated.</td>
</tr>
<tr>
<td>23 73 00 - 3.05</td>
<td>Indoor Central Station Air Handling Unit - Demonstration</td>
<td>One 8 hour day</td>
<td>Demonstration of operation and maintenance.</td>
</tr>
<tr>
<td>23 74 13 - 3.06</td>
<td>Packaged Outdoor Central Station Air Handling Unit</td>
<td>One 8 hour day</td>
<td>Demonstration of operation and maintenance.</td>
</tr>
<tr>
<td>23 81 03 - 3.06</td>
<td>Packaged Rooftop Air Conditioners</td>
<td>One 8 hour day</td>
<td>Demonstration of operation and maintenance.</td>
</tr>
</tbody>
</table>

C = Complete  A = Acceptable  

Owner Sign Off: __________________________ Date: __________
Existing Building – Customized Training

9.00
Training DVD

WSU.HurstCtr.Mech&ElevatorTraining

Air Handler

Air Handler Control Room

Boilers

Building Controls

Chiller

Heating Water Collector

01 / 02
Closeout
Contractor Closeout Checklists

Project Closeout Checklist:

Instruction:
- Owner instruction is complete per project documents.
- Post contract instruction for winterization or spring start-up arrangements have been made with Owner.

Warranty and Spares:
- 2 Year warranty has been provided with operations and maintenance manuals.
- All spares have been submitted to owner and receipt of materials signed.
  - 10% of each rotor head type
  - 2 quick disconnect couplings

Documentation:
- O&M Manuals are complete and submitted.
- As-built drawings, material list, technical literature, list of operation and maintenance manuals have been updated and included in the O&M manuals.

Final Acceptance:
- Final performance testing completed and system accepted by Owner and CA.

Please note: This checklist is not intended to represent all the items that may be required to complete the work as detailed within this section. Completion of the items on this checklist does not constitute any contractual obligation to complete all the work as detailed within this section.

<table>
<thead>
<tr>
<th>Team Member</th>
<th>Print Name/Co.</th>
<th>Initial</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installing Contractor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Contractor CC</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
All-in-One Approach

Emergency Generator

• Start-up
• Load Bank Testing
• Functional Test
• Training
• Project Closeout
• All in the same day
Systems Manual
a) Index of commissioning documents
b) Commissioning Report
c) OPR
d) As-built documents
e) Description of systems, including capabilities and limitations
f) Operating procedures for all normal, abnormal, and emergency modes of operation
g) Sequence of operation as actually implemented, with control system data including all set points, calibration data, etc.
h) Location of all control sensors and test ports.
i) Seasonal start-up and shutdown procedures.
j) Control schematics and computer graphics
k) Complete terminal interface procedures and capabilities for DDC systems.
l) A list of recommended operational recordkeeping procedures including sample forms, trend logs, or others, and a rationale for each
m) Maintenance procedures

Sample Systems Manual.pdf
Post Occupancy
Post Occupancy Review

Required by LEED EA CR3, but valuable any time
Good opportunity to see what did and did not stick
Have meeting, conduct interviews, perform surveys, evaluate trends and perform targeted functional testing
Provide review report

Sample Report
On Going Commissioning
Elements of an Integrated OCx Plan

- Overview, goals, roles & responsibilities, etc.
- List of systems/equipment/parameters to be included & performance criteria
- Detailed procedures for all elements
- Action plan for all elements – reporting requirements
- A schedule for all elements, tie into CMMS if possible, use Outlook tasks, etc.
- DDC alarm plan, with reporting and response
- Trend Logging Plan, with analysis procedures
- Data Logging plan, with analysis procedures
- Manual (paper) test forms and procedures
- Automated test forms and procedures
- Utility bill acquisition and analysis procedure
- Utility meter download acquisition, with analysis procedures
Integrated Approach for OCx

Calibration Check

Trend

Auto Test

Alarm

Building Static Pressure
setpt: 0.05 in H₂O

Duct Static Pressure
setpt: 0.75 in H₂O

89.3 °F
24.5 °C
CO₂
460.0 ppm
Key Concepts

• Always start with the end in mind – the OPR then Specifications
• The specifications will dictate what minimum requirements will be included – and that is all you will get
• Build and execute a commissioning plan that does not leave Turn-Over to chance
• Don’t allow the Owner to undermine themselves
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Questions?

Ideas?

Thank you

Bryan Welsh – Welsh Commissioning Group, Inc.

bryan@wcxg.com  253-856-3322

WCXG

PECI