

BEYOND

SMART CITIES

MAINTENANCE AND COMMISSIONING - CEM

REFRESHER TRAINING COURSE

KRISHNAJI PAWAR, LEED AP BD+C, GSAS CGP, ISO 14001:2015, GCP

CEM REFRESHER TRAINING COURSE

ENERGY MANAGEMENT SPECIALIST

BEYOND SMART CITIES

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COMMISSIONING DOCUMENTATION

FOR ENERGY PROFESSIONALS

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LEARNING OBJECTIVES

Design Intent Document

Basis of Design

Commissioning Plan

Commissioning Specifications

Start-up Verification

Functional Test Plans

O&M/Training Info

ENERGY MANAGEMENT SPECIALIST

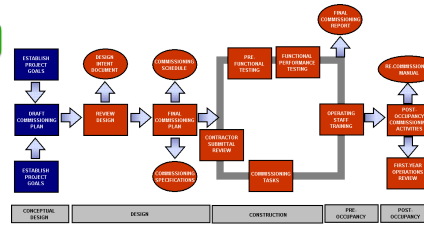
BEYOND SMART CITIES

COMMISSIONING DOCUMENTATION



Design Intent Document

- Basis of Design
- Commissioning Plan
- Specifications
- Start-up Verification
- Functional Test Plans
- O&M/Training Info



DESIGN INTENT

- ✓ Critical to a successful Commissioning Process
- ✓ Conveys the owner's "big-picture" needs
- ✓ Defines benchmark for determining success
- ✓ Utilized and updated by Commissioning team throughout the Cx Process
- ✓ Living Document



SAMPLE DESIGN INTENT CONTENT



- ✓ Project goals and design goals: Overall LEED™ Rating
- ✓ Measurable performance criteria: Applicable codes and standards, General efficiency, Energy goals, Tolerances of the IEQ objectives
 - ✓ Envelope U-values
 - ✓ Chiller kW/ton
 - ✓ Annual Energy Use Goal
- ✓ Operation plan & maintenance requirements
- ✓ Types of tenants, occupancy req's, operating schedule
- ✓ IEQ criteria: space temperature, relative humidity, indoor air quality, noise level, and illumination level



COMMISSIONING DOCUMENTATION



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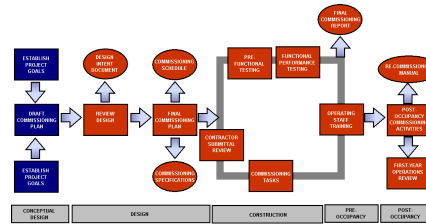
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BASIS OF DESIGN

- ✓ Required input from Design Engineers into the Commissioning Process
- ✓ Completed prior to the end of Construction Docs
- ✓ Documents engineering detailed assumptions
- ✓ Used to complete design reviews, submittal reviews, and write functional tests
- ✓ Utilized and updated by Commissioning team throughout the Cx Process

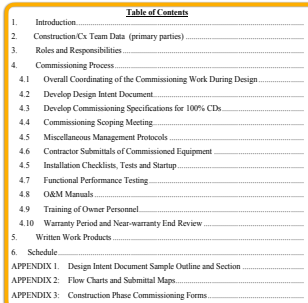


SAMPLE BASIS OF DESIGN CONTE

- ✓ Htg & Clg loads & design assumptions
- ✓ Engineering calcs (i.e. piping sizing, duct static, duct sizing, pump head, diversity factors)
- ✓ Outdoor weather conditions
- ✓ General ventilation strategies & requirements
- ✓ Filtration requirements
- ✓ Control system point list
- ✓ System and control requirements & maintenance personnel capabilities



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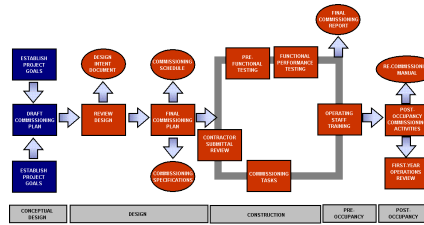
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CX SPECIFICATIONS

☒ Provide contractor's responsibilities for Commissioning

☒ Division 1, Section 01810 is Commissioning Requirements

☒ Additional Sections may be needed for more detailed information

- ☒ 01811: Mechanical Systems
- ☒ 01812: Electrical Systems

☒ Integrate with other specifications

- ☒ Scheduling
- ☒ Closeout
- ☒ O&M Data
- ☒ Training

☒ Requires coordination

- ☒ Specification writer
- ☒ Commissioning provider
- ☒ Design Professionals



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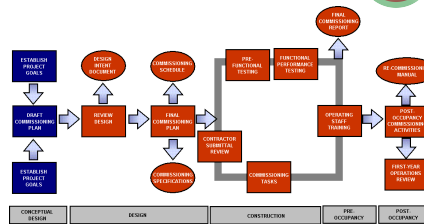
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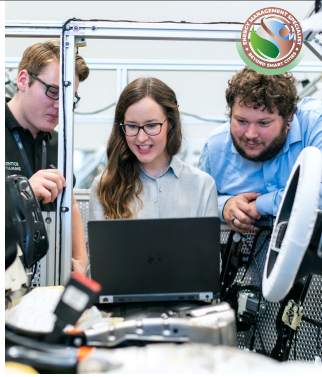
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START-UP VERIFICATION

- ✓ Work with contractor's to verify that start-up is completed
- ✓ Use *Pre-functional Checklists* to document completion
- ✓ Start-up is completed prior to Functional Testing



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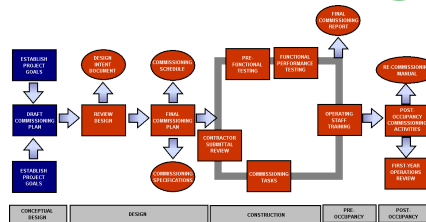
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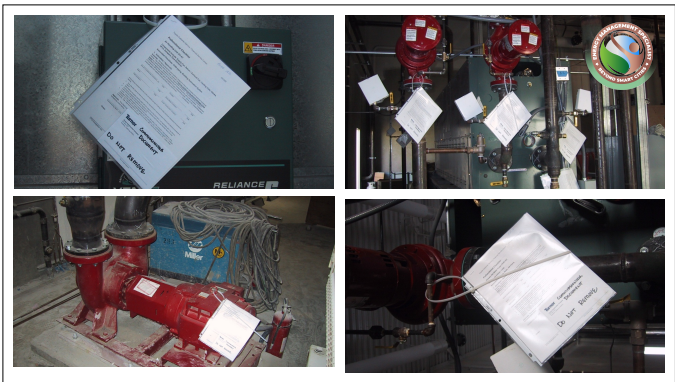


FUNCTIONAL TESTING & ANALYSIS

✓ Heart of Commissioning

- ✓ Design Intent is verified
- ✓ Most time-intensive Cx activity
- ✓ Requires collaboration between: Owner, Contractor, Cx Provider
- ✓ Cx Provider writes detailed procedures
 - ✓ Test each system
 - ✓ Test under all modes of operation



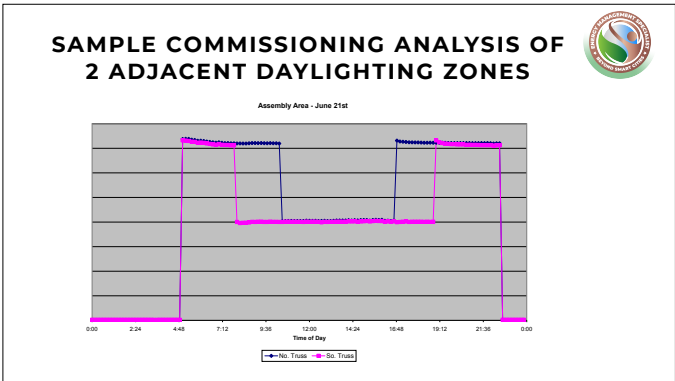




FUNCTIONAL TESTING & ANALYSIS



- ✓ Different methods of verification
 - ✓ Contractors test system and Cx Provider documents results
 - ✓ At-Risk Commissioning Provider performs and documents testing
- ✓ Cx Provider analyses test results
- ✓ Testing Completed Prior to Substantial Completion



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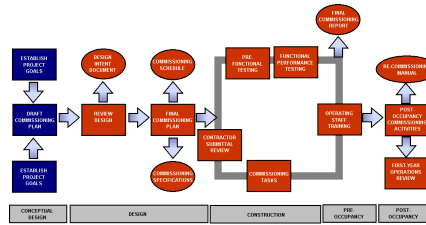
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O&M / TRAINING INFORMATION



✓ Tailor O&M and Training information for each project

✓ Who are facility staff:

- ✓ Maintenance Contractor
- ✓ "In-house" Crew that cares for several Bldgs
- ✓ Full-time staff dedicated to this building

✓ Capabilities of Facility Staff

✓ Complexity of systems

IS COMMISSIONING NECESSARY AND COST EFFECTIVE?

1. Increasing complexity of facility systems, specialization of subcontractors, energy and other facility costs all say that systems tuning and retuning are necessary.
2. First cost and schedule deadline paranoia always lead to operational problems. Commissioning can help minimize these problems.
3. Traditional methods neglect input and feedback from people that will run the facility (operations and maintenance staff). Commissioning forces this to happen resulting in better training and smoother transition.
4. Designers and contractors rarely participate in the entire process (especially start up and tuning). Commissioning forces this to occur.

IS COMMISSIONING NECESSARY AND COST EFFECTIVE?



5. Malfunctioning automated systems are often worse than malfunctioning manual systems. The problems usually cost more and are harder to fix. Commissioning ensures they are working at transition and that training has occurred.

6. Commissioning can cost 1 to 5% of the facility first cost but this can often be recovered in the first year of operation (very difficult to document; but think about your experiences).

7. Design professionals, contractors, facility operating and maintenance staff, and management all benefit from commissioning. It should be an important part of all facility construction and modification.

COMMISSIONING, RECOMMISSIONING, AND REAL TIME COMMISSIONING ARE COST EFFECTIVE AND THEY ARE EXPENSIVE



✓ See References (esp. BCBC Study, Northwest Utility Study, West Bend Mutual Insurance Company Study, and Canadian Public Schools Study)

✓ Estimate a minimum of .5 to 1% facility cost up to a maximum of 5% (4%) for a complex facility with lots of emergency and BASs; probably averages 2 to 3%.

REAL TIME COMMISSIONING



✓ 11. A Texas A&M study started Continuous Commissioning™ on 80 campus buildings in 1995. By 1999, more than \$2,000,000 was spent for metering and another \$2,000,000 was spent for analysis and implementation of recommendations. Cumulative savings over the same time period were more than \$10,000,000.