



# Whole Building Commissioning

*“Between the idea and the  
reality....falls the shadow” T. S. Eliot*



# **Introductions & Learning Objectives**

- 1. An understanding of the commissioning tasks**
- 2. When these tasks are done and how they are completed**
- 3. Benefits and challenges of commissioning various types of projects**

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**What *exactly* is commissioning?**

**How is commissioning different from traditional start-up services?**



**Why should it be done?**

# What is Commissioning (Cx)?



The process of verifying and documenting that the building and systems perform interactively according to the design intent and Owner's operational needs.

Commissioning provides a methodology for establishing and maintaining high performance buildings.

**The traditional start up services only include “static” testing of individual components which falls short of confirming operational functionality as required by the Owner’s Project Requirements**



### **Examples of Problems Not Uncovered:**

- Incorrect boiler response to terminal unit control signals
- Thermostats are inoperable
- Elevator recalls to wrong floor on activation
- Graphic interface systems incorrectly display physical equipment



# C<sub>x</sub> Driving Forces

- 50% suffer Controls problems
- 40% suffer HVAC problems
- 15% have missing equipment
- 25% FMS/Economizers/VFD's don't function
- 60% of insurance claims = HVAC
- #1 source of complaints = HVAC

\* Study of 60 new buildings by Lawrence Berkeley National Lab

# Goals of Commissioning (Cx)

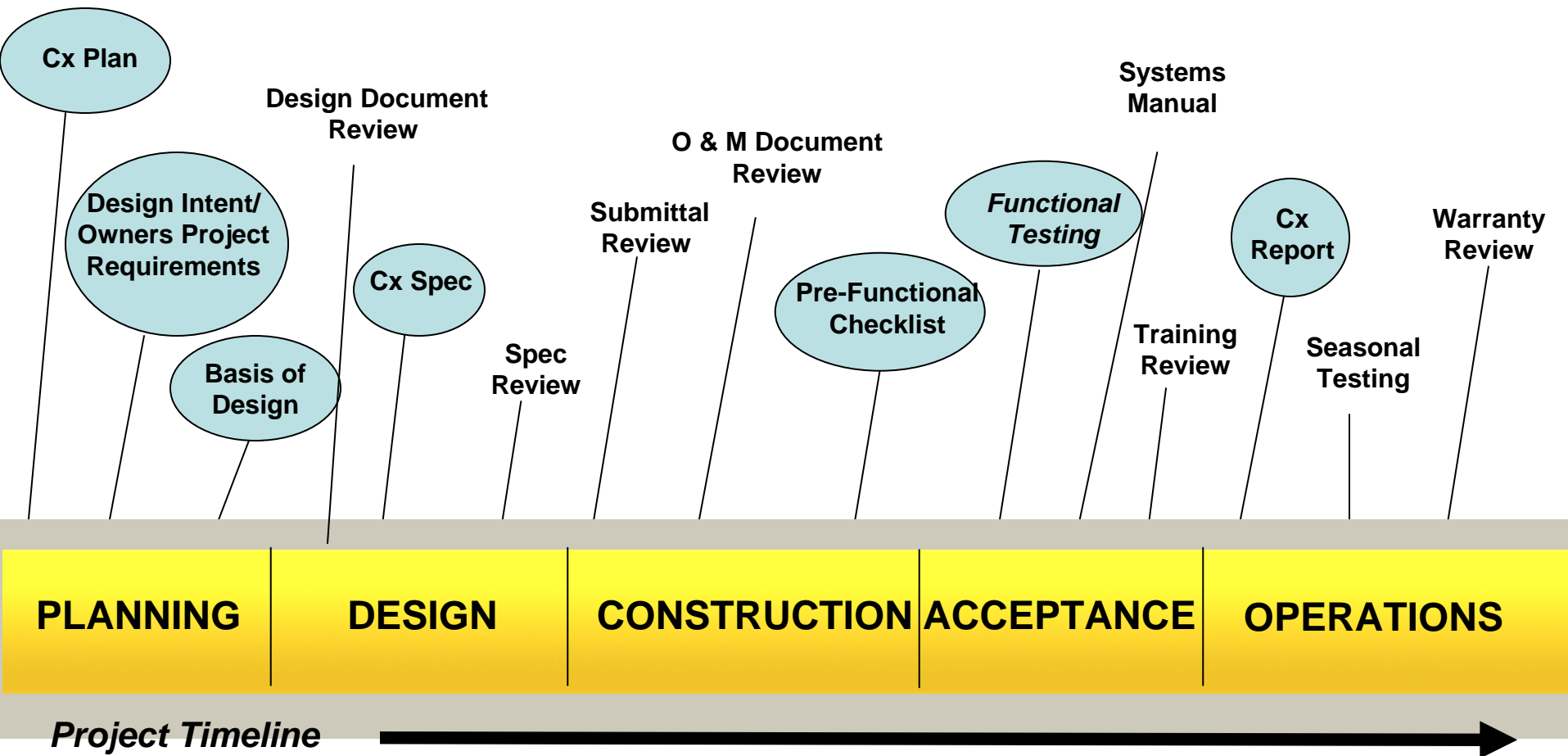
- Focus on and **Document** owner's goals and requirements
- **Prevent** or eliminate **problems** inexpensively
- **Verify** systems operations
- **Lower** overall **costs** for the owner
- **Increase profits** for project team by decreasing costs
- **Set up systems** for continuous improvement

# Types of Commissioning

- New Construction – First use
- Retro-Commissioning – The process of commissioning existing building systems that were not commissioned when originally constructed. Seeks to improve performance.
- Re-Commissioning – The process of commissioning an existing building which has been previously commissioned.
- LEED Fundamental
- LEED Enhanced

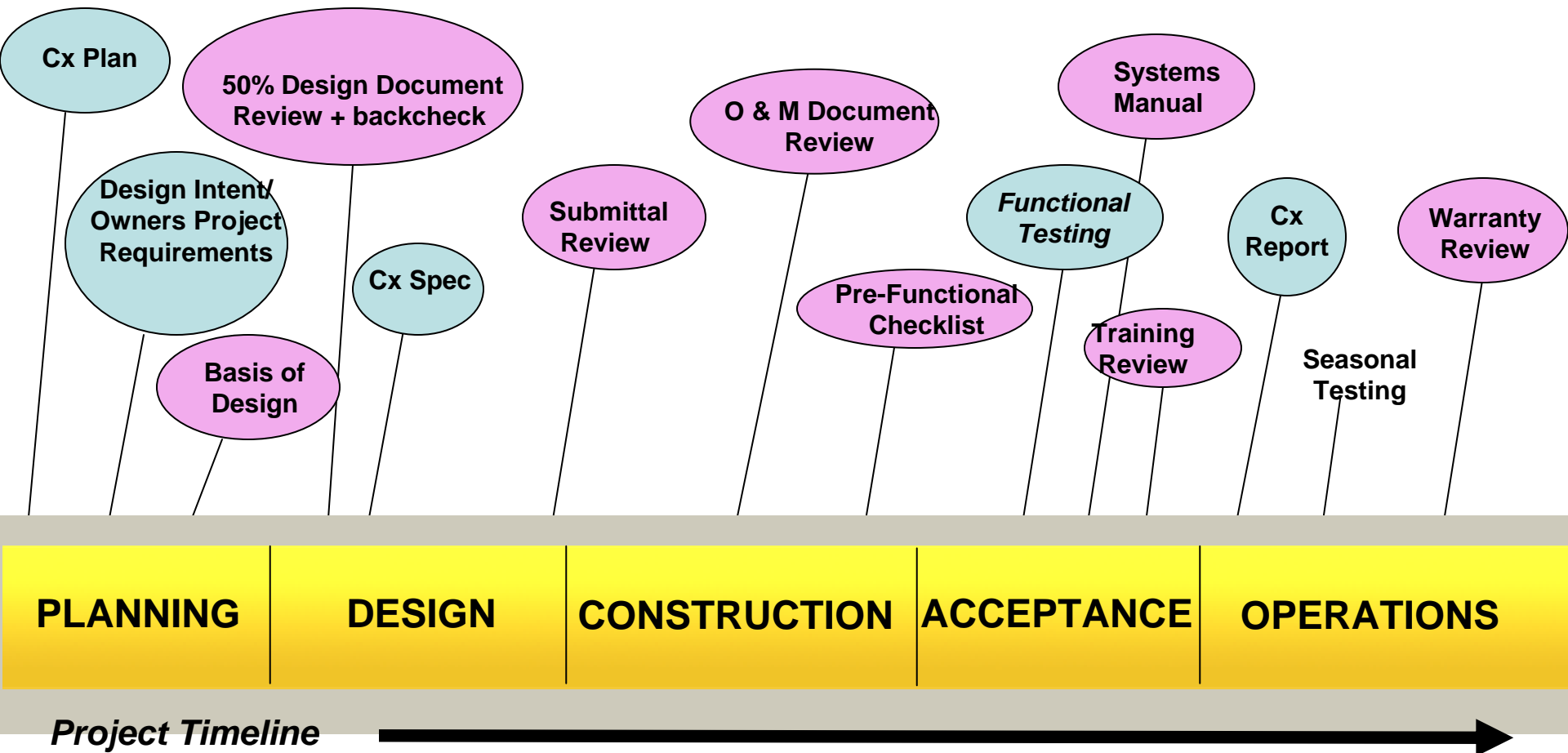


# Commissioning Process LEED-NC Fundamental



CA – Does not include individuals directly responsible for design or construction

# Commissioning Process LEED-NC Enhanced



CA – Completely independent third-party individual

## Owner's Project Requirements

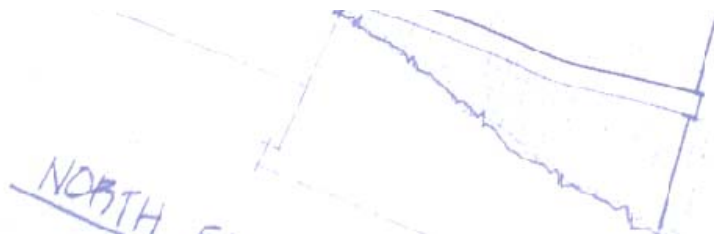
- What are functional requirements of the building?
- How would you describe this project as a success?
- What absolutely cannot happen?

## Basis of Design

- Rationale and assumptions for calculations and decisions.
- Pros and cons of various options.
- Document safety factors, diversities, velocities, etc.

# Design Review

- If Enhanced Point is desired, CxA must provide a review of the designs during Design Development and then back check during Construction Documents
- Some Items to consider: Sufficient access, monitoring points, data collection, adequate O&M and training, envelope integrity.
- Includes the equipment and systems to be commissioned



# Envelope Design Review

## ➤ Thermal Continuity

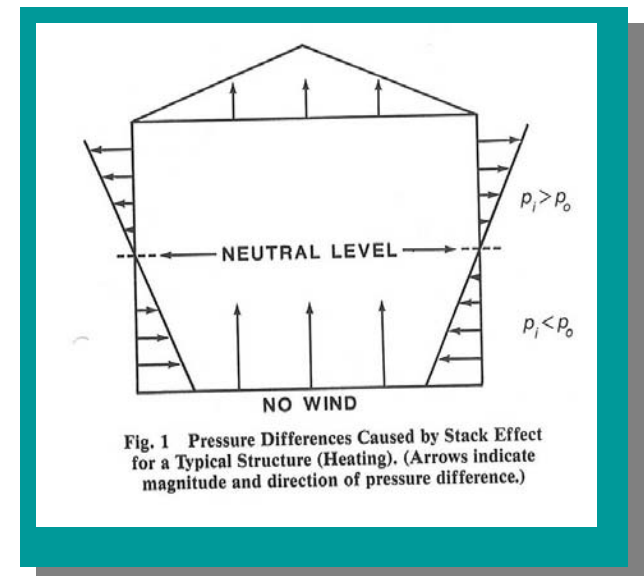
- “Relatively small conductive elements within an insulating layer can substantially reduce the average thermal resistance of a component” ASHRAE Fundamentals, 1989, Chapter 22

## ➤ Dew Point/Vapor Pressure

## ➤ Building Envelope Air

## Leakage Review

- Stack effect



# Commissioning Specification

- Specification 01810 created by the CxA
- Coordinated with other Sections
- Includes the equipment and systems to be commissioned
- Examples of pre-functional and functional checklists
- Requirements for O&M manuals and Owner training

# Typical Commissioned Systems

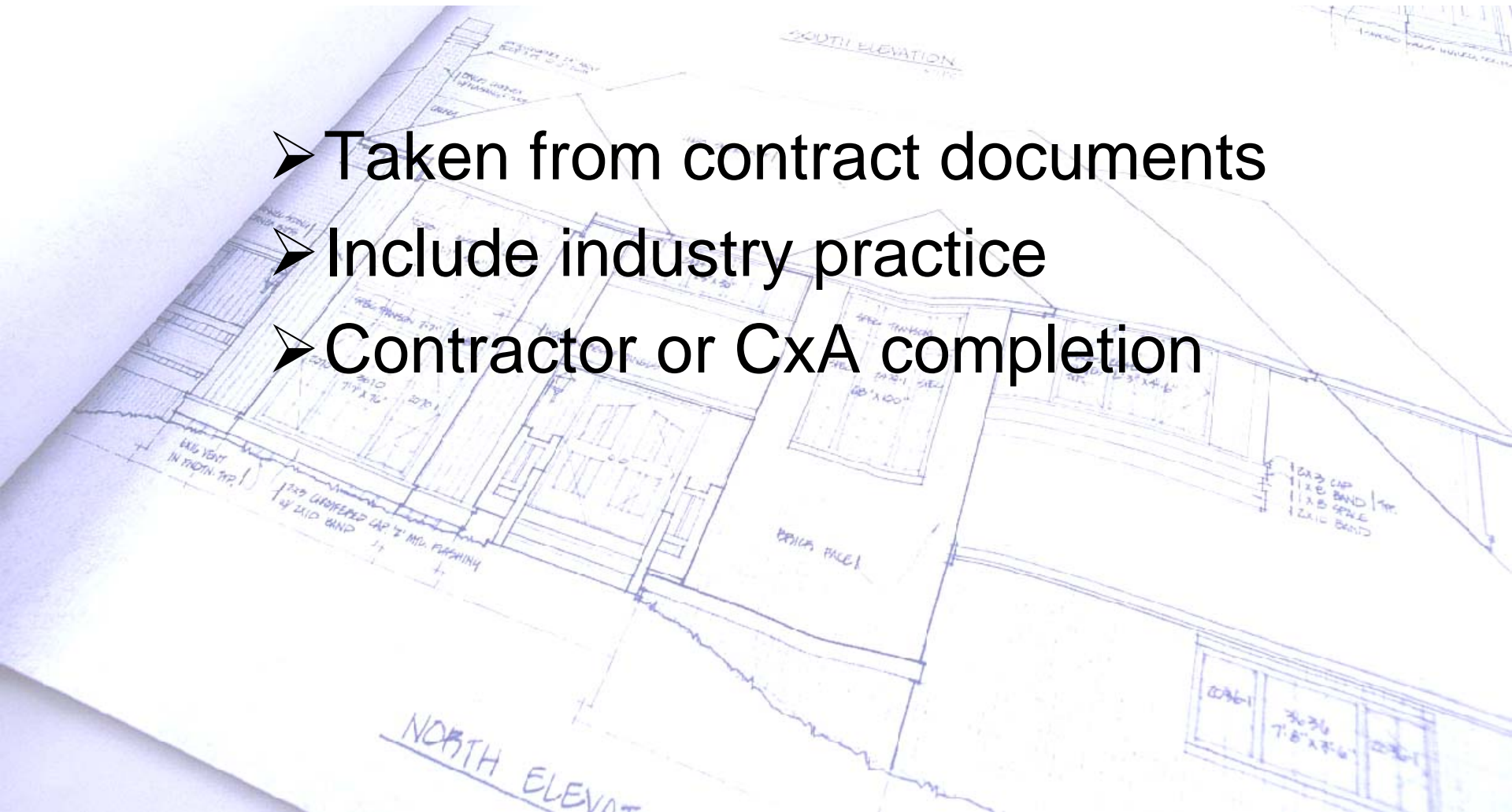
Mechanical	Electrical	Plumbing/FP
AHU	Emergency Standby Power System	Domestic Water Heating System (heaters, pumps, mixing valves)
Terminal devices (VAV, FCU, radiant panels, etc)	Performance Lighting System	Plumbing fixtures
Chilled water systems	Lighting Controls	Fire Pump and Automatic Sprinkler System
Hot water systems, steam systems	Fire Alarm System	Medical gas, Vacuum systems
Typical Computer Room A/C unit	Security System	Other – Building envelope
Exhaust Fans	Master Clock System	
HVAC Controls on all of the above	Sound, Intercom, and Auxiliary Sound systems	

# Commissioning Plan

- Provide the team with a plan
- The plan should describe roles & responsibilities
- The plan should include the checklists and performance tests
- It should also include the equipment list, Master Deficiency List, and trip reports

# Creating a Pre-Functional Checklist

- Taken from contract documents
- Include industry practice
- Contractor or CxA completion



# Creating a Functional Performance Test

- What is the purpose of the system/equipment
- What are the modes of operation?
- How do you measure capacity? Loading? Safety?
- How should this system react to external stimuli? Interacting with other systems?
- Is the system performing as expected?

# Building Envelope Performance Test

- Pressurization testing (ASTM E779, CAN 148.10 and 149.15)
- Tracer Gas (ASTM 1186)
- Infrared Imaging (ASTM E 1186)
- Air barrier bonding (ASTMD4541 – adhesion pull test)
- Water test (12-15 psi, ASTM E783, )

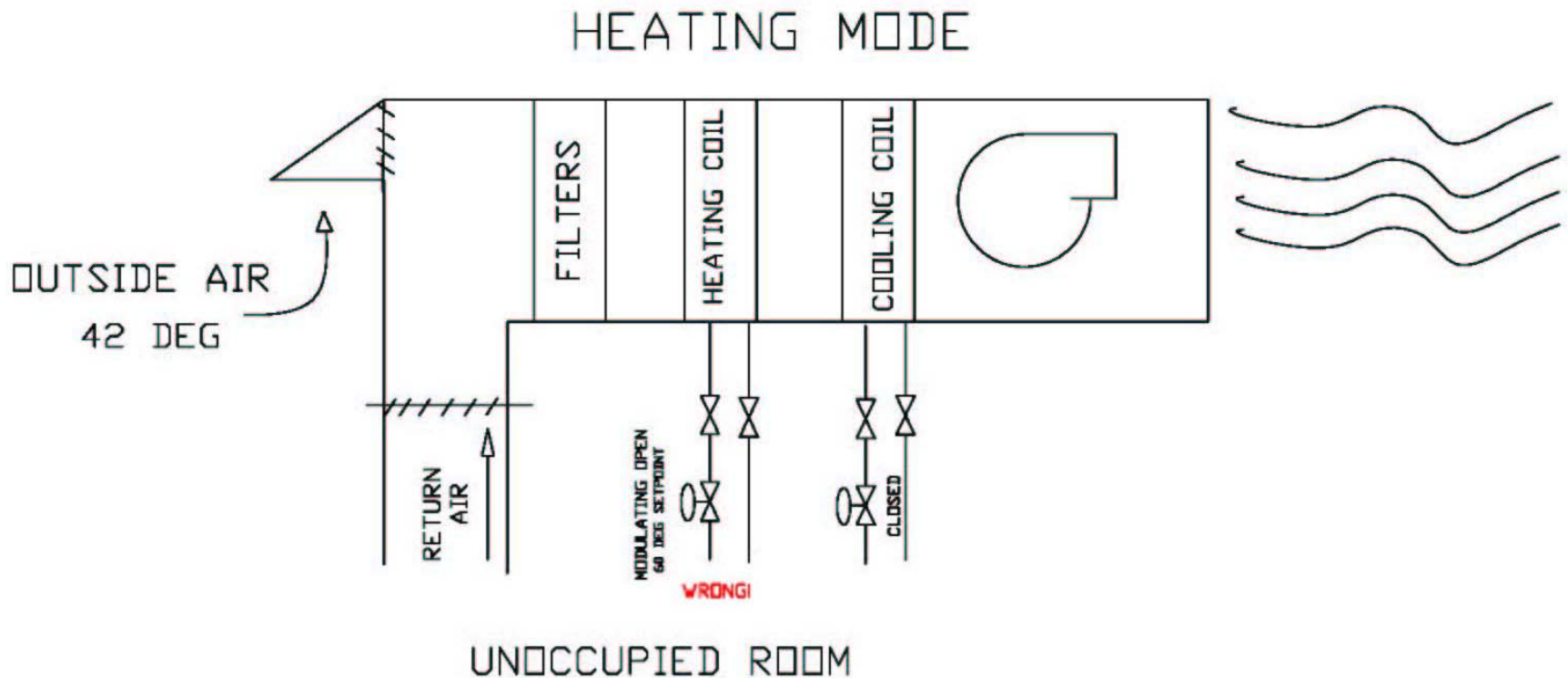


**Following are some  
examples of  
commissioning benefits.**

The controls contractor has set the Unoccupied Low limit set point at 60 deg F, rather than at 55 deg F as required.

No energy savings heating an empty room. All systems would be energized more often.

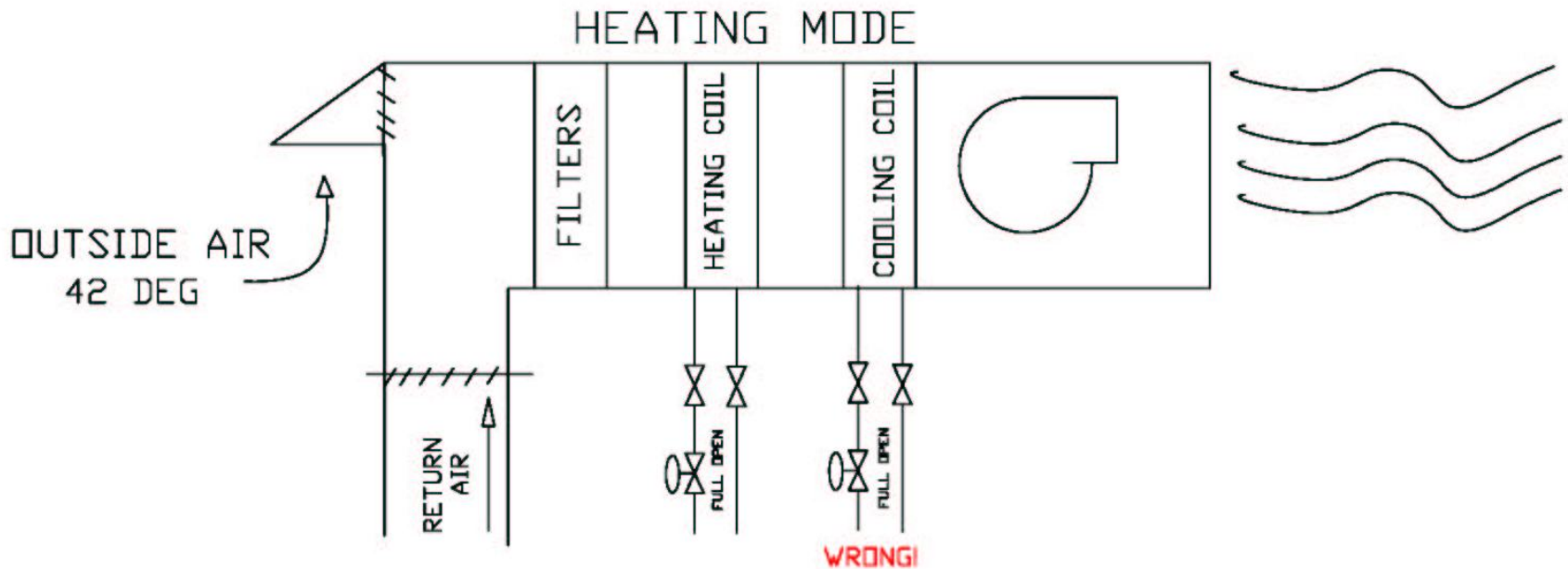
**\$2,170/year cost.**



When AHU-1 and AHU-4 operated in heating mode, the CHW valve reverted to a full open position due to a programming error.

The hot water valve had to completely open in order to warm the room. **This is like driving with your foot on the gas and the brake at the same time!**

**\$11,880/year cost**

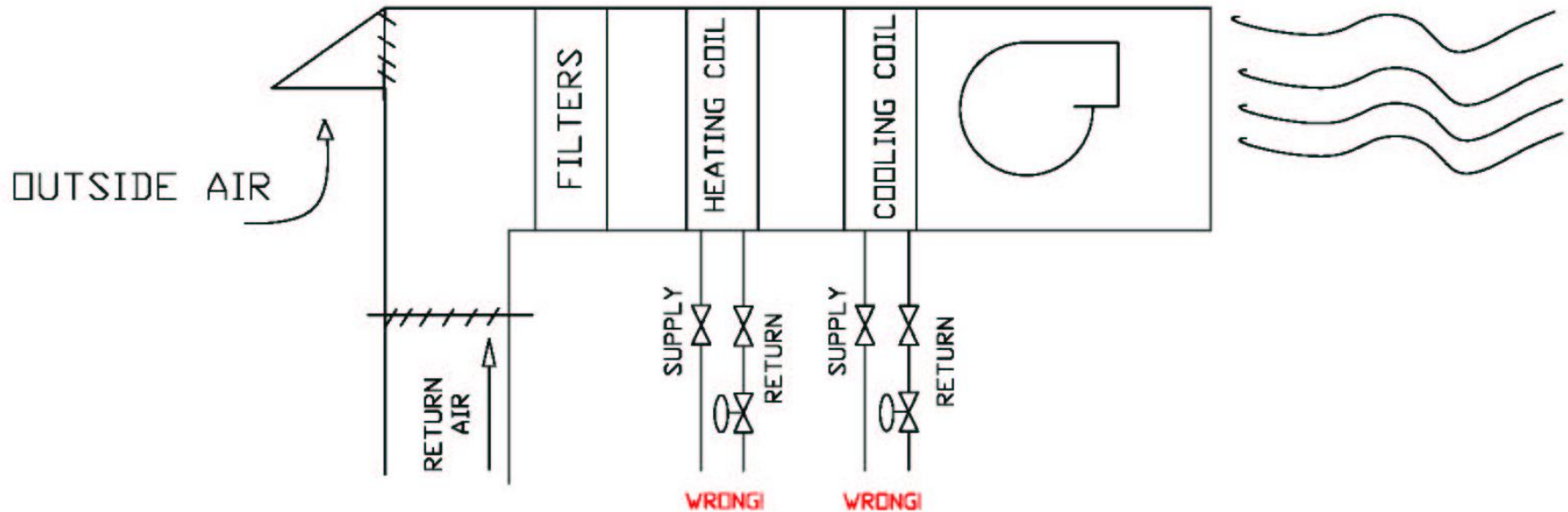


Piping to chilled water and hot water coils at AHU-1 was piped incorrectly.

The incorrectly piped coils would result in efficiency reductions in both the cooling and heating coil performance.

**\$1,304/per year cost**

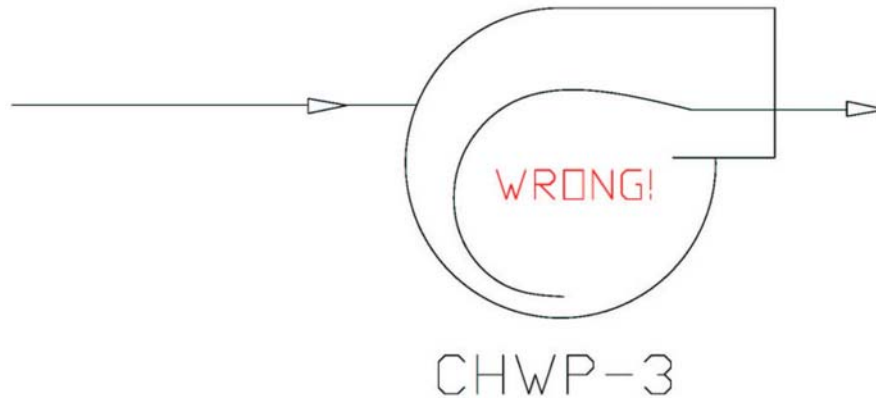
INCORRECT PIPING - NEED COUNTERFLOW



Chilled water pump CHWP-3 was found to be running in reverse rotation.

Water would be pumped, but at a great cost in efficiency. Also, the pump would tend to fail on over-current, jeopardizing the life of the pump.

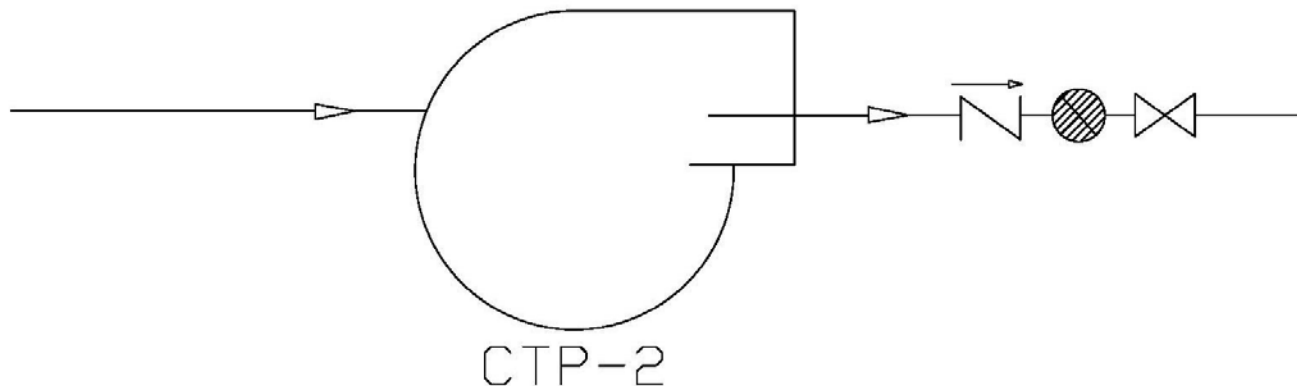
**\$3,112/per year cost.**



Triple Duty Valve on a condenser water pump was 80% closed.

The system had been balanced and flows were acceptable. However, the Owner could have been realizing savings with the correct size impeller. Trimming the impeller reduced horsepower requirements by 7.5 hP for the same flow rate.

**\$2,935/per year cost.**



# Master Deficiency Log

## Classification of Findings



- **Deficiencies Involving Life Cycle Savings (Energy Efficiency)**
- **Deficiencies Involving First Cost Savings**
- **Deficiencies Classified as 'Priceless' – Life Safety/Occupant Health and Safety**

# Commissioning Example

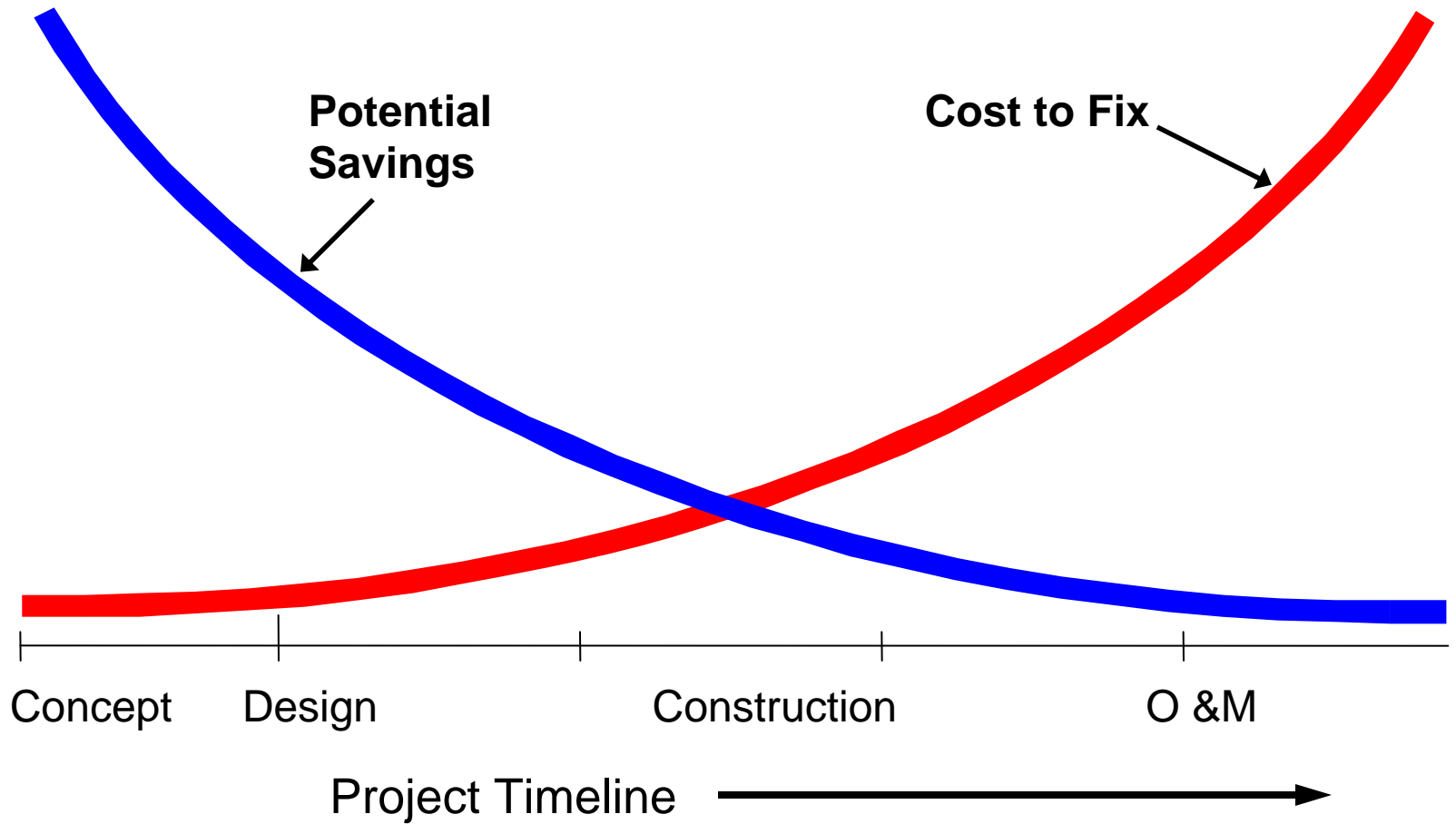
## COST

- Contract Amount: \$100,000  
(Base + Reimbursable Expenses)
- Contract With: Owner's Representative
- Commissioning Authority brought on board in latter stages of design
- Contract Costs:
  - Per Square Foot: \$0.79
  - % of Construction: 0.53

## BENEFIT

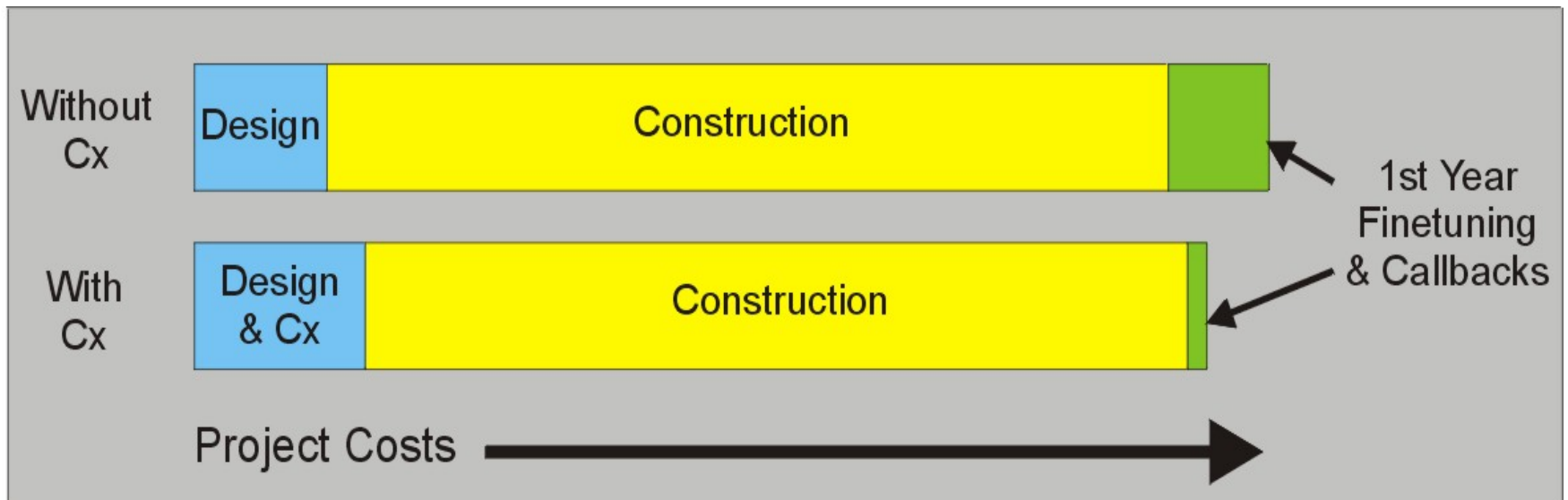
- Energy Savings:
  - Annual: **\$108,923/year**
  - 'First Cost' Equivalent: **\$1,089,230**
- One Time Savings: **\$67,000**
- Priceless Items: **6** (Life Safety, Indoor Air Quality, Security)
- Payback: **\$11.83 for every \$1 spent**

# Potential Savings vs. Project Schedule



# Cx Shifts Project Costs

- Costs shift from the end of the project to the beginning
- Reduces overall investment



# Commissioning Governance



ASHRAE Guideline 0-2005

1-1996

Chapter Series

NIBS Guidelines

ACG Commissioning Guideline

**Involvement of other organizations**

**Portland Energy Conservation, Inc.  
Building Commissioning Association**

Certification levels

# Who is providing Cx?

<b>Commissioning firms</b>	Primary business focus
<b>Engineering firms</b>	Constructability, conflict of interest
<b>Balancing firms</b>	Capability, pot conflict of interest
<b>Controls firms</b>	Conflict of interest, MEP equipment
<b>General Contractor</b>	Capability, conflict of interest
<b>MEP Contractor</b>	Conflict of interest, capability

# Selecting your Provider

1. Conflict of interest
2. Done it before
3. Experienced with your issues – controls, troubleshooting, balancing, design, equipment, energy
4. References
5. Approach – comparable scope of work
6. More technical and less management
7. Affiliations, certifications

# Where do you begin?

- Develop a plan
  - Identify problems, needs and goals (energy, thermal comfort, IAQ, training, expenses, LEED)
- Contract for services
  - Identify qualified providers
- Implement measures
  - Execute commissioning plan
- Verify performance
  - Evaluate is reached your goal



# Questions

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# Thank you!