



18th National Conference on Building Commissioning

A PEGI EVENT

Commissioning in Energy Saving Performance Contracts

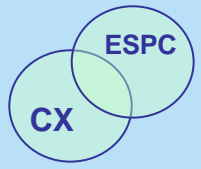
Karl Stum, P.E.

Principal

Summit Building Engineering



AIA Quality Assurance

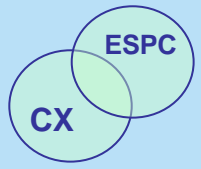


Learning Objectives

Understand:

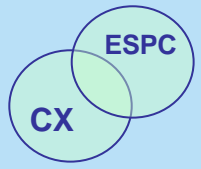
1. The basic elements of ESPC's
2. Why and when to retro-commission with ESPC's
3. The importance of commissioning in ESPC's
4. How to integrate commissioning into ESPC's
5. The pros and cons of different parties performing the commissioning process
6. The application of ongoing commissioning in ESPC's

Terms



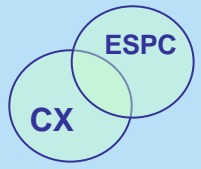
- **Retro-commissioning (RCX)**—*identifies deficiencies and opportunities* in existing equipment
- **Commissioning (CX)**—*confirms proper operation* in new equipment
- **Ongoing Cx**—confirms proper operation *and* identifies opportunities

RCX



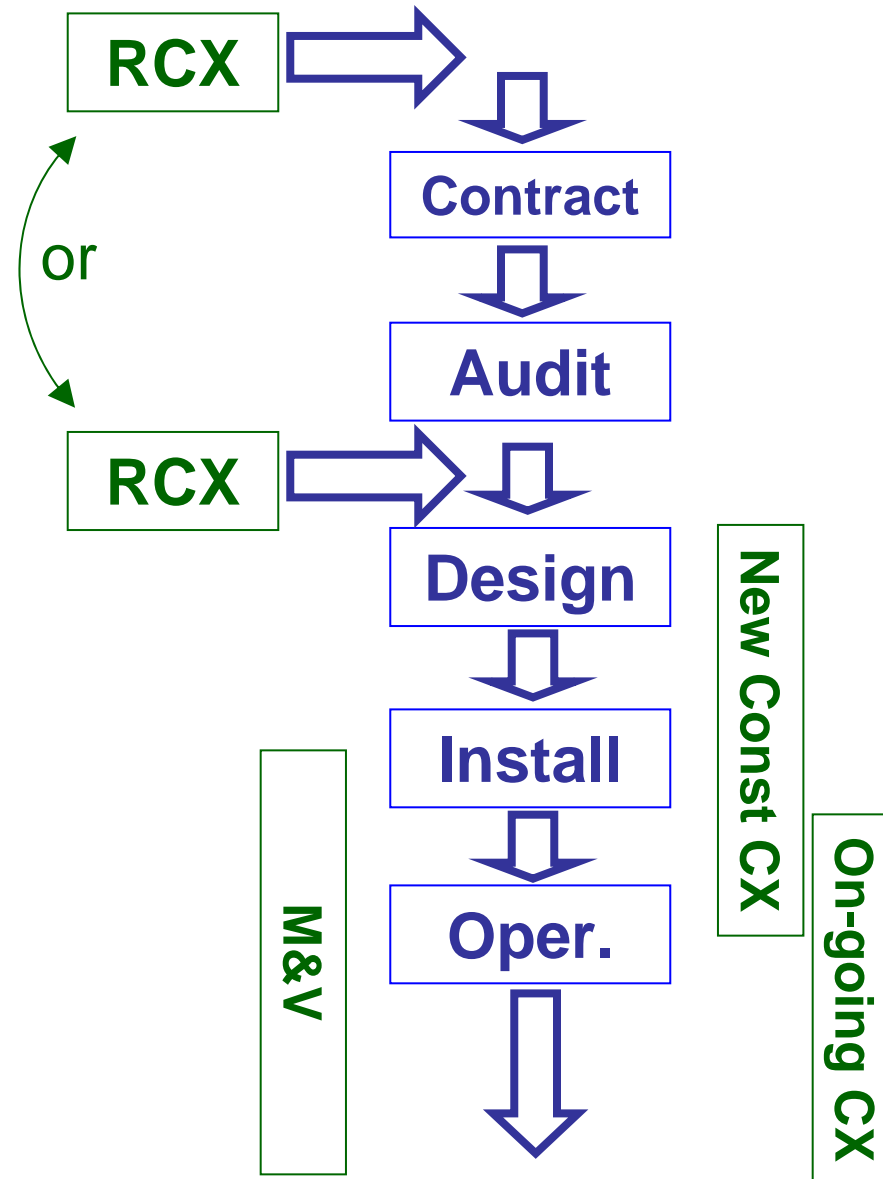
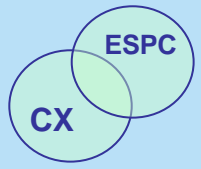
- **RCX process identifies low cost improvements**
- **Primarily in controls & operations**
- **Should be part of every ESPC project**
- **Can be applied before or after ESPC investment grade audit (IGA)**

RCX When and By Whom

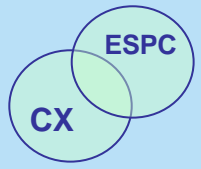


- **Do RCX before ESPC audit, if ESPC is likely to be very cost effective**
- **If not, incorporate RCX and its savings into ESPC**
- **Have Independent Cx Provider (ICP) do RCX if done before audit, otherwise have ESCO do it with ICP review**

RCX, CX, Ongoing Cx Flow Chart

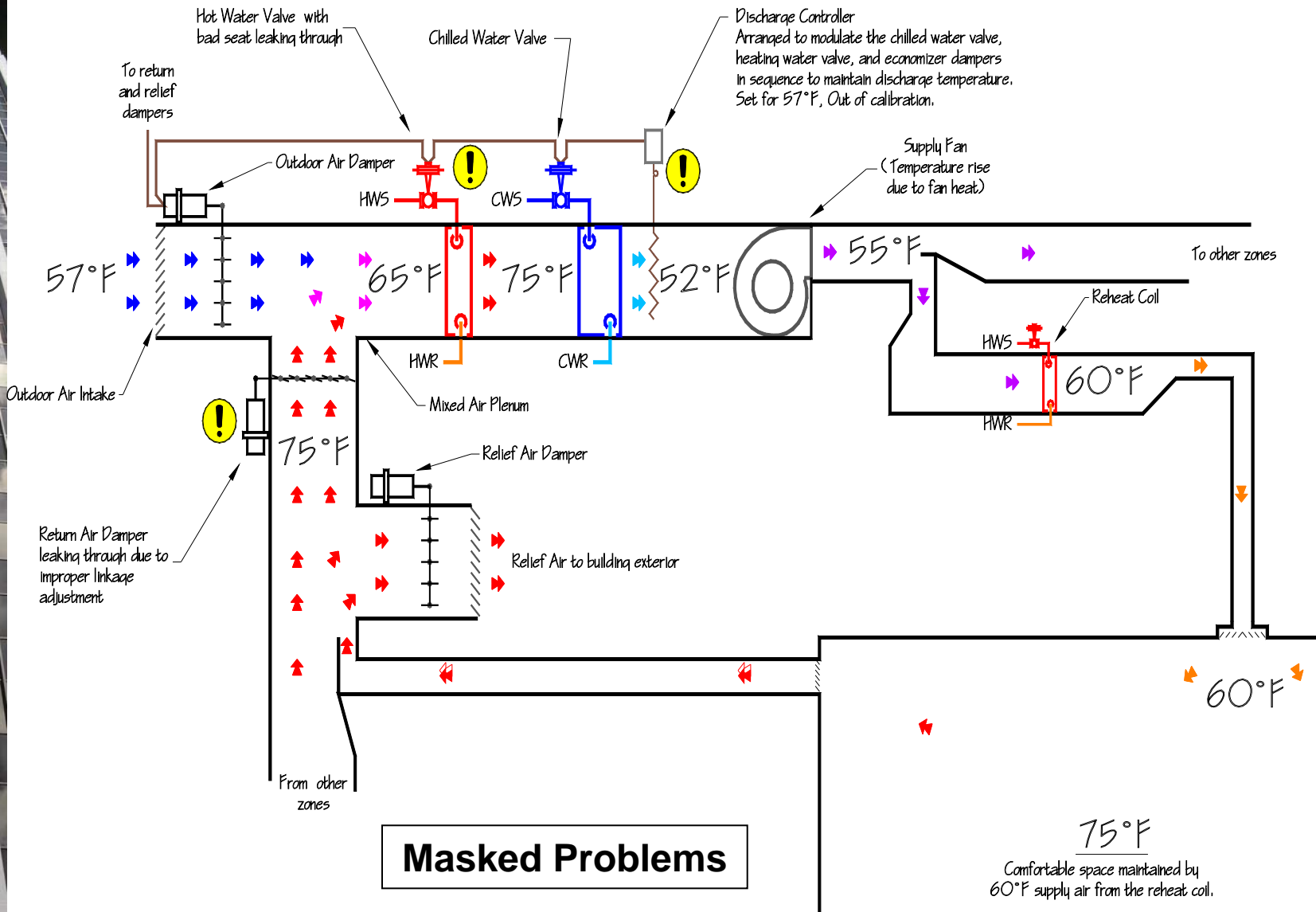
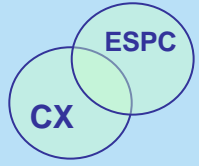


Typical RCX Findings



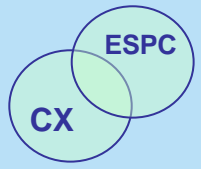
- **Equipment scheduled on when not needed (HVAC and lighting)**
- **Equipment running at higher than needed capacities (air handler and pump pressures and flows)**
- **Air side economizers not working or optimized**
- **Inefficient set points (supply air temperature, condenser water temperature, chilled water temperature)**
- **Simultaneous heating and cooling (HC and CC valve sequencing, valve or damper leak-by, fighting T-stats)**

Masked Problems



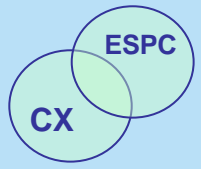
Masked Problems

Cx of New Installations--Summary



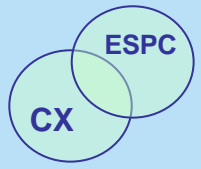
1. Ensure that project requirements are clearly documented
2. Ensure that there are no significant design deficiencies
3. Ensure that commissioning, documentation and training are completely specified in the bid documents
4. Ensure that systems are installed properly

Cx-New Cont.



5. **Test systems** to ensure proper operation
6. Ensure proper **O&M documents** are left on-site
7. Ensure that **staff training** is completed
8. **Observe, adjust and optimize** during first year
& beyond

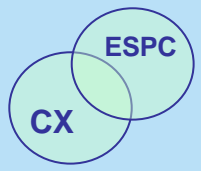
Objectives—Cx vs. ESPC



- **Commissioning (Cx)**
 - Ensure **systems** function according to the specifications and have the full potential to save energy
- **Energy Savings Performance Contracts (ESPC)**
 - Ensure the systems save the energy they were predicted to

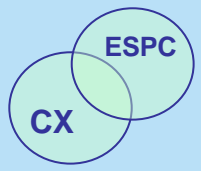
**A system may meet either goal,
both goals, or neither**

M&V does not equal Cx



- **Measurement & verification (M&V) is the verification component of an ESPC**
- **M&V quantifies energy savings**
- **Cx confirms proper functionality and performance of parameters that may save energy**
- **Cx does not guarantee PC target will be met**
- **Not meeting PC target does not mean Cx was poor**
e.g., Variable speed drive
 - Flawless operation + *high* pre- or *low* post (M&V) savings estimates = will not meet PC target
 - Poor operation + *low* pre- or *high* post (M&V) savings estimates = will meet PC target

ESPC M&V Types (IPMVP)



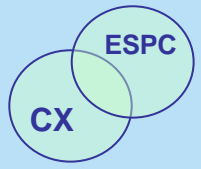
Option A. Savings determined from field measurement of parameters which define energy use (fan speed or pressure)

Option B. Savings determined from field measurement of ECM energy use (fan kWh)

Option C. Savings determined from field measurement of whole or partial facility (utility bills)

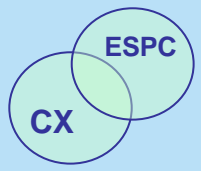
Option D. Savings determined energy simulation of whole or partial facility (e-Quest hourly simulation)

ESPC Process Summary



- **Site scoping assessment**
- **Investment grade audit and baseline**
- **Partial design and proposal**
- **Full design and final proposal**
- **Installation**
- **Testing**
- **Ongoing evaluation and true-up (unless stipulated savings)**

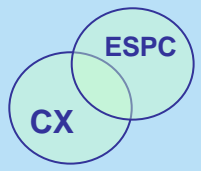
Why not just let the ESCO worry about commissioning?



- **Their focus is on the energy-issues**
- **What about the O&M issues?**
 - Equipment standby functions
 - Alarms, safeties
 - Ease of maintenance
 - Acoustical, visual; thermal comfort
 - IAQ

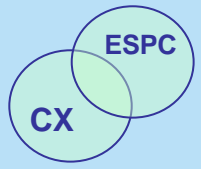


Most ESCOs realize *proper* Cx is Needed

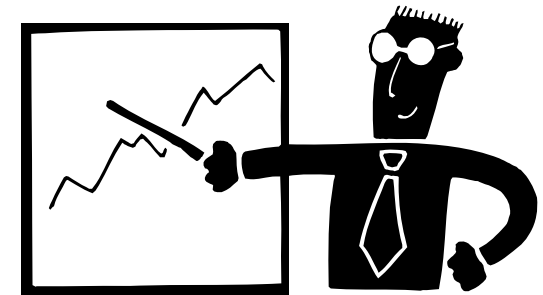


- **A major national ESCO has retained a full-time forensic engineer to address problems**
- **One key finding:** Many systems don't save as they should because they were not *properly* commissioned

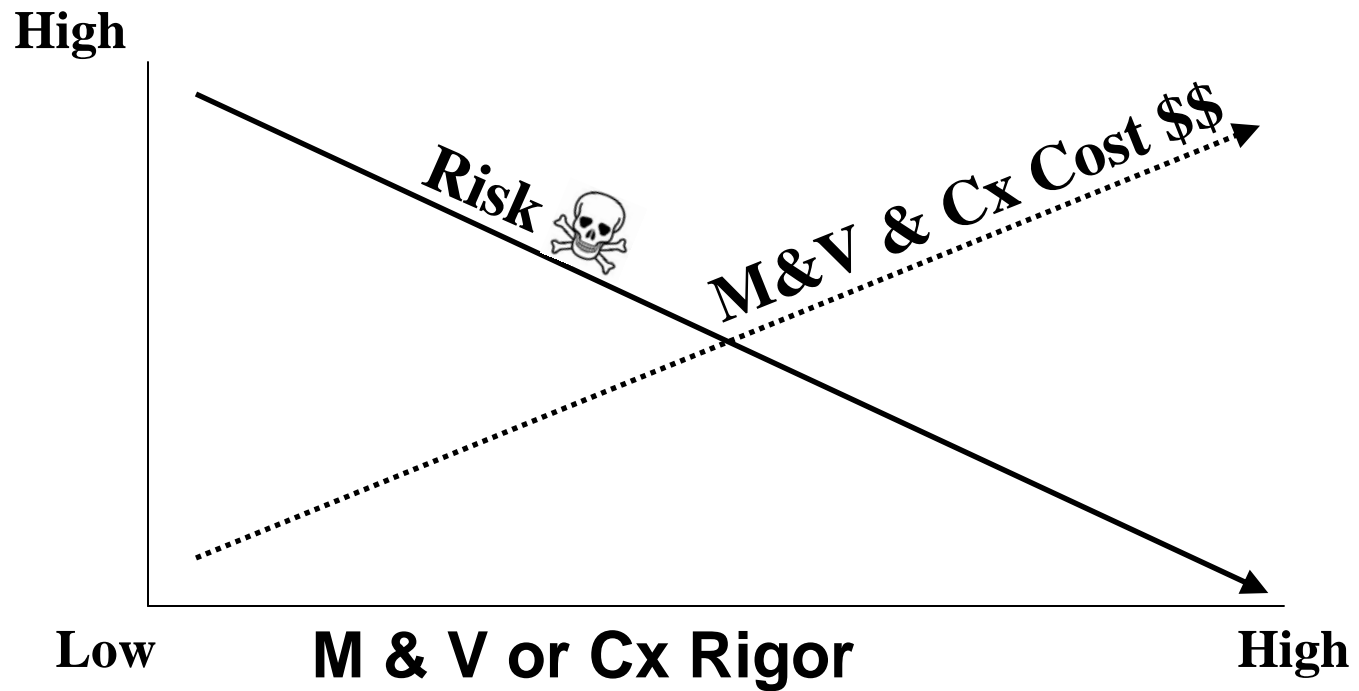
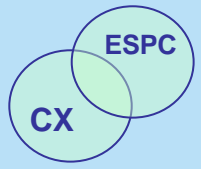
Cx Advantages to the ESCO



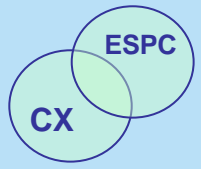
- **More likely to meet goals**
- **Increased profits**
- **Customer satisfaction**
 - Better customer relations
 - More referrals--more business
- **Fewer hassles with call-backs**



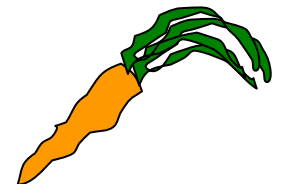
Risk and Cost



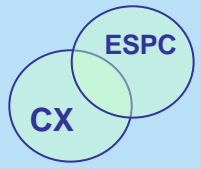
Who Should Do the Cx?



- **Not as important who does it, as that someone is responsible and held accountable**
- **If person responsible is conflicted:**
 - More detailed specifications, plan and documentation requirements
 - More rigorous oversight by technical party
 - Immediate and parallel reporting



Who Should Do the Cx?

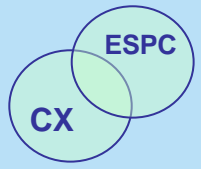


- **Not likely that all Cx activities will be done by one entity**

e.g., small packaged AC

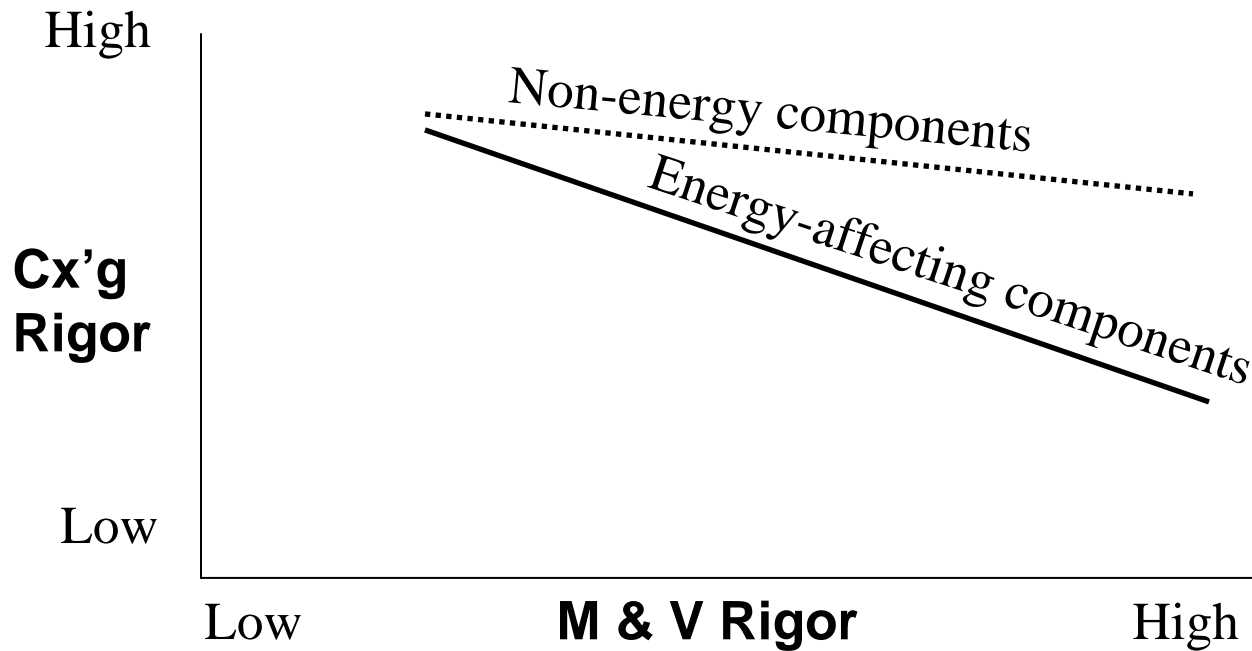
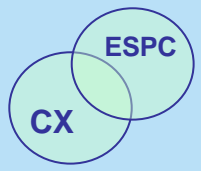
- Design review--by CA or owner
- Submittal review--by owner
- Test procedure writing--by CA
- Test execution and documentation--by ESCO
- Spot checking--by CA or owner
- Trending--by ESCO, with analysis by CA

Who Should Do The Cx?

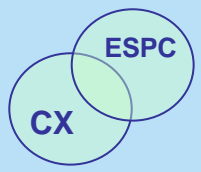


- **Not likely that all ECMs will have the same rigor and party verifying operation (testing)**
 - **Lighting:** owner
 - **Lighting controls:** owner or CA
 - **Chiller sequencing:** CA

Commissioning and M&V Rigor

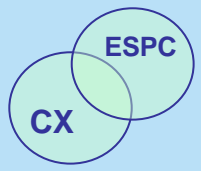


Testing & Documenting-- How Rigorous?

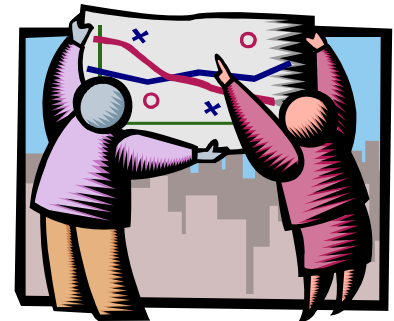


- **Simple and not important--LOW**
- **Simple and important--MODERATE**
- **Complex and not important--MODERATE**
- **Complex and important--HIGH**
- **Likely to be found by staff and easily corrected--LOW**
- **Likely to be found by staff and difficult to fix--HIGH**
- **Unlikely to be found by staff--MODERATE to HIGH**

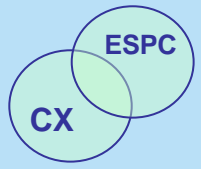
Overall Guidelines



- **Engage a commissioning provider early--prior to the proposal**
- **Develop a plan for risk management**
 - Use appropriate effort in:
 - design
 - initial savings calculations
 - Cx
 - M&V

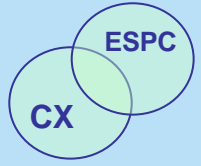


Overall Plan



- **Have all QA/QC tasks listed by project phase**
 - who will do what
 - differentiate “managing” vs. “executing”
 - documentation requirements
 - reporting (content and frequency)
 - reviews and approvals

Roles

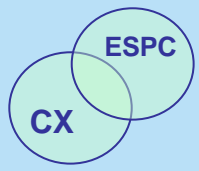


Check and Testing Responsibility Table

	1	2	3	4	5	6	7	8	9	10
System or Assembly	Submittal Review (Info. Or Review) [3]	Field Observation [3]	Prepare Const. Checks and/or \$Plan	Perform & Document Check Lists	Prepare Test Procedures	Review Test Procedures	Coordinate, Oversee & Document Test	Perform Test	Witness Test [1] (Spot or All)	Review Test Report [2]
Chilled Water System (A)	R-CA	CA; U	CA	TC	CA	MC, CC	CA	MC; CC	A-CA; U	U
Heating Water System (A)	R-CA	CA; U	CA	TC	CA	" "	CA	MC; CC; MSR	" "	U; CA
Air Handlers (B)	R-CA	CA; U	CA	TC	CA	MC, CC	CA	MC, CC	A-CA; U	U
Air Terminal Units (C)	I-CA	CA; U	CA	TC	CA	MC, CC	CA	MC, CC	A-CA; U	U
Duct Leakage Tests	None	none	none	None	none	NA	MC	MC	S-U	CA

General Management & Overview

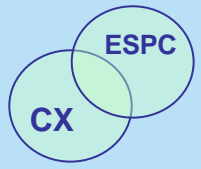
--Simple Systems--



Measure Parameters & Calculate Energy (Option A)	Measure or Simulate Energy Performance (Option B, C; D)
<ul style="list-style-type: none">• Cx provided by ESCO. Detailed oversight by OTR. Use detailed specifications.• Initial contract setup needs independent review.	<ul style="list-style-type: none">• Cx provided by ESCO with less oversight by OTR than Option A.• Initial contract setup needs independent review.

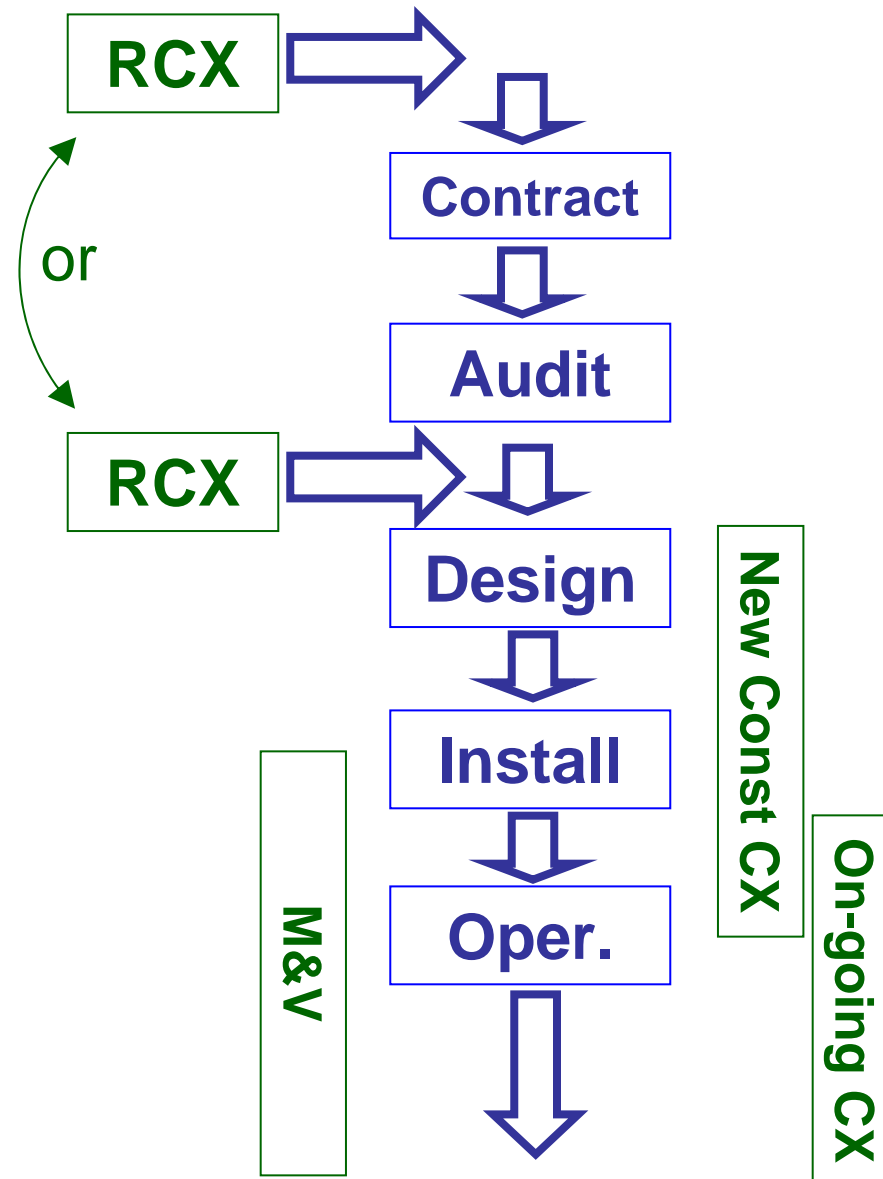
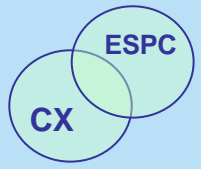
Cx = commissioning, ESCO = performance contractor,
OTR= owner's technical rep., ICP = independent Cx provider

--Simple Systems--

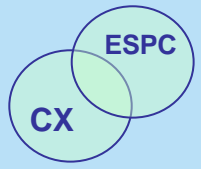


Project Tasks	Measure Parameters & Calculate Energy (Option A)	Measure or Simulate Energy Performance (Option B, C; D)
RCX	<ul style="list-style-type: none"> • By ESCO 	<ul style="list-style-type: none"> • By ESCO
Design and specification review	<ul style="list-style-type: none"> • Performed by ICP 	<ul style="list-style-type: none"> • Performed by OTR (or ICP)
Submittal review	<ul style="list-style-type: none"> • Performed by OTR (or ICP) 	<ul style="list-style-type: none"> • Performed by OTR (or ICP)
Construction observation and installation verification	<ul style="list-style-type: none"> • Performed by OTR (or ICP) 	<ul style="list-style-type: none"> • Performed by OTR (or ICP)
Review building simulation and energy calc assumptions	<ul style="list-style-type: none"> • By ICP of final calcs for contract • ICP reviews changes after install 	<ul style="list-style-type: none"> • By ICP of final model for contract • ICP reviews changes after install

RCX, CX, Ongoing Cx Flow Chart

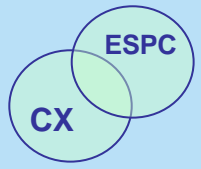


Ongoing Commissioning



- **Optimization**
- **Energy accounting**
- **Schedule checks, calibrations and tests**
- **Not M&V, but each can inform each other**

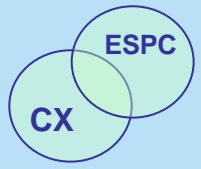
Ongoing Commissioning



Optimize Operation

- **When: during occupancy, after installation commissioning**
- **Review trends to identify waste**
- **Make obvious set points and resets more aggressive when appropriate**
- **Perform operational tests to try more aggressive strategies**

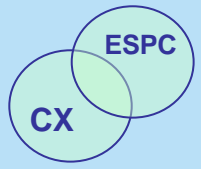
Ongoing Commissioning



Energy Accounting

- **Not normally part of Cx in an ESPC**
- **Done by ESCO**
- **Track monthly energy use against baseline, calibrated simulation, OA temp (CCD and HDD) and hours of operation**
- **Quantify overall heating and cooling efficiency**
- **Track rolling 12 month energy use**
- **Look for energy creep and lowering efficiencies**

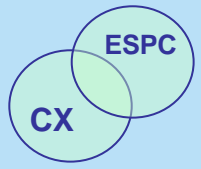
Ongoing Commissioning



Schedule Checks, Calibrations and Tests

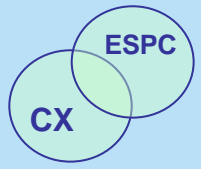
- **Review time of day and equipment schedules**
- **Keep critical sensors and actuators calibrated**
- **Test sequences of operation**
 - Frequency and rigor depend on likelihood of failure and magnitude of energy waste
 - Use auto-diagnostics, trends and/or manual tests
- **Update as-built sequences and systems manual**

Financing Commissioning



- **If needed, roll cost of commissioning into overall PC**
- **If no other way, have an independent CA contracted by the ESCO**
 - Owner approves CA
 - Parallel and immediate reporting to owner and ESCO

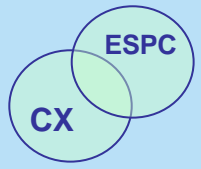
Summary



- **Systematic quality assurance procedures are essential**
 - *Regardless* of ESPC type **or** M&V type **or** who's responsible for the QA,
- **the commissioning process is that systematic QA**

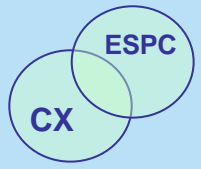


Summary



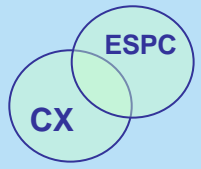
- Don't say, “*Should* we commission it?” Just say, “*Who* should commission it?” and “How rigorous should it be?”
- Commissioning can trade off for some M&V
- Commissioning can reduce the risk of owner and contractor

Summary



- **RCX should be incorporated before or at the beginning of the project**
- **New equipment Cx should be employed during the PC design and install**
- **Ongoing Cx should be employed during occupancy**
- **Take advantage of synergies**

AIA Quality Assurance



Portland Energy Conservation, Inc is a registered provider with The American Institute of Architects Continuing Education Systems. Credit earned on completion of this program will be reported to CES Records for AIA members. Certificates of Completion for non-AIA members are available on request.

This program is registered with the AIA/CES for continuing professional education. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the AIA of any material of construction or any method or manner of handling, using, distributing, or dealing in any material or product. Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.



**Summit Building Engineering
Vancouver. WA**

