"Commissioning 21st Century 7x24 Facilities"

Presented by:
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Rocky Mountain Chapter

September 15, 2009

Mission

Rocky Mountain Chapter

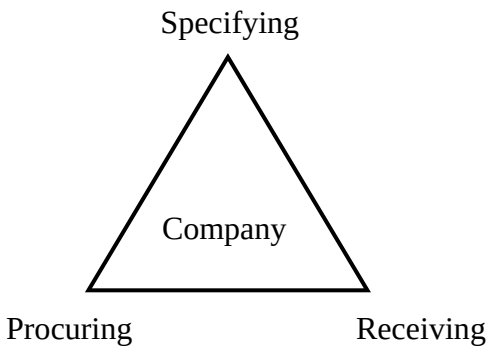
The leading knowledge exchange among those who design, build, use and maintain mission-critical enterprise infrastructures, 7x24 Exchange's goal is to improve end-to-end reliability by promoting dialogue among these groups.

DirecTV – Castle Rock, CO

Issues

- Commissioning is probably the most ***misunderstood*** word in the design/construction industry.
- Common concern - Owners, contractors, and others don't understand the value or benefit of providing what appears to be another layer of service that should already be included in the project. Isn't acceptance testing of the electrical system and balancing of the mechanical systems already in the contract price?

Three-way Authority Splits



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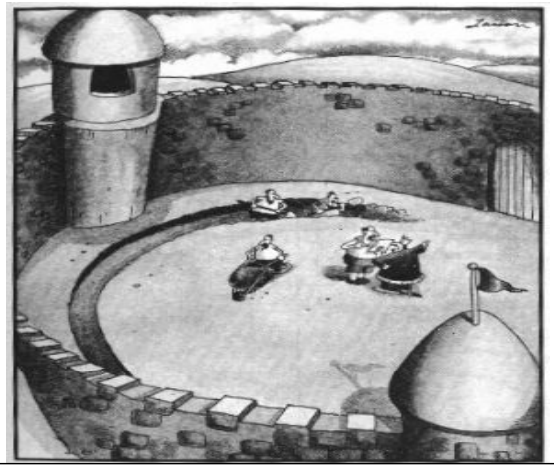

Suddenly a heated exchange took place between the king and the moat contractor

6

OR HOW TO GET WHAT YOU'VE PAID FOR

Commissioning Protocol

Commissioning is the process of ensuring that mechanical, electrical and other building systems are installed, tested, and perform interactively in accordance with the design documents. This systematic process provides an independent verification that systems are functioning properly, as designed, and as required for a complete operating system.

The commissioning process provides the means to integrate the owner's facilities staff into day-to-day operation of the various systems. This interactive process enables the staff to keep track of system functionality testing leading up to final acceptance. Additionally, commissioning offers a mechanism for raising key operational issues and having them documented and addressed.

Background

- Other industries - better established
  - Naval vessels
  - Industrial process

9

Background

- Current Organizations & Guidelines
  - ASHRAE, Guideline 1.1- 2007
  - DOE “Model Comm. Plan and Guide Spec.”, 3/97
  - NEBB “Procedural Stds. For Bldg. Sys. Comm.”
  - SMACNA “HVAC Sys. Comm. Manual”
  - Building Comm. Assoc., AABC, AEE.
  - ASHRAE, Guideline O-2005
  - PECI
  - ASHE

10

Background

- Current Practice - focus on HVAC-Controls
  - Typically weak on Electrical and other systems
  - Data Comm industry doing more on Elec. Cx as expected
    e.g., IBM Boulder,
  - Pharmaceuticals and Health Care also taking a broader approach (MSK Cancer Research Center, Unified Labs BSL-3, U of New Mexico Children's Hospital)
  - Recent interest in other building systems such as envelope, roofing, alternative energy, etc.
  - ASHRAE Guideline Committee 1.1-2007 at work

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11

Design

•Specification

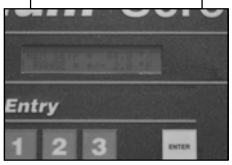
•Select Building systems to commission

Major Areas

1. Mechanical

2. Electrical

3. Controls



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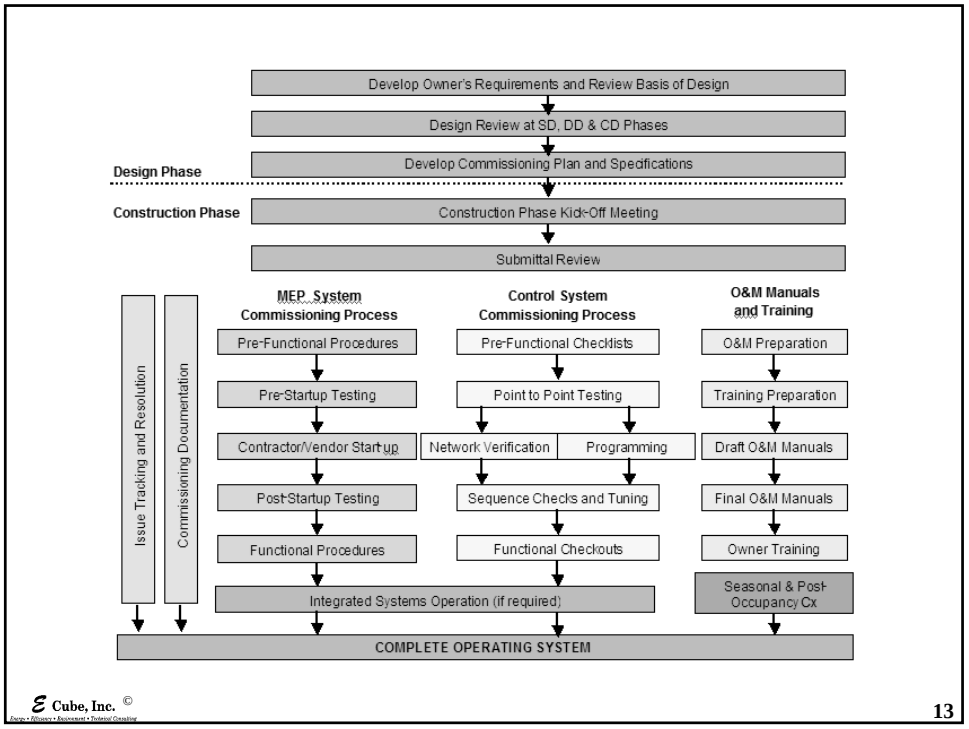

Documentation

Issue Tracking and Resolution

Field Observation Notes sm (example)

updated on: 5/17/01 By: JD # of FONs 9

!! = Priority: 1: Immediate Attention, 2: Review, 3: FYI, 4: Enhancement Strikethrough = resolved items, BOLD = new Issues/Comments

AHEC / E3 #	!!	Ident. Date	Iden. Source	Spec. / Dwg.	Respn Party	Location	Equip / System	Description	Comments / status	Resolution date
318	1	11/15/00	AHEC-FE		JCI			Will Johnson Ctrls interface with Trane Tracer so that AHEC gets all points needed for control of chillers on BAS? (From transmittal by Frank E. to Stuart Crawford of Hp dated 5/01/00.)	Trane waiting on call from USE, coord w/ JCI will complete w/ chiller perf check out in May	
232	1	10/5/00	JPG		JPG		AHU-4	Cannot get enough air to branches and larger branches do not have balance dampers	need to add balance damper to linear diffuser branches 2 ea. 6 total (11/9) baffle installed need to verify need to see air T&B report	
64	2	6/9/00	AHEC/JP		USE	AHU-9	AHU-9	AHU 9, can we have a door installed on the north side of the unit to access the supply fan motor? Same as #49, which is not a closed issue?	DL-ME, Cool Breeze submittals showed all required access doors to get to fans. Doors were also required in the specs. Cool Breeze owes all access doors. Installed by the first week of Dec. USE will install door	

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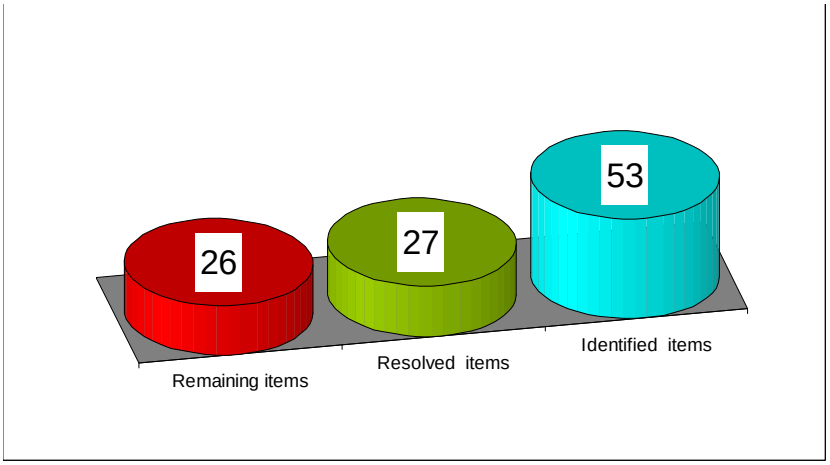
14

Documentation

Issue Tracking and Resolution

Field Observation Totals sm (example)



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Design Phase

Design Document Review

- Clear Communication of the Design Intent
- Commissionability
- Balancability
- Maintainability.

Bid Package Review

- Commissioning Process Is Clearly Defined
- Inclusion of Requirements and Information
- Assure Commissioning Process Will Be a Key Goal.

Commissioning Plan and Documents

- Commissioning Process Developed
- Key Tasks, Participants, and Schedules
- Pre-functional, Functional, and Other Forms Developed

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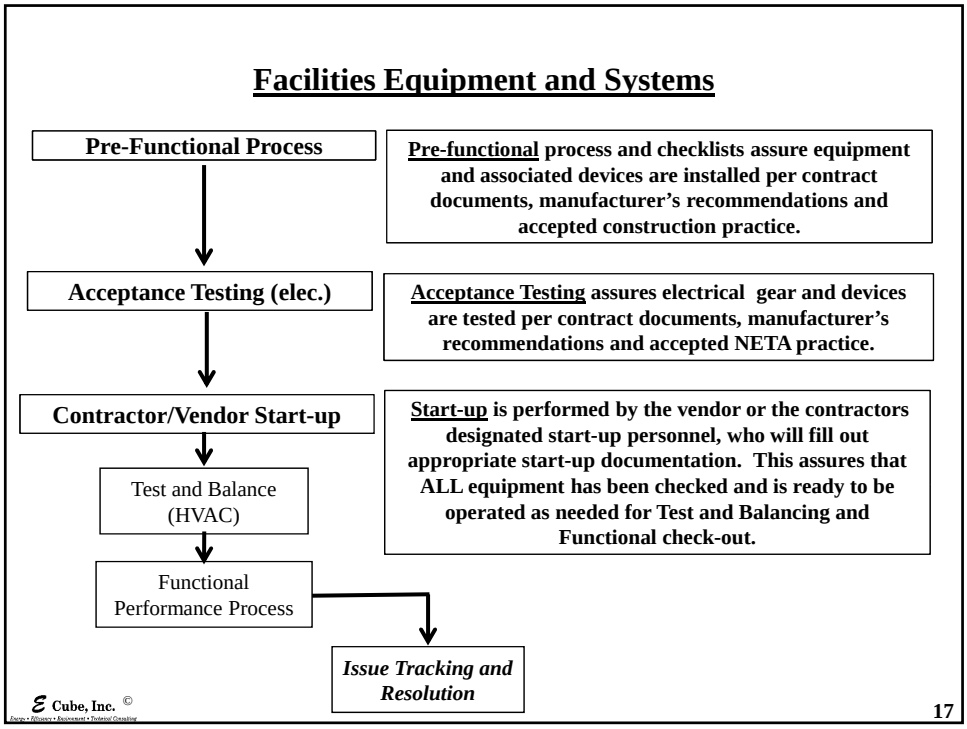
16


Facilities Equipment and Systems
Pre-Functional Process
Pre-functional process and checklists assure equipment and associated devices are installed per contract documents, manufacturer's recommendations and accepted construction practice.
Acceptance Testing (elec.)
Acceptance Testing assures electrical gear and devices are tested per contract documents, manufacturer's recommendations and accepted NETA practice.
Contractor/Vendor Start-up
Start-up is performed by the vendor or the contractors designated start-up personnel, who will fill out appropriate start-up documentation. This assures that ALL equipment has been checked and is ready to be operated as needed for Test and Balancing and Functional check-out.
Test and Balance (HVAC)
Functional Performance Process
Issue Tracking and Resolution
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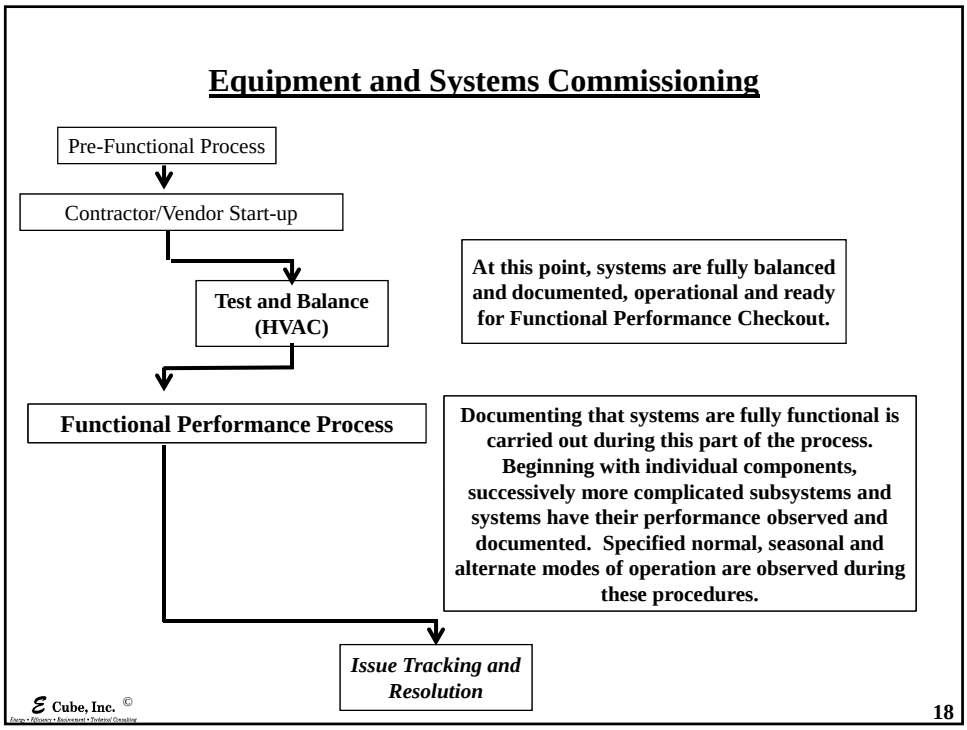
17


Equipment and Systems Commissioning
Pre-Functional Process
Contractor/Vendor Start-up
Test and Balance (HVAC)
At this point, systems are fully balanced and documented, operational and ready for Functional Performance Checkout.
Functional Performance Process
Documenting that systems are fully functional is carried out during this part of the process. Beginning with individual components, successively more complicated subsystems and systems have their performance observed and documented. Specified normal, seasonal and alternate modes of operation are observed during these procedures.
Issue Tracking and Resolution
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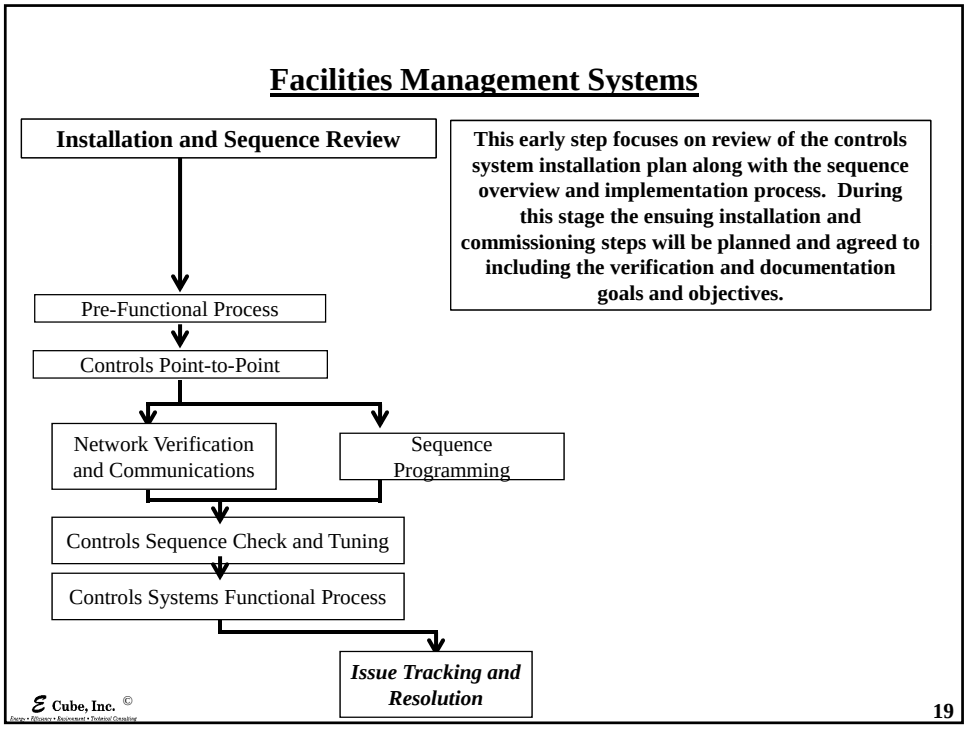
18


Facilities Management Systems
Installation and Sequence Review
This early step focuses on review of the controls system installation plan along with the sequence overview and implementation process. During this stage the ensuing installation and commissioning steps will be planned and agreed to including the verification and documentation goals and objectives.
Pre-Functional Process
Controls Point-to-Point
Network Verification and Communications
Sequence Programming
Controls Sequence Check and Tuning
Controls Systems Functional Process
Issue Tracking and Resolution
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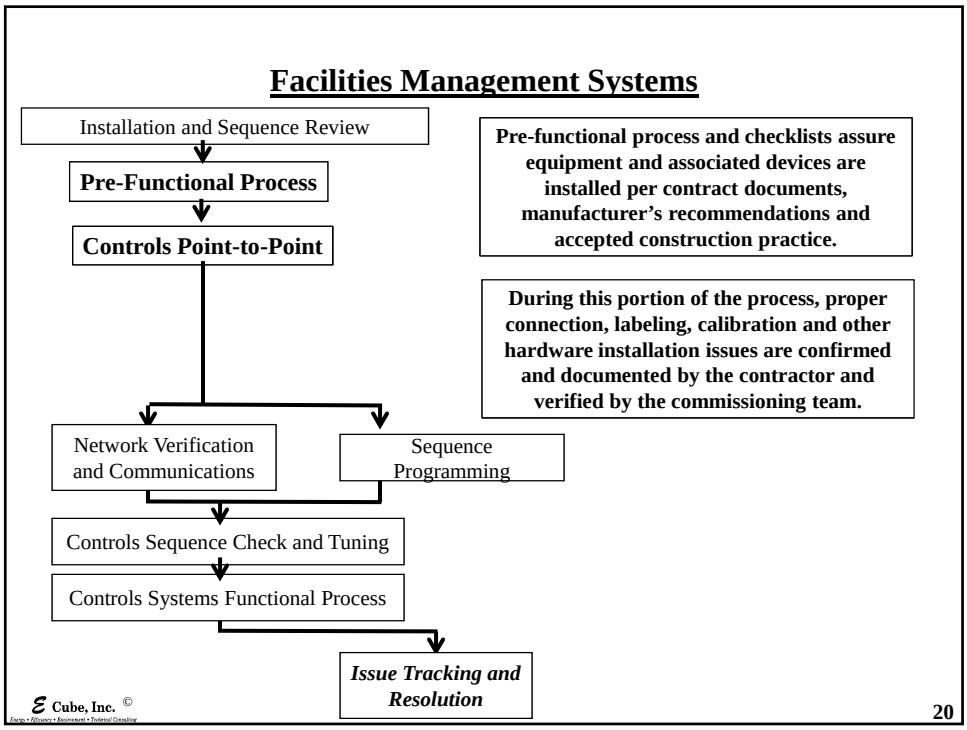
19


Facilities Management Systems
Installation and Sequence Review
Pre-Functional Process
Controls Point-to-Point
Pre-functional process and checklists assure equipment and associated devices are installed per contract documents, manufacturer's recommendations and accepted construction practice.
During this portion of the process, proper connection, labeling, calibration and other hardware installation issues are confirmed and documented by the contractor and verified by the commissioning team.
Network Verification and Communications
Sequence Programming
Controls Sequence Check and Tuning
Controls Systems Functional Process
Issue Tracking and Resolution
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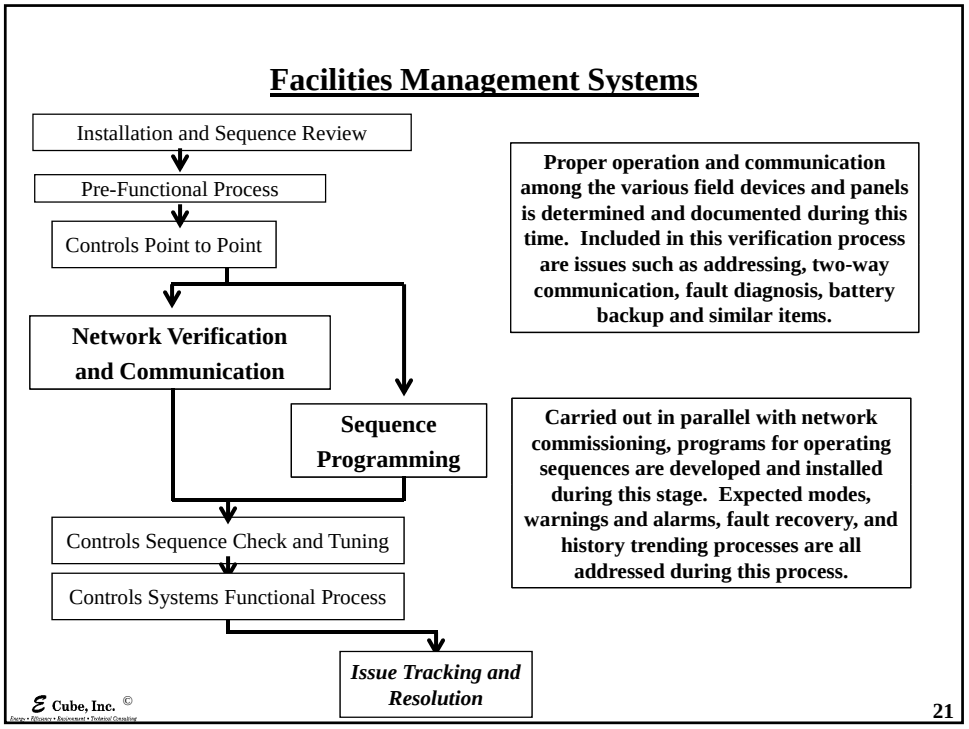
20


Facilities Management Systems
Installation and Sequence Review
Pre-Functional Process
Controls Point to Point
Network Verification and Communication
Sequence Programming
Controls Sequence Check and Tuning
Controls Systems Functional Process
Issue Tracking and Resolution
Proper operation and communication among the various field devices and panels is determined and documented during this time. Included in this verification process are issues such as addressing, two-way communication, fault diagnosis, battery backup and similar items.
Carried out in parallel with network commissioning, programs for operating sequences are developed and installed during this stage. Expected modes, warnings and alarms, fault recovery, and history trending processes are all addressed during this process.
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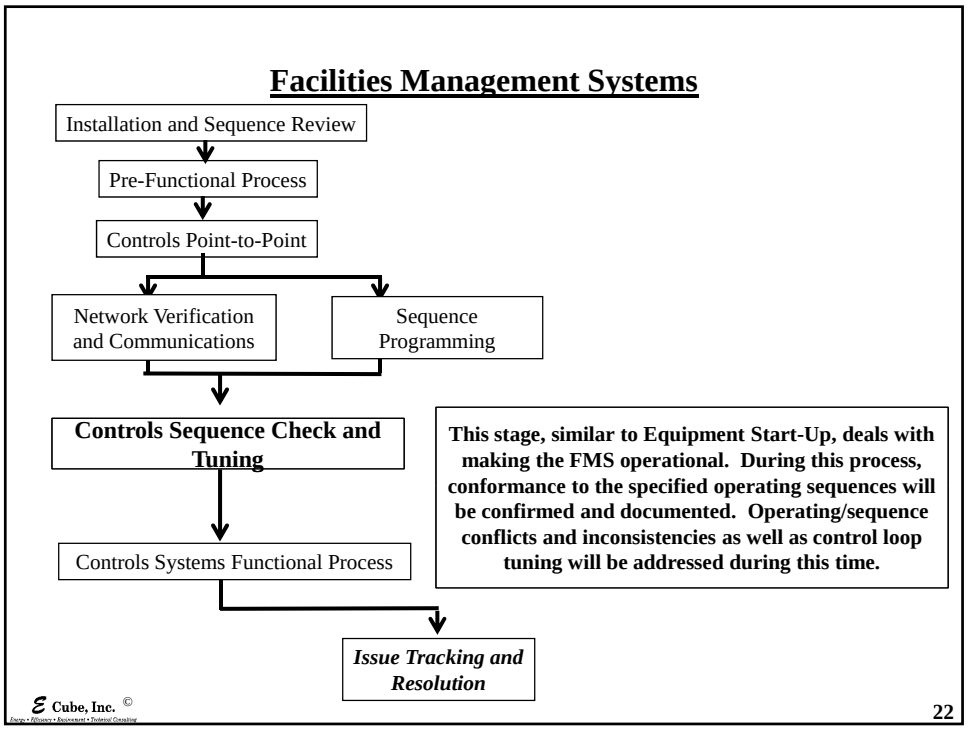
21


Facilities Management Systems
Installation and Sequence Review
Pre-Functional Process
Controls Point-to-Point
Network Verification and Communications
Sequence Programming
Controls Sequence Check and Tuning
Controls Systems Functional Process
Issue Tracking and Resolution
This stage, similar to Equipment Start-Up, deals with making the FMS operational. During this process, conformance to the specified operating sequences will be confirmed and documented. Operating/sequence conflicts and inconsistencies as well as control loop tuning will be addressed during this time.
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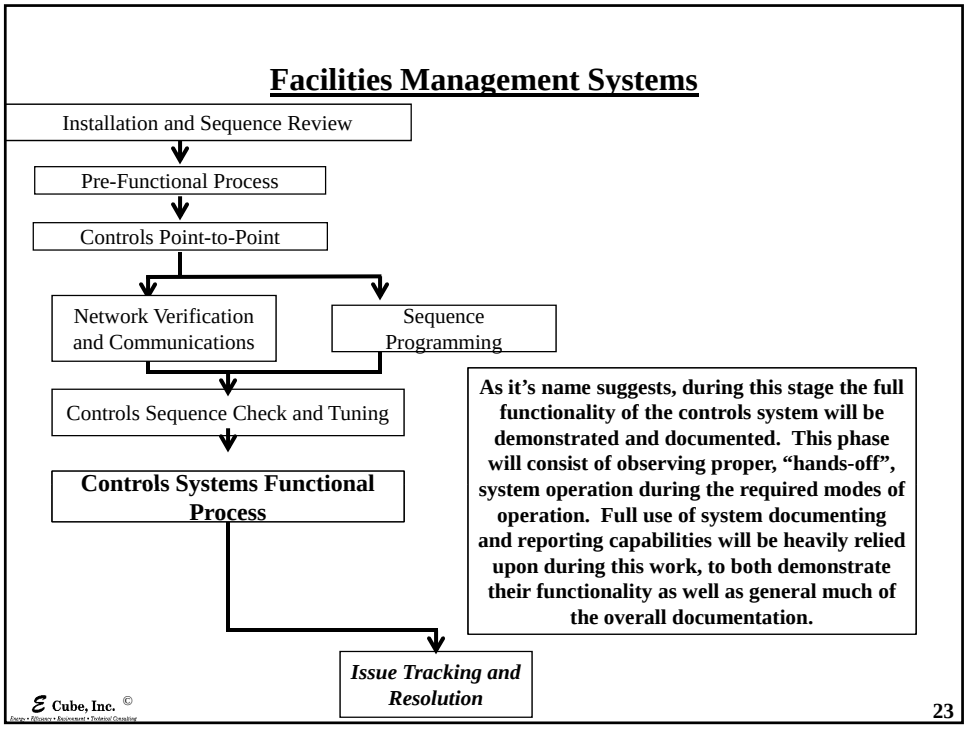
Facilities Management Systems
Installation and Sequence Review
Pre-Functional Process
Controls Point-to-Point
Network Verification and Communications
Sequence Programming
Controls Sequence Check and Tuning
Controls Systems Functional Process
Issue Tracking and Resolution
As it's name suggests, during this stage the full functionality of the controls system will be demonstrated and documented. This phase will consist of observing proper, "hands-off", system operation during the required modes of operation. Full use of system documenting and reporting capabilities will be heavily relied upon during this work, to both demonstrate their functionality as well as general much of the overall documentation.
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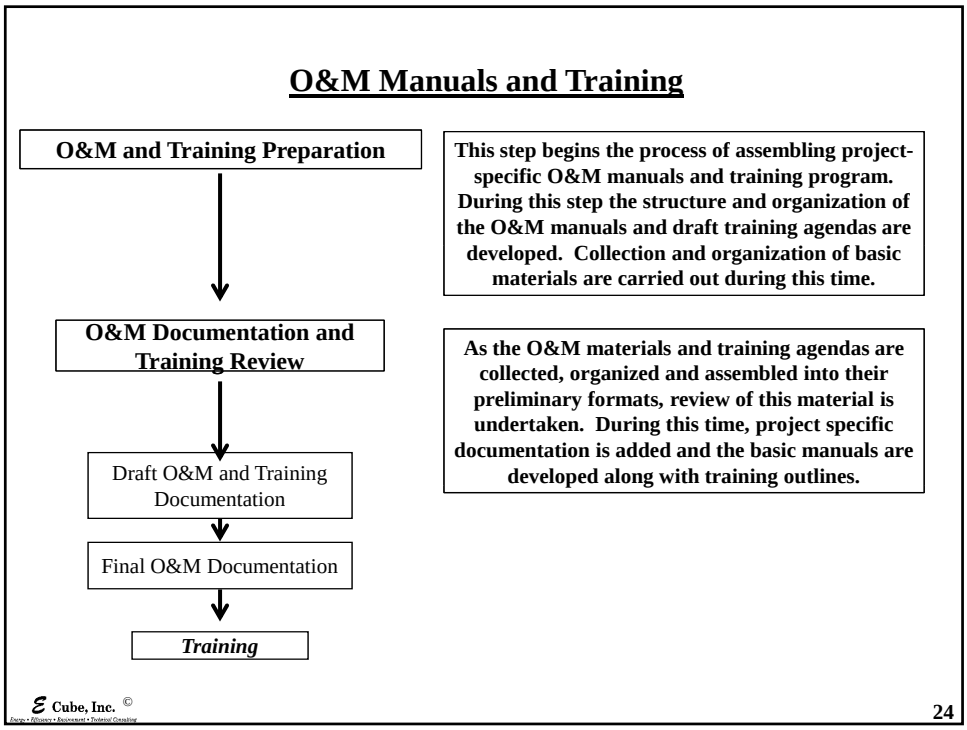
O&M Manuals and Training
O&M and Training Preparation
This step begins the process of assembling project-specific O&M manuals and training program. During this step the structure and organization of the O&M manuals and draft training agendas are developed. Collection and organization of basic materials are carried out during this time.
O&M Documentation and Training Review
As the O&M materials and training agendas are collected, organized and assembled into their preliminary formats, review of this material is undertaken. During this time, project specific documentation is added and the basic manuals are developed along with training outlines.
Draft O&M and Training Documentation
Final O&M Documentation
Training
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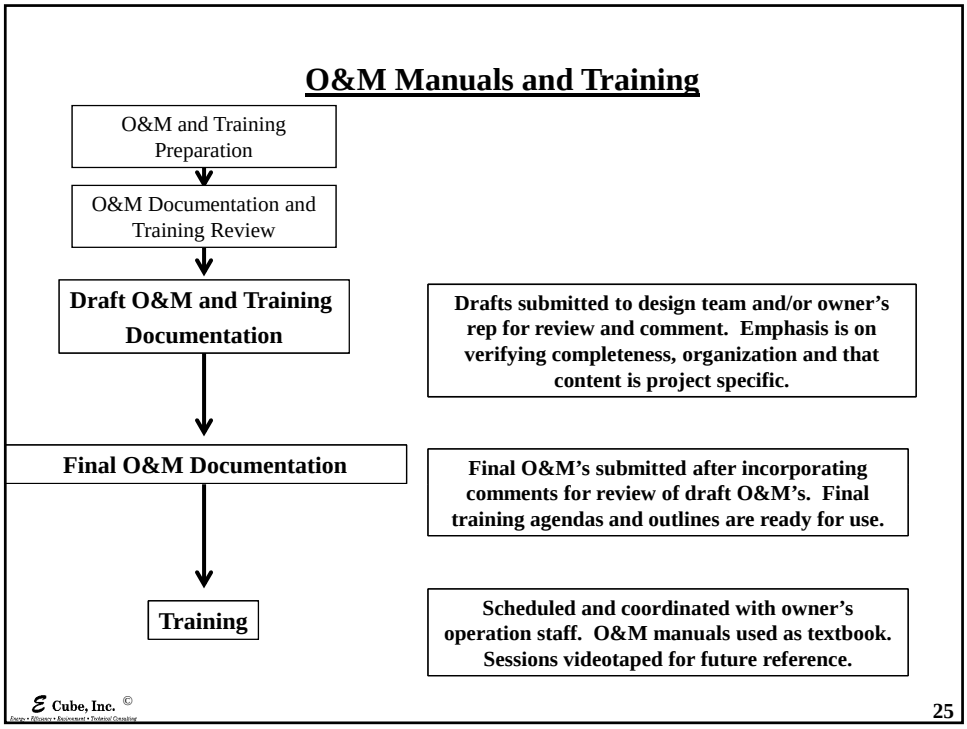
24


O&M Manuals and Training
O&M and Training Preparation
O&M Documentation and Training Review
Draft O&M and Training Documentation
Drafts submitted to design team and/or owner's rep for review and comment. Emphasis is on verifying completeness, organization and that content is project specific.
Final O&M Documentation
Final O&M's submitted after incorporating comments for review of draft O&M's. Final training agendas and outlines are ready for use.
Training
Scheduled and coordinated with owner's operation staff. O&M manuals used as textbook. Sessions videotaped for future reference.
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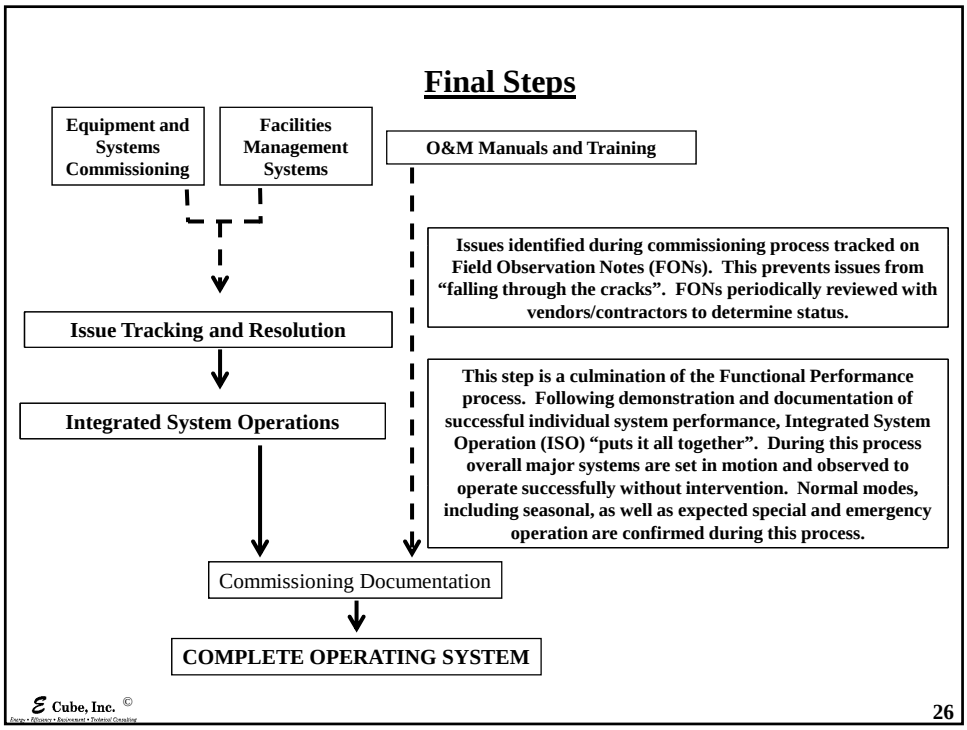
25


Final Steps
Equipment and Systems Commissioning
Facilities Management Systems
O&M Manuals and Training
Issues identified during commissioning process tracked on Field Observation Notes (FONs). This prevents issues from "falling through the cracks". FONs periodically reviewed with vendors/contractors to determine status.
Issue Tracking and Resolution
This step is a culmination of the Functional Performance process. Following demonstration and documentation of successful individual system performance, Integrated System Operation (ISO) "puts it all together". During this process overall major systems are set in motion and observed to operate successfully without intervention. Normal modes, including seasonal, as well as expected special and emergency operation are confirmed during this process.
Integrated System Operations
Commissioning Documentation
COMPLETE OPERATING SYSTEM
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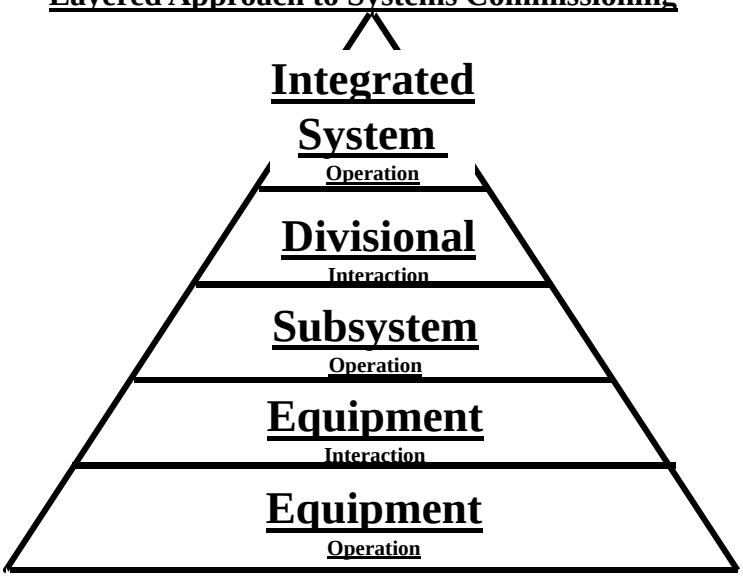
26

Layered Approach to Systems Commissioning



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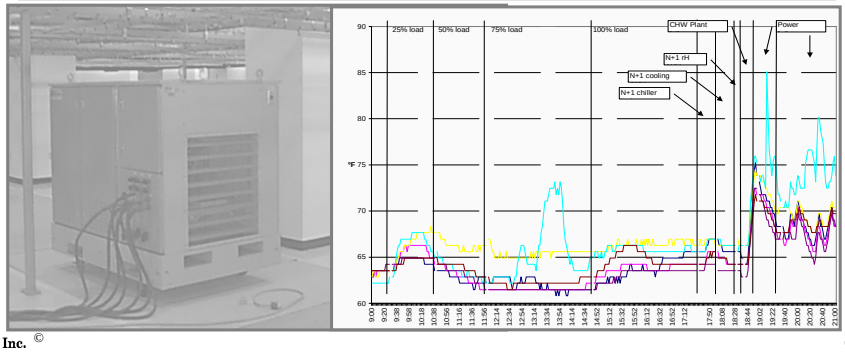
27

Process

Integrated Systems Testing

•This step is a culmination of the Functional Performance process. Following demonstration and documentation of successful individual system performance, Integrated System Operation (ISO) "puts it all together". During this process overall major systems are set in motion and observed to operate successfully without intervention. Normal modes, including seasonal, as well as expected special and emergency operation are confirmed during this process.



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28

Integrated Systems Testing

		SIMULATED CHILLER FAILURE UNDER LOAD					
48	0:01	14:30	14:31	Fail the lead Chiller by shutting off power at the local Chiller Control Panel.	E Cube	Lead Chiller off-line. Chiller failure alarm at operator workstation.	Chiller failure alarm _____
49	0:15	14:31	14:46	Monitor chilled water supply and return temperatures, and IP room air temperatures during transition. (Step timing for this and the next steps depend on system response.)	E Cube	Chilled water supply and return temperatures rise.	
50	0:02	14:31	14:33	Verify standby chiller energized after failure of the chiller chilled water supply pump, conderser water supply pump, or chiller failure.	E Cube	Chilled water pump energized.	
51	0:01	14:33	14:34	Verify DP switches around stand-by chilled water pump prove flow and control valve modulates open.	E Cube	Chilled water flow through stand-by chiller achieved.	
52	0:01	14:34	14:35	Verify paddle switch proves flow through stand-by chiller and chiller brought on-line.	E Cube	Chiller start-up sequence initiated.	
53	0:20	14:35	14:55	Verify compressors stage on until load satisfied.	E Cube	Chilled water temperatures stabilize.	
54	0:15	14:55	15:10	Monitor chilled water supply and return temperatures, and IP room air temperatures after standby online.	E Cube	Chilled water supply and return temperatures stabilize.	
55	0:30	15:10	15:40	Monitor operation of stand-by chiller.	E Cube	Standby chiller operates without interruption under full load.	
56	0:05	15:40	15:45	Return lead chiller to a power-on condition by turning on power at the local control panel.	E Cube	Chiller start-up sequence initiated.	
	COMMENTS:						

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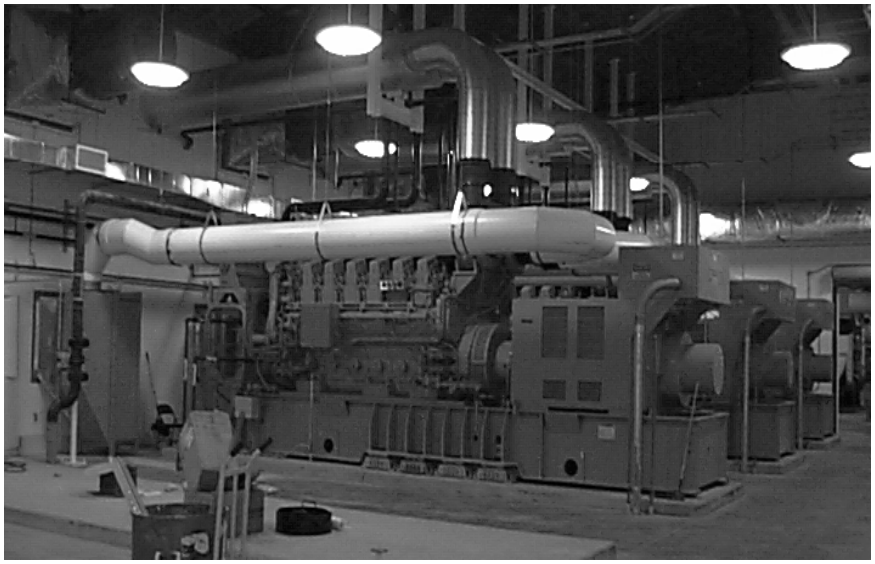

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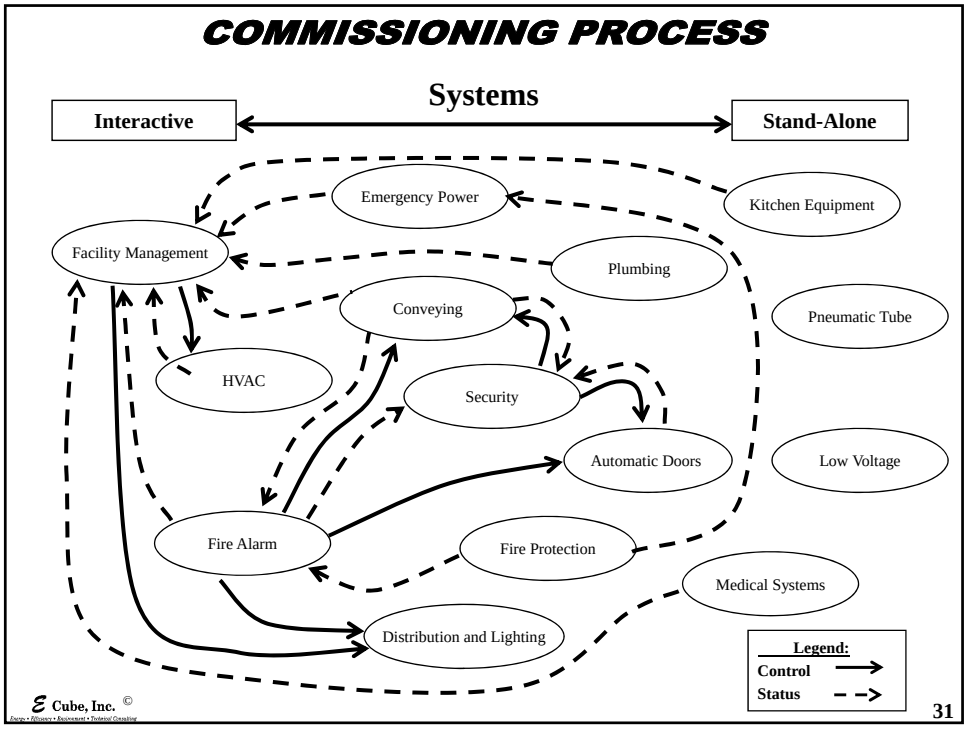
COMMISSIONING PROCESS
Systems
Interactive
Stand-Alone
Emergency Power
Kitchen Equipment
Facility Management
Plumbing
Conveying
Pneumatic Tube
HVAC
Security
Automatic Doors
Low Voltage
Fire Alarm
Fire Protection
Medical Systems
Distribution and Lighting
Legend:
Control
Status
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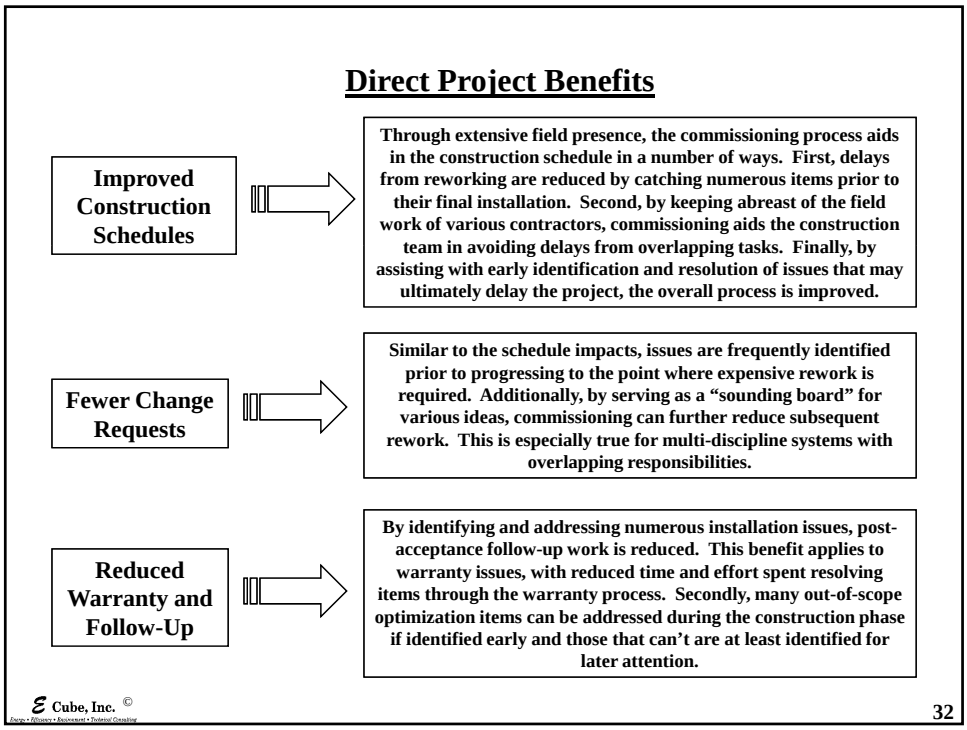
Direct Project Benefits
Improved Construction Schedules
Through extensive field presence, the commissioning process aids in the construction schedule in a number of ways. First, delays from reworking are reduced by catching numerous items prior to their final installation. Second, by keeping abreast of the field work of various contractors, commissioning aids the construction team in avoiding delays from overlapping tasks. Finally, by assisting with early identification and resolution of issues that may ultimately delay the project, the overall process is improved.
Fewer Change Requests
Similar to the schedule impacts, issues are frequently identified prior to progressing to the point where expensive rework is required. Additionally, by serving as a "sounding board" for various ideas, commissioning can further reduce subsequent rework. This is especially true for multi-discipline systems with overlapping responsibilities.
Reduced Warranty and Follow-Up
By identifying and addressing numerous installation issues, post-acceptance follow-up work is reduced. This benefit applies to warranty issues, with reduced time and effort spent resolving items through the warranty process. Secondly, many out-of-scope optimization items can be addressed during the construction phase if identified early and those that can't are at least identified for later attention.
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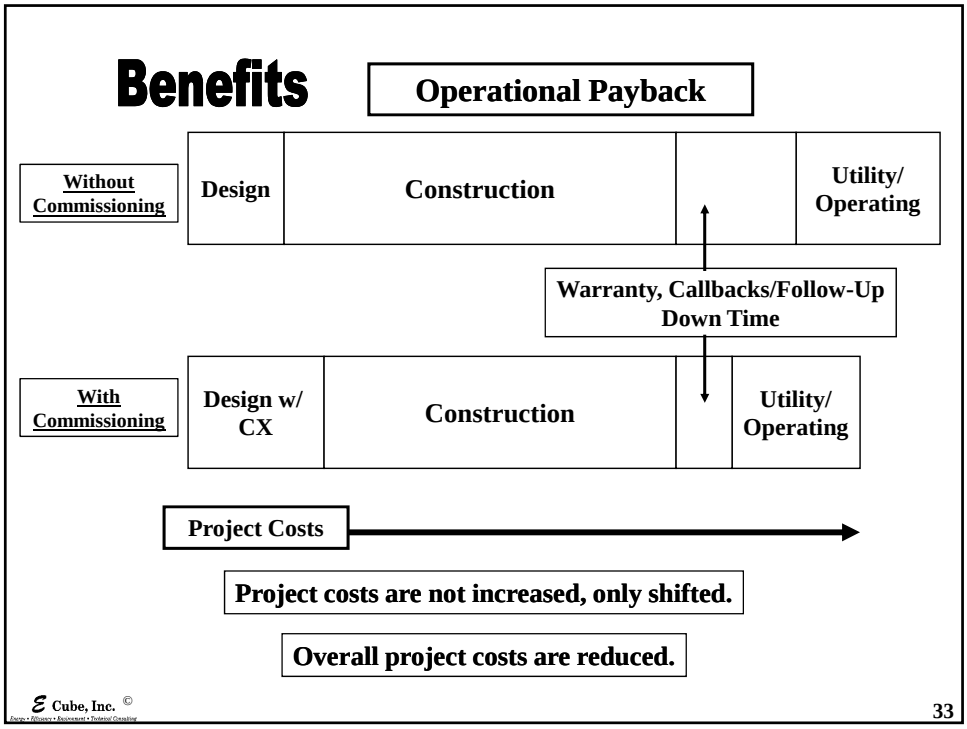
32


Benefits
Operational Payback
Without Commissioning
Design
Construction
Utility/ Operating
Warranty, Callbacks/Follow-Up Down Time
With Commissioning
Design w/ CX
Construction
Utility/ Operating
Project Costs
Project costs are not increased, only shifted.
Overall project costs are reduced.
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33


Thank you!
Questions
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34