INCOSE International Symposium
Philadelphia, PA
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Applying Systems Engineering to Transit Facilities: Advancing Beyond *"Building Commissioning"*

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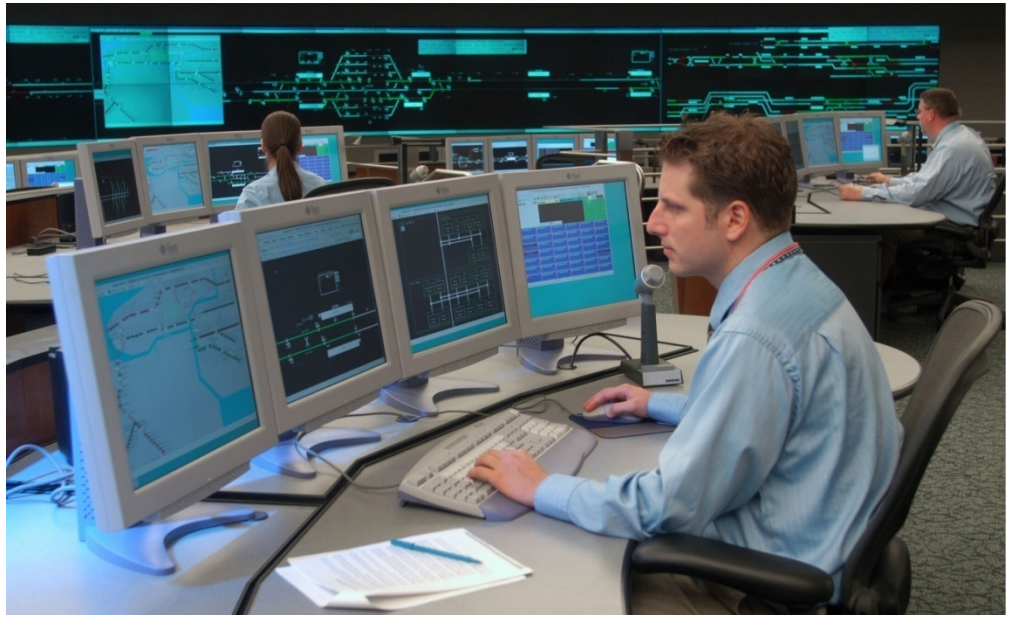
Outline

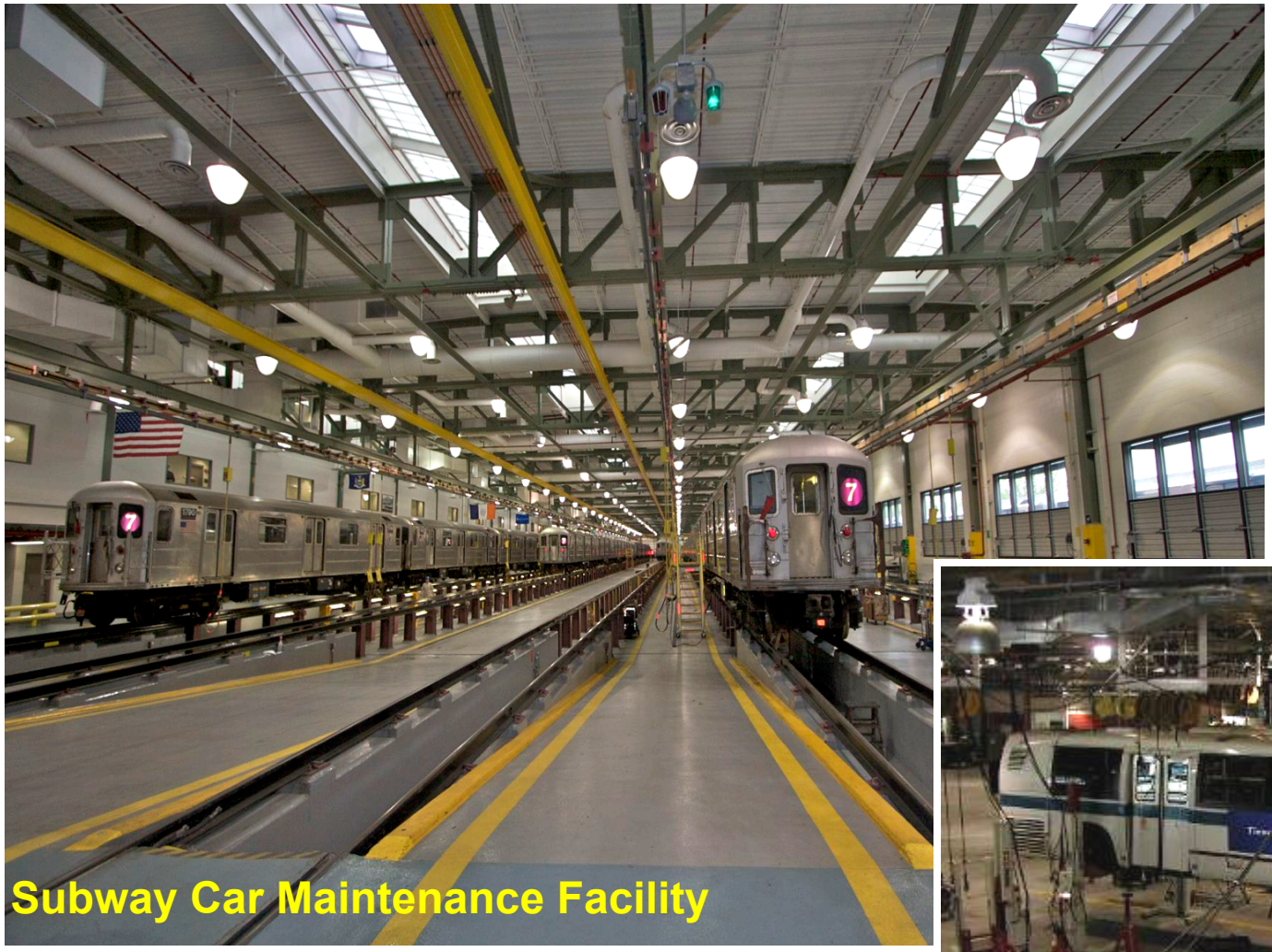
- Increasing Complexity for Facility Systems
- Building Industry "Commissioning Process" versus Systems Engineering Approach
- NYCT Implementation Case Studies
- Further SE Tailoring Plans
- Conclusions

Operating Facilities for Transit



Rail Control Center

Maintenance Facilities for Transit



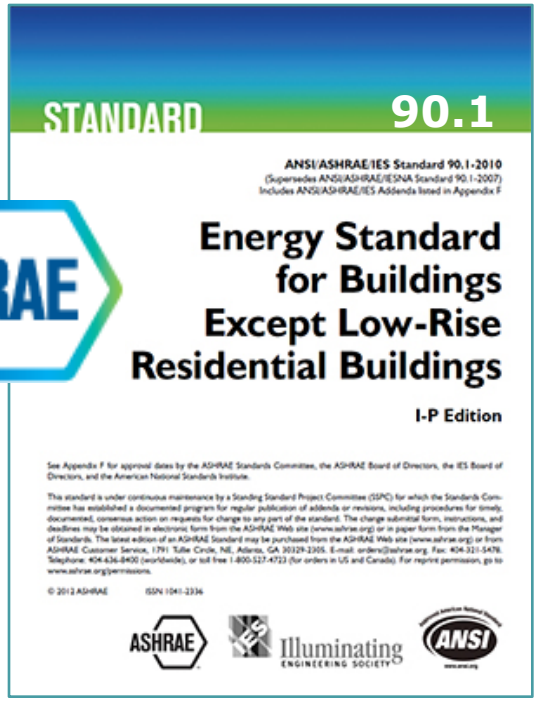
Subway Car Maintenance Facility

Bus Maintenance and Storage Facility

LEED Certified Subway Car Maintenance Facility

Increasing Complexity for Facility Systems: Drivers for Change to Facilities

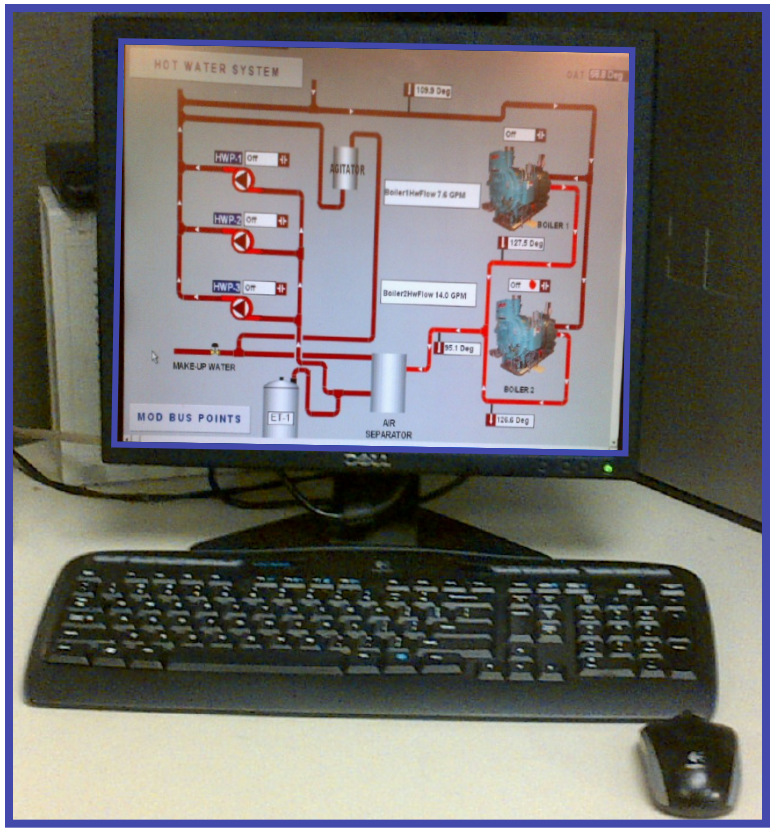
LEED = Leadership in Energy Efficiency and Environmental Design



BUILD SMART NY

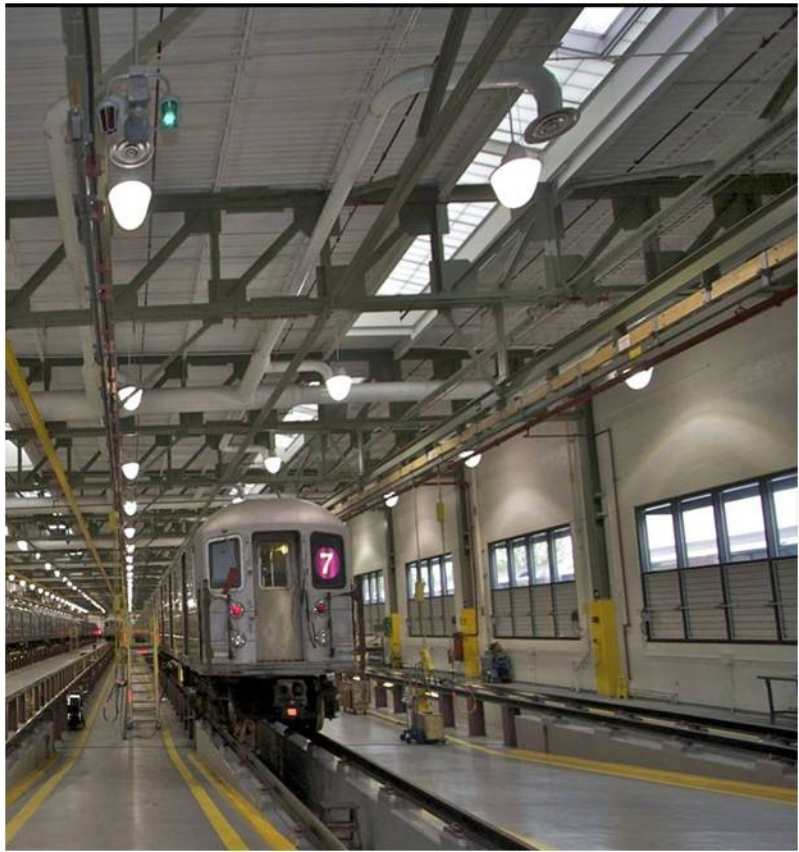
BUILD SMART NY Initiative –
Reduce energy consumption in State buildings **20%** by 2020

Heat Recovery Unit (HRU)



Building Automation System

Air Conditioning



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Natural Lighting & Natural Ventilation

New York City Transit

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Renewable Energy - Solar Panels

New York City Transit

Green Roof at Signal Crew Quarters

Water Resource Conservation

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Rain Water Collection

Grey Water Reuse

Integrated Fire Alarm System with Fire Suppression Systems and Elevator


Fire Alarm Panel


Emergency Exhaust Fan

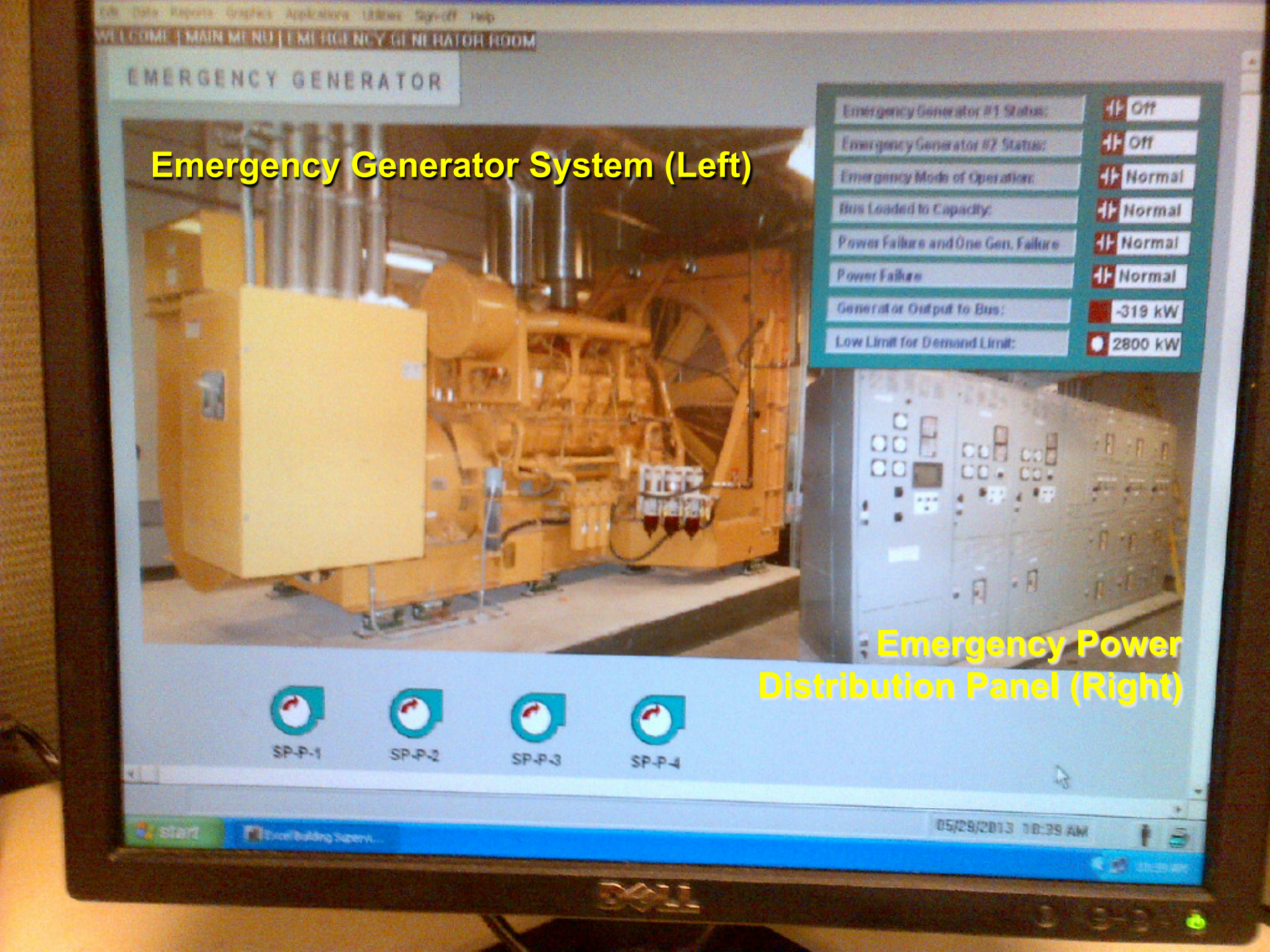
Elevator


Wet suppression


Clean agent Suppression

Fire Pull Station

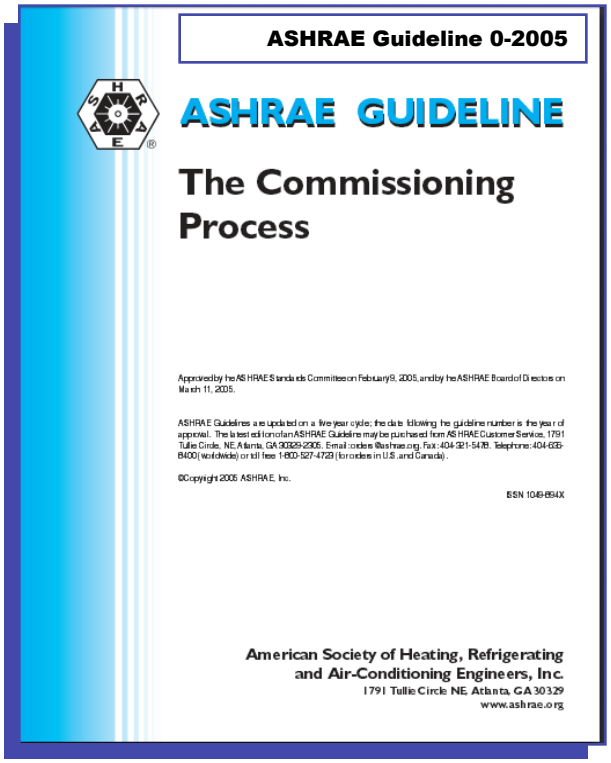
Security Systems


EMERGENCY GENERATOR
Emergency Generator System (Left)
Emergency Generator #1 Status: Off
Emergency Generator #2 Status: Off
Emergency Mode of Operation: Normal
Bus Loaded to Capacity: Normal
Power Failure and One Gen. Failure Normal
Power Failure Normal
Generator Output to Bus: -319 kW
Low Limit for Demand Limit: 2800 kW
Emergency Power Distribution Panel (Right)
SP-P-1
SP-P-2
SP-P-3
SP-P-4
start
05/29/2013 10:39 AM

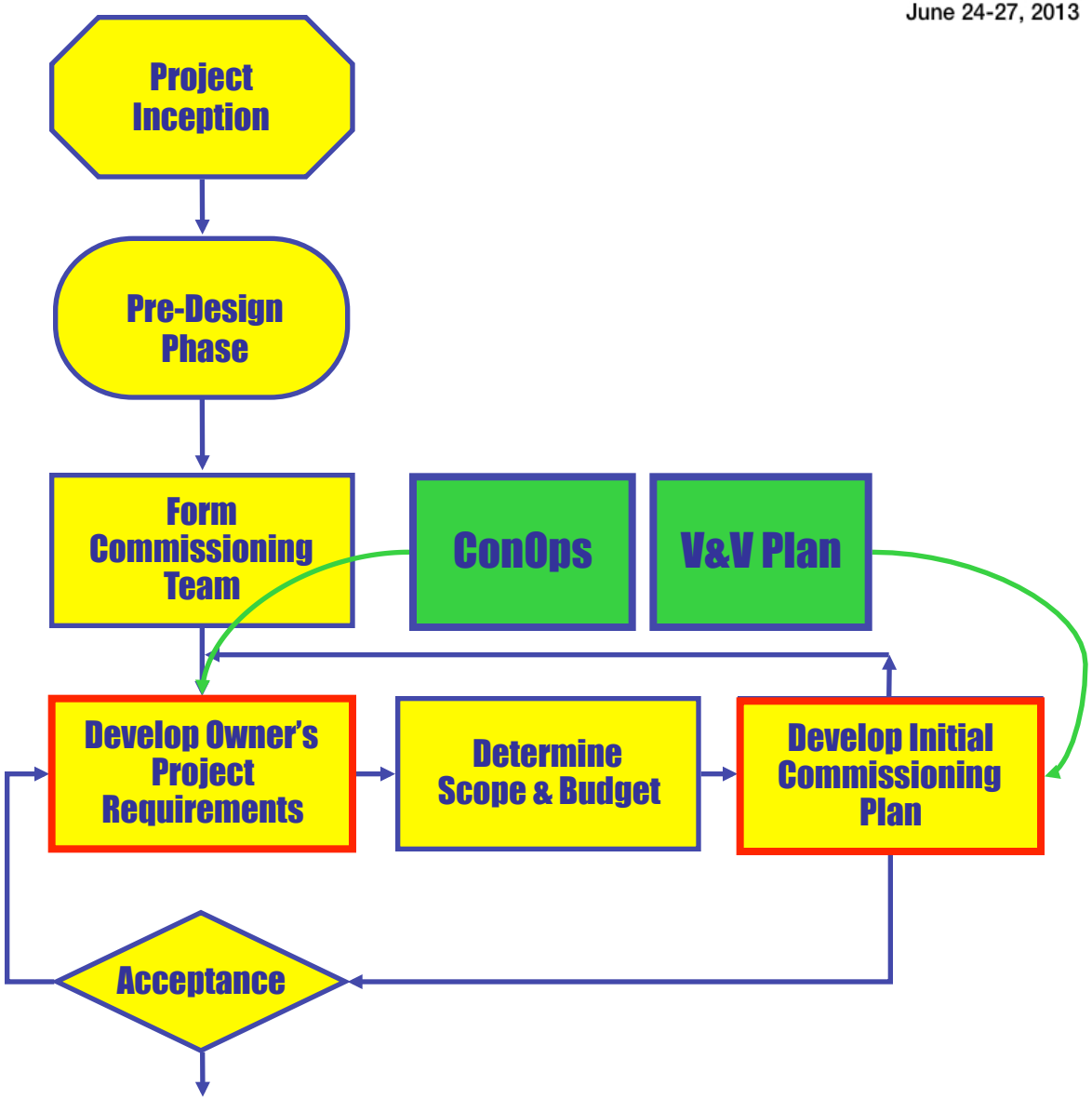
Addressing Increased System Complexity

- **LEED certification requires "Commissioning"**
- ***Building Commissioning* governed by ASHRAE Guideline 0**

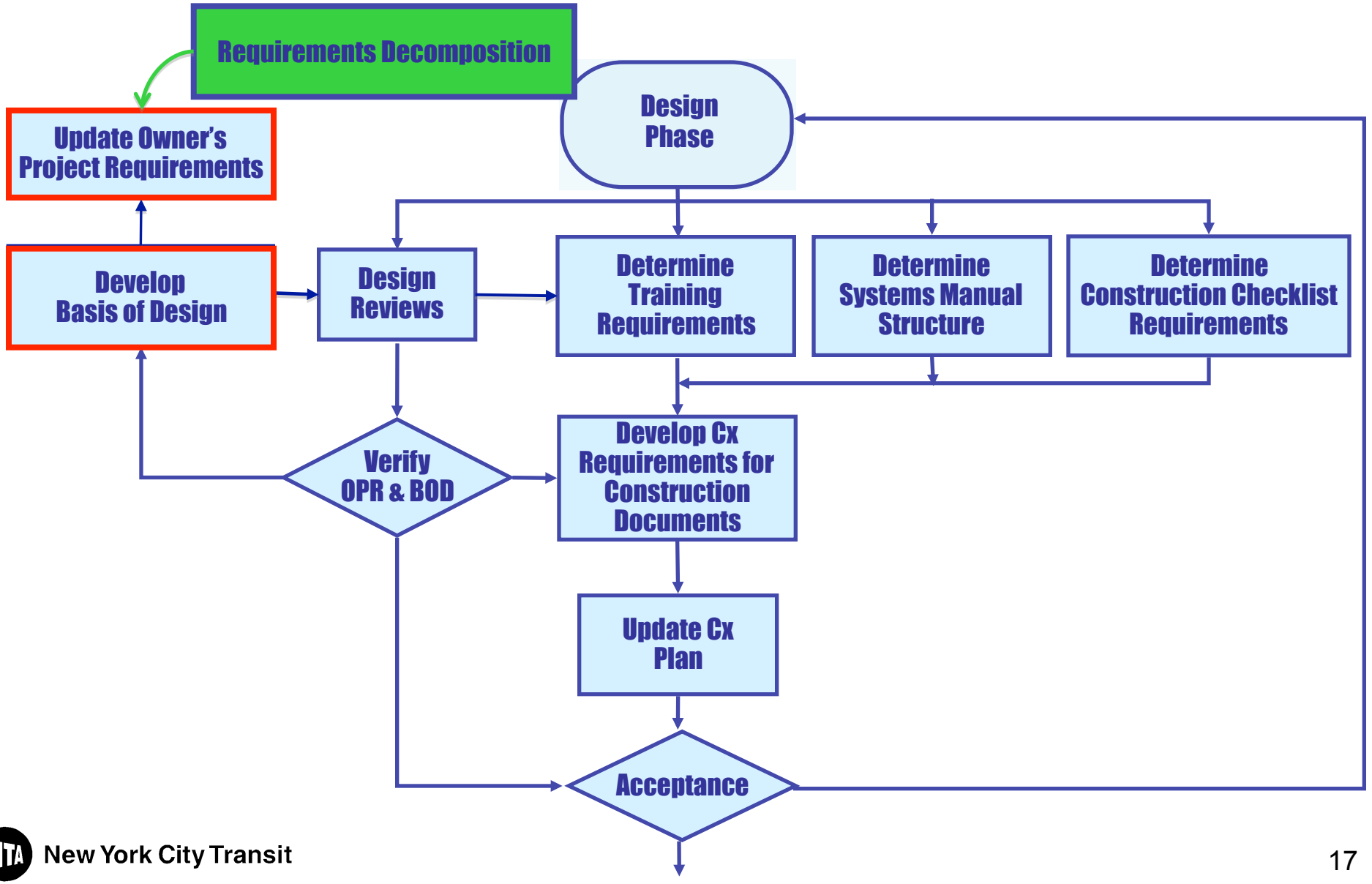
For Building Industry ***Commissioning*** *"provides documented confirmation that building systems function according to criteria set forth in project documents to satisfy the owner's operational needs."*



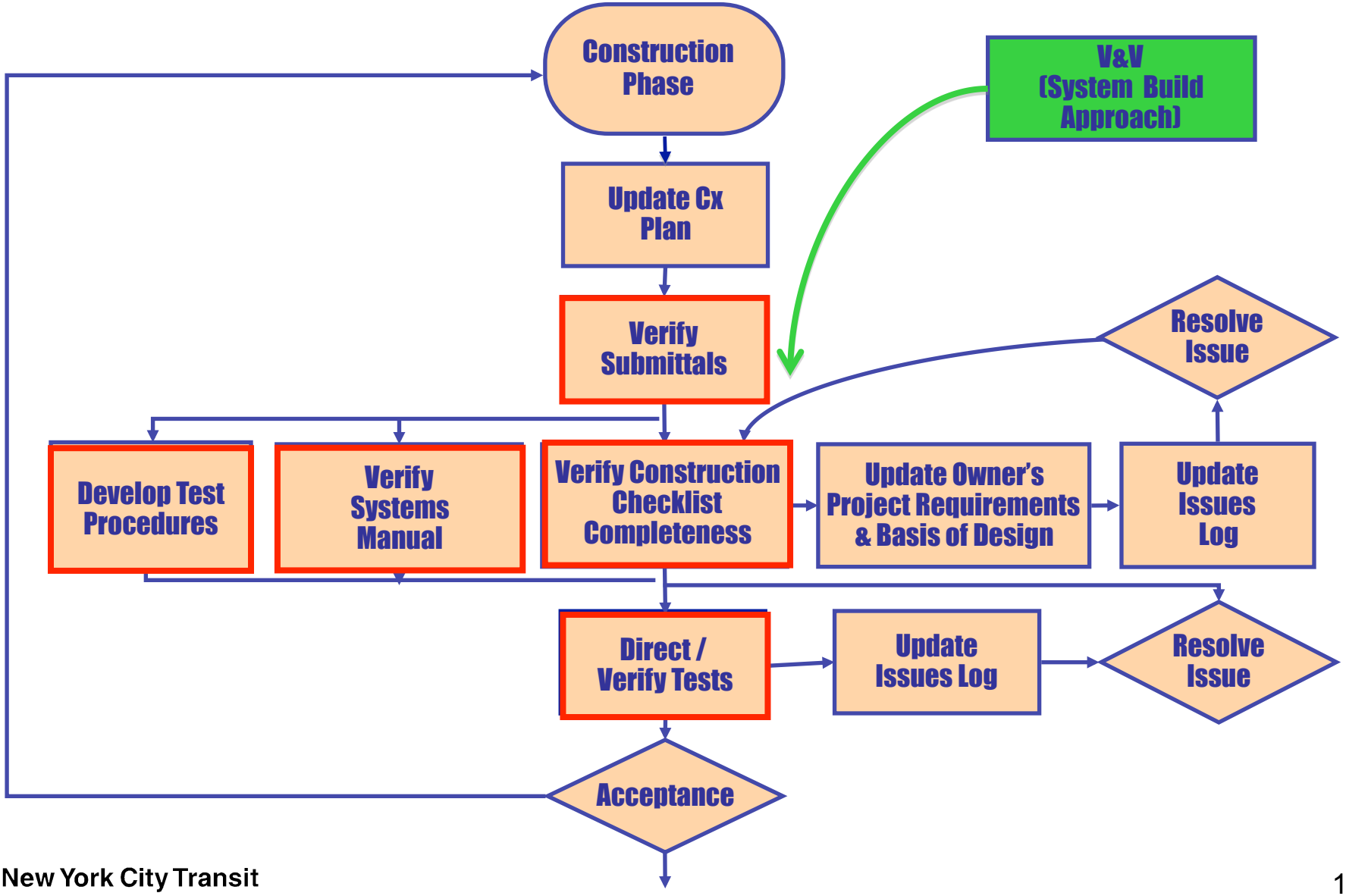
Commissioning Process versus SE Approach
> Planning Phase



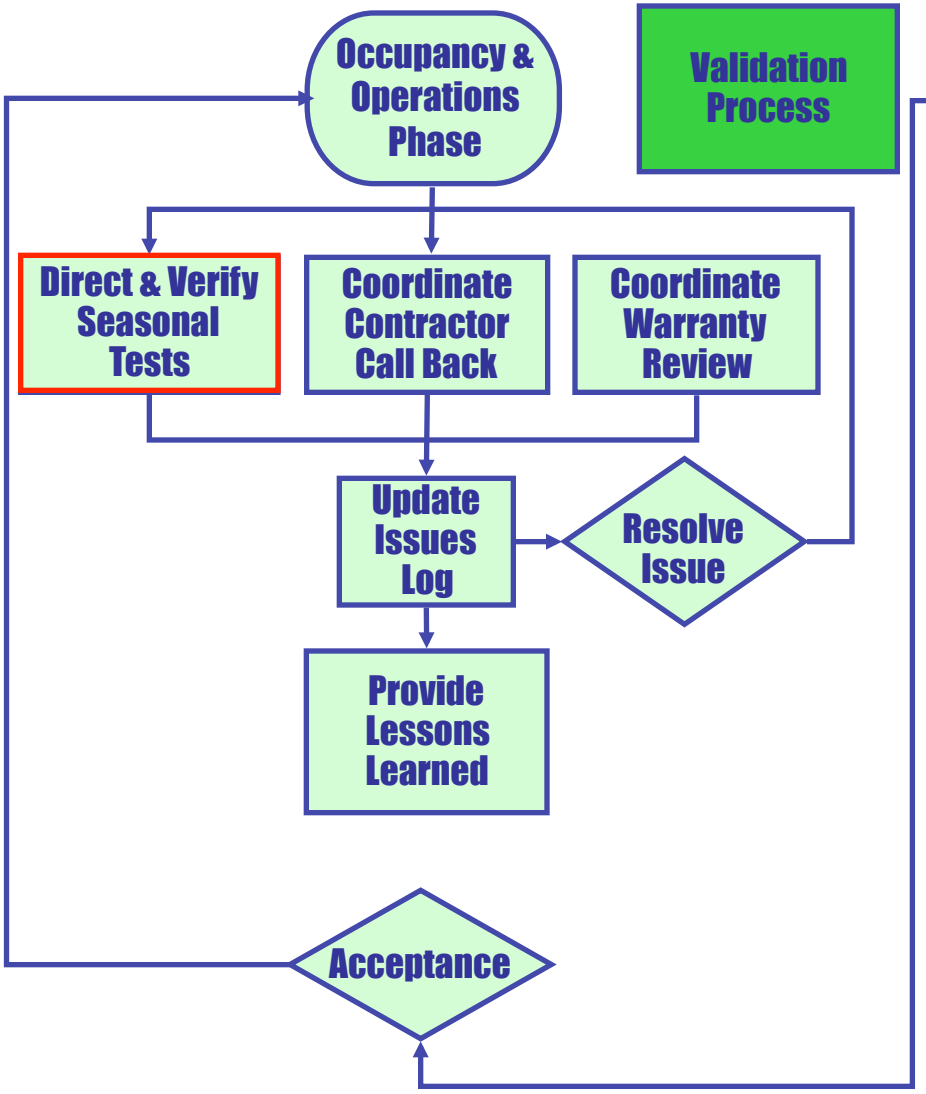
Commissioning Process versus SE Approach > Design Phase

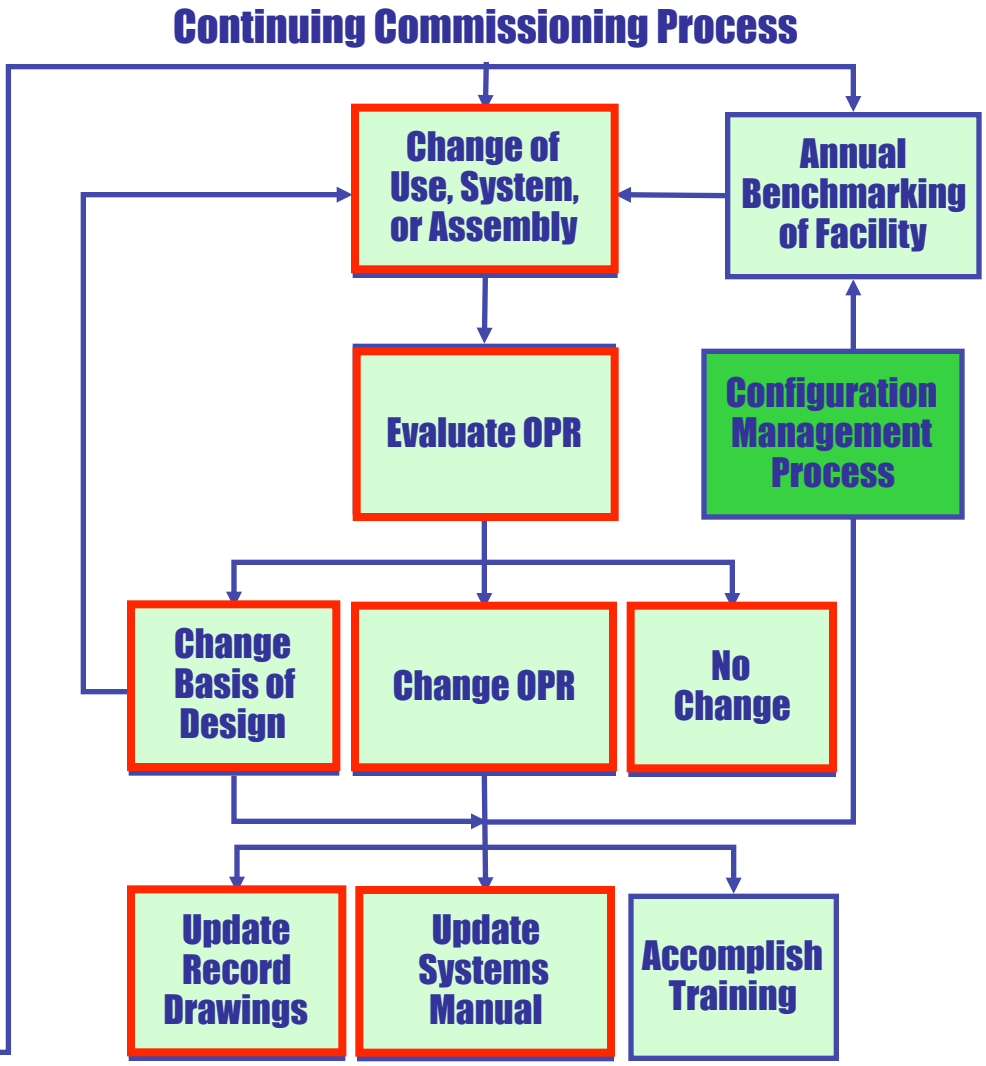


Commissioning Process versus SE Approach
> Construction Phase



Commissioning Process versus SE Approach > Operations Phase





NYCT Implementation Case Studies: Subway Car Maintenance Facility

NYCT Implementation Case Studies:
Subway Station Portal & Police District Facility

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NYCT Implementation Case Studies:
Bus Maintenance Facility

NYCT Implementation Case Studies:
Bus Maintenance and Storage Depot Facility

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Challenges for Successful Integrated Facilities

- Limited knowledge of Systems Practices in Building Industry
- Existing Commissioning Providers have limited technical systems breadth
- Operating personnel need new skills, maintenance knowledge

Further SE Tailoring Plans

- Expand ConOps use to document Operational needs and intent
- Improve Requirements:
  - Systems descriptions, decomposition
  - Use System Architecture to enhance interface definition
- Enhance V&V:
  - Start V&V Plan earlier; perform activities earlier
  - Follow Systems Build Approach
  - Conduct Validation

Conclusions

- Growing need for SE Approach given increased facility system complexity
- Current Building Industry process diverges from robust systems principles and practices
- This evaluation reinforced degree of divergence and further tailoring required
- Peer benchmarking confirms SE process and knowledge gaps exist across transit industry