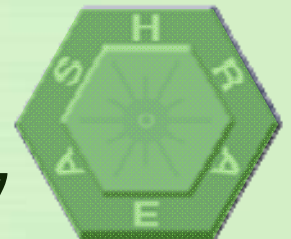


Steps Towards Achieving Advanced Energy Performance in Existing Buildings



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Presidential Member
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Steps to Advanced Existing Building Energy Performance

Topics to be Presented

- **Energy Efficiency Guidance for Existing Commercial Buildings**
- **Advanced Energy Guidance for Existing Commercial Buildings**
- **Technical Retro-commissioning/Commissioning of Existing Buildings**



Why should architects and engineers be concerned with resource conservation?

- **Buildings consume**
 - **49%** of all energy used and **over 70%** of electrical energy use
 - **17%** of all fresh water
 - **25%** of wood produced
- **Buildings produce 39%** of CO₂ emissions
- **Buildings generate 30%** of waste in landfills





**Energy Efficiency Guide
for Existing Commercial Buildings:
The Business Case for
Building Owners and Managers**

**Dennis R. Landsberg, Mychele R. Lord
with Steve Carlson, Fredric Goldner**

Developed by:
American Society of Heating, Refrigerating and Air-Conditioning Engineers
The American Institute of Architects
Illuminating Engineering Society of North America
U.S. Green Building Council

*In collaboration with:
Building Owners and Managers Association International
U.S. General Services Administration*



Energy Efficiency Guide for Existing Commercial Buildings

- New Buildings = 2% of Building Programs
- 86% of Annual Building Construction Expenditures Relate to Building Renovations
- Even with Commissioned Buildings, their Performance Deteriorates after 3 years by 30%
- ASHRAE Research has shown that the “potential” for reduction of a building’s energy use is between 10% and 40% simply by changing operational strategies
- 70% - 80% of Buildings in 2030 exist today
- Over next 30 years, 150 billion square feet of existing buildings **will be renovated**

Energy Efficiency Guide for Existing Commercial Buildings

Steps to Take to Identify & Improve a Building's Energy Performance

1. Measure the energy performance and carbon emissions of a building
2. Evaluate the building's energy performance and set goals accordingly
3. Implement no-cost & low-cost operational adjustments to improve operational efficiency
4. Conduct an ASHRAE Level 1 Walk-Thru Energy Audit or hire an independent 3rd party to conduct Retro-commissioning/ASHRAE Level 2 Energy Audit

Energy Efficiency Guide for Existing Commercial Buildings

Steps to Take to Identify & Improve a Building's Energy Performance

5. Evaluate, develop a plan for and implement Energy Efficiency Measures (EEMs) identified in Audits or Retro-commissioning
6. Take integrated approach to any planned replacements – staging replacements, evaluate new technologies, on-site power gen. & tax credits
7. Incorporate energy management into standard policies & procedures, O&M and ensure ongoing performance tracking/monitoring

Energy Efficiency Guide for Existing Commercial Buildings

Measuring a Building's Energy Efficiency & Setting Performance Goals

- Setting a Building's Energy Performance Goals
 1. Establish "Benchmark"
 2. 1st Target should be to achieve at least a 75% level of operation of any national building performance rating
 3. 2nd Target → Increase performance 10% - 30% (15%)
 4. 3rd Target → Achieve performance of current version of ASHRAE Standard 90.1 (2007)
 5. 4th Target → Go 30%, 50% or 70% beyond 90.1
 6. 5th Target → Go to Net-Zero Energy

Energy Efficiency Guide for Existing Commercial Buildings

Improving Energy Performance

- Energy Audits
 - ASHRAE Procedures for Commercial Building Energy Audits
 - * **Level I** – Walk-through Analysis will identify and provide a savings and cost analysis for low-cost/no-cost measures
 - Listing of potential capital improvements that merit further consideration & estimates for implementation costs and utility savings
 - * **Level II** – Energy Survey & Engineering Analysis provides a more detailed building survey and energy analysis of all practical measures that meet owner's constraints and economic criteria
 - Recommend changes to O&M procedures



Energy Efficiency Guide for Existing Commercial Buildings

Improving Energy Performance

- Energy Audits
 - ASHRAE Procedures for Commercial Building Energy Audits
 - * **Level III** – Detailed Analysis of Capital-Intensive Modifications identified during the Level II analyses → more rigorous engineering evaluations (Investment Grade Audit-IGA) that provide a high level of confidence for major capital investment decisions
 - More detailed field data may be required to support the required engineering analyses
 - Produces very detailed implementation costs and utility/O&M savings information



Energy Efficiency Guide for Existing Commercial Buildings

Improving Energy Performance

- Commercial Building's Energy Usage
 - Lighting Systems Savings Opportunities
 - * Occupant sensor/control = 10% - 20% savings
 - * Natural lighting in perimeter areas
 - * Light Emitting Diodes (LEDs) save energy and reduce O&M costs (e.g. exit signs, high-repetitive use applications)
 - * Compact Fluorescent Lamps (CFLs) now provide output similar to incandescent lamps



Energy Efficiency Guide for Existing Commercial Buildings

Improving Energy Performance

- Commercial Building's Energy Usage
 - Lighting Systems Savings Opportunities
 - * Super T-8 ballasts and lamps provide ~ 60% savings
 - * Hi-output T-5 fixtures good for warehouses and high bay areas (replace HID lighting)
 - * Pulse start metal halide good for garages; with occupancy sensors they idle at 50% power
 - * Some fluorescent fixtures operate down to 0 Deg.F; Photocell or Astronomic time clock control



Energy Efficiency Guide for Existing Commercial Buildings

Improving Energy Performance

- Commercial Building's Energy Usage
 - Plug Loads
 - * Produce “Phantom” electric loads that consume power when turned off
 - * ENERGY STAR equipment can use 60% less energy
 - * Power strips with occupancy sensors
 - * Typically account for 0.5 – 2.0 watts/SF in office buildings



Energy Efficiency Guide for Existing Commercial Buildings

Improving Energy Performance

- Commercial Building's Energy Usage
 - Refrigeration Loads
 - * Waste heat recovery systems
 - * Use of multi-stage equipment or variable speed components
 - * Triple glazing in lieu of anti-sweat heaters
 - * LEDs instead of fluorescent fixtures
 - * Covering of open-face cases



Energy Efficiency Guide for Existing Commercial Buildings

Improving Energy Performance

- Commercial Building's Energy Usage
 - Building Envelope
 - * Increase insulation levels in walls and roof
 - * Improve windows' thermal resistance
 - * Reduce heat gain w/film and shading
 - * Reduction of air infiltration
 - * Control of moisture intrusion/water vapor that cause surface condensation



Energy Efficiency Guide for Existing Commercial Buildings

Improving Energy Performance

- Commercial Building's Energy Usage
 - Distribution of Heating and Cooling
 - * Review Distribution Systems to determine if:
 - Pumps & fans have high efficiency motors
 - Constant flow systems → variable flow
 - Proper control of economizer operation
 - Air/water distribution properly balanced
 - Controls are operating as designed/per OPR
 - Energy recovery for O/A systems



Energy Efficiency Guide for Existing Commercial Buildings

Improving Energy Performance

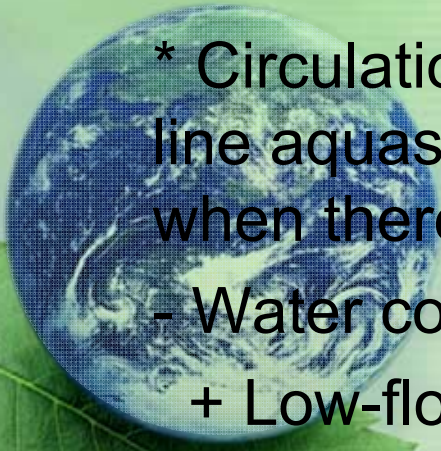
- Commercial Building's Energy Usage
 - Ventilation Air
 - * Energy recovery with energy recovery wheels, heat pipes, cross flow H/E and run-around loops reduce energy costs 50% - 75%
 - * Demand Control Ventilation (DCV) with CO₂ monitoring
 - * Important to maintain positive pressure with a Dedicated Outside Air System (DOAS)
 - * High ambient RH – Humidistat controls for O/A



Energy Efficiency Guide for Existing Commercial Buildings

Improving Energy Performance

- Commercial Building's Energy Usage
 - Water Heating
 - * Equipment – storage tanks, circulation & instantaneous
 - * Storage temps must be maintained above 125°F
 - * Ensure sufficient storage and piping insulation levels
 - * Circulation pumps controlled by a “reverse acting” return line aquastat (better than a time clock) that turns pump off when there is no hot water demand
 - Water conservation = energy conservation
 - + Low-flow toilets, faucets & showerheads, waterless urinals, gray water systems & rain-water harvesting



Energy Efficiency Guide for Existing Commercial Buildings

Finding Low-Hanging Fruit Within O&M

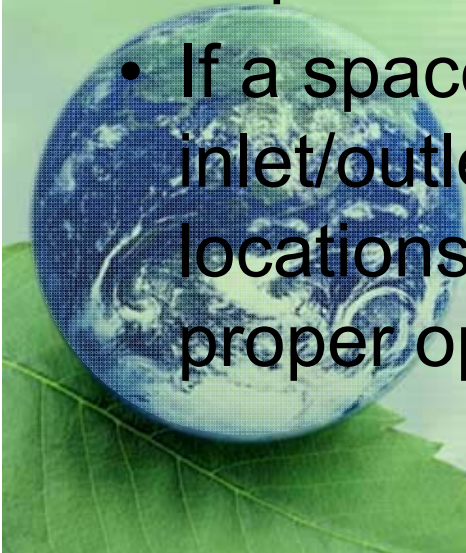
- Efficient Operations & Maintenance Items
 - Find & repair all air, steam and water leaks
 - Calibrate control sensors on a periodic basis
 - Review all control set-points for space temperatures, hot & chilled water, and economizers
 - Review schedules of equipment operation and set-points during un-occupied periods
 - Adjust any morning warm-up or cool-down and associated optimum start times
 - Adjust ventilation schedules to track occupancy



Energy Efficiency Guide for Existing Commercial Buildings

Finding Low-Hanging Fruit Within O&M

- Efficient Operations & Maintenance Items
 - Tour facility at midnight to see what equipment is left on/operates unnecessarily
 - Check for excess ventilation amounts that aren't required for maintaining proper IAQ
 - If a space/area undergoes remodeling, check duct inlet/outlet locations as well as thermostat/sensor locations and adjust accordingly in order to ensure proper operation and area comfort



Energy Efficiency Guide for Existing Commercial Buildings

Additional O&M and EEM Considerations

- Heat exchanger Equipment – Clean both air-side and water-side of coils to reduce deposit build-up (10%)
- Chiller Tune-ups
 - Chilled Water (increase) & Condenser Water (decrease) Temperature Resets if possible
 - Chiller Tube Cleaning and Water Treatment
 - Reciprocating Compressor Unloading – pressure sensor setting
- Boiler Tune-up
 - Boiler System Steam Traps open or leaks



Energy Efficiency Guide for Existing Commercial Buildings

Additional O&M and EEM Considerations

- Boiler Tune-up
 - Combustion Air adjustment per oxygen levels in flue gas (increase of 0.7% per 10% excess reduction)
 - Boiler Tube Cleaning and Water Treatment (2.5% - 8.5%)
- Lighting Systems
 - Maximize Luminaire Efficiency – high Visual Comfort Probability (VCP) of 90%+



Energy Efficiency Guide for Existing Commercial Buildings

Making the Business Case

- Business case for increasing a building's energy efficiency level involves assessing the cost, the benefits and the risk (Owner's Language)
- **Types of Risk** to consider:
 - **Market Risk** – marketplace is beginning to recognize the importance of and place value on a building's energy performance level
 - **Regulatory Risk** – global movement toward the regulation of energy and carbon
 - **Environmental Risk** – directly impacts insurers



Energy Efficiency Guide for Existing Commercial Buildings

Making the Business Case

- **Barriers** to Energy Efficiency
 - **Capital Constraints** = Available internal monies are usually spent on aesthetic building improvements
 - **Collateral Issues** = Lenders want strong, investment-grade borrowers on equipment loans vs unrated potential high-liability companies
 - **Holding Period Bias** = Investment property holders do not want to encumber property > 3 – 5 years
 - **Split Incentive** = Who pays? And Who benefits? Landlords vs Tenants and lease language

Energy Efficiency Guide for Existing Commercial Buildings

Making the Business Case

- Financial Analysis Methodologies
 - Simple Payback Period (SPP)
 - Net Present Value (NPV)
 - Internal Rate of Return (IRR)
 - Life-Cycle Cost Analysis (LCC)



Energy Efficiency Guide for Existing Commercial Buildings

Making the Business Case

- Financial Analysis Methodologies

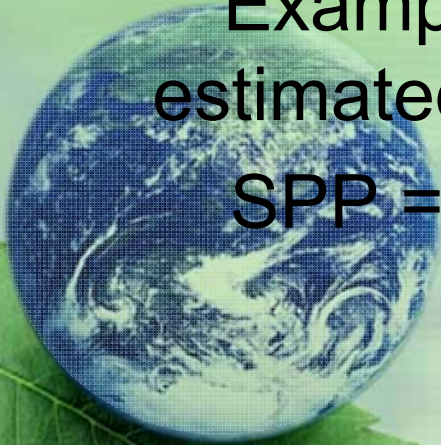
- Simple Payback Period (SPP)

- * $SPP = \frac{\text{Total Project Cost}}{\text{Annual EEM Savings}}$

Annual EEM Savings

- * Example – Total Project Cost = \$900,000 and estimated annual EEM savings = \$103,680/year

- $SPP = \$900,000 / \$103,680/\text{yr} = 8.7 \text{ years}$



Energy Efficiency Guide for Existing Commercial Buildings

Making the Business Case

- Financial Analysis Methodologies

- Net Present Value (NPV)

$$* \text{ NPV} = \left(\sum \frac{\text{Annual Change}}{(1 + \text{Discount Rate})^n} \right) - \text{Total Proj. Cost}$$

Example – Total Project Cost = \$900,000, Annual Change = \$103,680/yr, Discount Rate = 7% and time period (*) = 20 years; NPV = \$198,387

- If NPV > 0, Accept

- If NPV < 0, Reject

- If NPV = 0, Accept or Reject

Energy Efficiency Guide for Existing Commercial Buildings

Making the Business Case

- Financial Analysis Methodologies
 - Internal Rate of Return (IRR)
 - * IRR = Rate of return on the investment that yields a NPV of “zero”
 - * Not useful to rank mutually exclusive projects such as done when evaluating/choosing EEMs



Energy Efficiency Guide for Existing Commercial Buildings

Making the Business Case

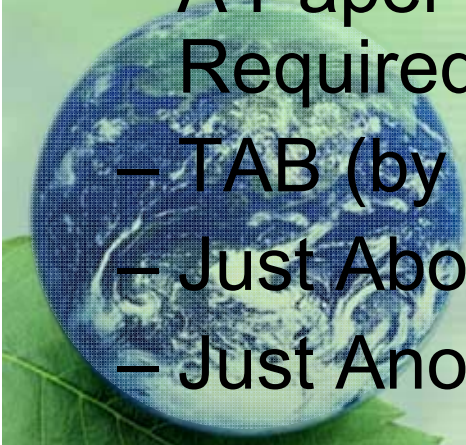
- Financial Analysis Methodologies
 - Life Cycle Cost Analysis (LCC)
 - * Best suited for comparing alternative choices for a single EEM (lowest LCC is best investment)
 - * Ideal for evaluating mutually exclusive alternatives for a single EEM such as standard efficiency vs high efficiency
 - * Can be used to rank or prioritize EEMs based upon budget constraints
 - * NIST BLCC Program – a free download



Energy Efficiency Guide for Existing Commercial Buildings

Improving Energy Performance

- **Technical Retro-Commissioning (RCx)**
 - * Process RCx utilizes First Party Validation
 - * Technical RCx utilizes Third Party Validation
- **Technical Retro-Commissioning is NOT:**
 - A Paper Work Process → Jeans & Workboots Are Required
 - TAB (by Itself)
 - Just About System Troubleshooting
 - Just Another Inspection Process



Technical Retro-commissioning (RCx) of Existing Commercial Buildings

Benefits of Technical RCx

(LBNL Study July 2009)

- Median whole-building energy savings = \$0.30/SF
- Median payback time = 1.2 years
- Median benefit-cost ratio = 4.5/1
- Cash-on-cash return = 91%
- Projects employing **Technical** RCx attained twice the overall median level of savings, and **five-times** the savings of projects using standard **Process** approach
- Potential savings = minimum \$30 billion by 2030 and annual greenhouse gas emissions reductions of > 340 megatons/year

Energy Efficiency Guide for Existing Commercial Buildings

Improving Energy Performance

- Technical Retro-Commissioning (RCx)
 - * Owner must be **actively involved** with production of OPR & managing Issues Log
 - * 3rd Party validation with **no sampling**
 - * Establish Functional Project Milestones **not** punch list milestones
 - * Fix **all** found deficiencies
 - * Provide **actual** M&V for proof of energy efficiency



Technical Retro-commissioning (RCx) of Existing Commercial Buildings

Technical RCx Phases

- Contract Phase
- Pre-site Investigation Phase
- Site Investigation Phase
- Analysis Phase
- Corrective Action Phase
- + Technical Commissioning of ALL Modified Systems
- Follow-up Phase



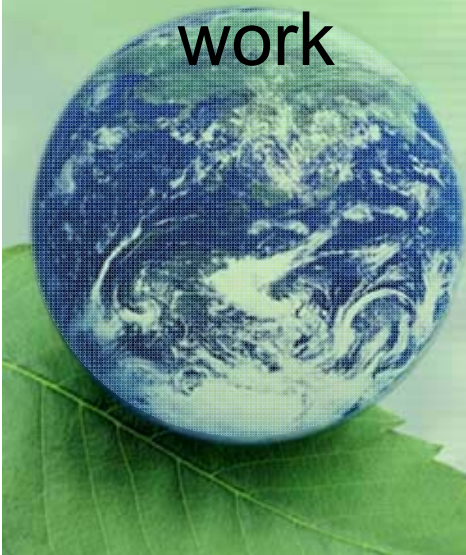
Technical Retro-commissioning (RCx) of Existing Commercial Buildings Contract Phase

- Facility Walk Through
 - Check Building Condition, Pressure and Construction details
 - Security concerns, special work conditions
 - Availability of drawings, energy records & staff
- RCx Team Development
 - Knowledge & experience in HVAC systems, controls, construction, electrical & lighting systems and building envelope



Technical Retro-commissioning (RCx) of Existing Commercial Buildings Contract Phase

- Proposal Development
 - Define deliverables, owner's obligations, project schedule and costs
 - Develop scope of services
 - Estimate time requirements per scope of proposed work



Technical Retro-commissioning (RCx) of Existing Commercial Buildings Pre-Site Investigation Phase

- RCx Plan Development
- RCx Kickoff Meeting
- Document Procurement & Review
 - Drawings & Specifications
 - O&M Manuals
 - TAB Reports
 - Utility Bills
 - Maintenance, Repair & Replacement Orders
- Interviews
 - Management, O&M Staff and occupants

Technical Retro-commissioning (RCx) of Existing Commercial Buildings Site Investigation Phase

- Issues looked for
 - Installation defects
 - Design deficiencies
 - Control issues
 - Deferred maintenance
 - HVAC System problems



Technical Retro-commissioning (RCx) of Existing Commercial Buildings Site Investigation Phase

- Retrieval of Data Loggers launched during Pre-Site Investigation Phase
 - Types & quantities (min. one/zone) required of:
 - * Temperature
 - * Humidity
 - * CO₂/IAQ
 - * Lighting
 - Location is critical
- Data Logger Trending
- BAS Trending



Technical Retro-commissioning (RCx) of Existing Commercial Buildings Site Investigation Phase

- Equipment & System Assessment
 - Building Envelope
 - HVAC
 - HVAC Controls
 - TAB
 - IAQ
 - Electrical
 - Plumbing
 - “Quick Fixes” – no cost



Technical Retro-commissioning (RCx) of Existing Commercial Buildings Site Investigation Phase

- Equipment & System Assessment
 - HVAC Controls
 - * Original sequence wrong/not understood
 - * Lack of re-set sequences/sequence overridden
 - * Schedules inoperative or overridden
 - * Sequence never implemented
 - * Standard sequence misapplied
 - * No sequence documentation



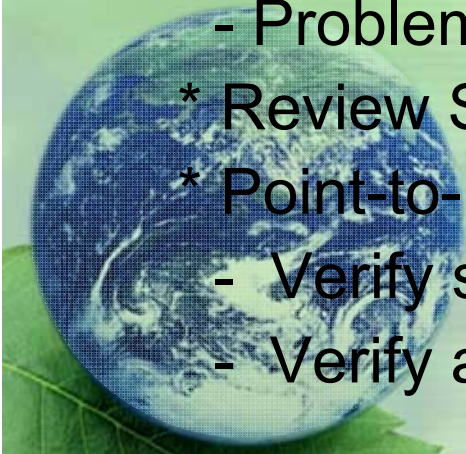
Technical Retro-commissioning (RCx) of Existing Commercial Buildings Site Investigation Phase

- Equipment & System Assessment
 - HVAC Controls
 - * Run Control System trends for
 - O/A
 - Temperatures (space, equipment & air/water systems)
 - Humidity
 - * Pressures (building, air/water systems)
 - * Equipment start/stop times
 - * Alarm trends



Technical Retro-commissioning (RCx) of Existing Commercial Buildings Site Investigation Phase

- Equipment & System Assessment
 - HVAC Controls
 - * Purpose of trends
 - Comparison with Data Loggers
 - System sequence confirmation
 - Problem identification
 - * Review System Alarm Logs
 - * Point-to-Point Testing & Calibration
 - Verify sensors calibration
 - Verify actuators



Technical Retro-commissioning (RCx) of Existing Commercial Buildings Site Investigation Phase

- Equipment & System Assessment
 - Perform “Quick Fixes”
 - * Temp controls
 - * Piping leaks
 - * Electrical connections & lighting
 - * Ductwork
 - * System adjustments
 - * Building envelope



Technical Retro-commissioning (RCx) of Existing Commercial Buildings Site Investigation Phase

- Equipment & System Assessment
 - Indoor Air Quality
 - * Contaminants
 - * CO₂
 - * Occupant problems
 - Sick Building Syndrome
 - Causes
 - Solutions



Technical Retro-commissioning (RCx) of Existing Commercial Buildings Site Investigation Phase

- Equipment & System Assessment
 - Electrical & Lighting
 - * Testing
 - * Deferred maintenance
 - * Condition Assessments



Technical Retro-commissioning (RCx) of Existing Commercial Buildings Site Investigation Phase

- Equipment & System Assessment
 - Plumbing Equipment & Assessment
 - * Water usage
 - * Healthcare issues
 - * IAQ issues
 - * Deferred maintenance
 - * Condition assessment
 - * Code violations



Technical Retro-commissioning (RCx) of Existing Commercial Buildings Site Investigation Phase

- Equipment & System Assessment
 - General Guidance
 - * **Don't jump to conclusions**
 - * Don't stop at obvious
 - * Not a linear process
 - * Follow RCx Plan to completion
 - * Holistic approach
 - * Record all observations



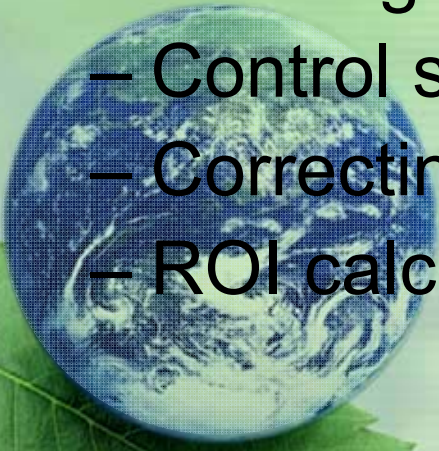
Technical Retro-commissioning (RCx) of Existing Commercial Buildings Problem Analysis & Synthesis Phase

- Provide solutions that are meaningful to owner
- Diagnostic Process
 - Testing
 - Fixes
 - Recommendations
- Savings Calculations
 - Modeling Software (DOE-II/EnergyPlus, E-Quest, TRACE)
 - Integrated load analysis



Technical Retro-commissioning (RCx) of Existing Commercial Buildings Problem Analysis & Synthesis Phase

- Savings Calculations
 - Lighting retrofit
 - VFDs
 - Economizers
 - New high-efficiency equipment
 - Control sequence changes
 - Correcting deferred maintenance issues
 - ROI calculations



Technical Retro-commissioning (RCx) of Existing Commercial Buildings Problem Analysis & Synthesis Phase

- Corrective Action Report
 - Photos
 - Quick fix summary
 - Trend log analyses
 - Recommendations
 - Deliver Recommendations + Solutions
 - Support Owner's Business Plan
 - Prioritize Recommendations
 - Implementation Schedule



Technical Retro-commissioning (RCx) of Existing Commercial Buildings Corrective Action Phase

- Corrective Action done by another contractor
- RCx oversees or conducts TAB
- RCx Commissions the Design, Installation thru Acceptance Phases
- RCx conducts Follow-up activities
 - Deferred testing
 - Warranty review
 - Performance evaluation
 - Co-ordinate training/workshop(s) required by owner



Definitions of Commissioning

- **Building Process Commissioning (Cx)** – A Quality Assurance Process that Spans the Entire Design and Construction Process and Helps Ensure that the New Building and its Systems' Performance Meet the Owner's Expectations. The Management of a Project is Based Upon Observations and Processes Performed by the Project Designers and Contractors (1st Party).
- **Building Technical Commissioning (Cx)** – Manages and Verifies the Technical Testing of Building Systems by Field Inspectors, Contractor Test Observations and Actual Field Testing by the Technical Commissioning Provider (3rd Party).

Technical Retro-commissioning (RCx) of Existing Commercial Buildings Required Instrumentation Measurements

- Digital camera
- Temperature Measurement - air, immersion & contact
- RMS Electrical Measurement – volts AC, amperes
- Air Pressure Measurement
- Air Velocity Measurement
- Humidity Measurement
- Hydronic Pressure Measurement
- Hydronic Differential Pressure Measurement
- Temperature Data Loggers



Technical Retro-commissioning (RCx) of Existing Commercial Buildings Required Instrumentation Measurements

- Humidity Data Loggers
- Sound Level Meter/ or Vibration Analyzer
- Total Dissolved Solids (TDS) Meter
- Thermal Imaging Camera
- Capacitance Moisture Meter
- Door Pressure Assembly



Your Role, Your Duty and Your Responsibility

“What will you do today, tomorrow or next week that will make a difference?” (Floyd Lee & the Pegasus Chow Hall, Baghdad)

Do we have “**any other option**” but to work toward achieving an **independent and sustainable future** for those who are depending upon us?





Task	Description	Documents	Comments	Responsibilities				
				Owner	Cx	Designer	Contractors	
Pre-Design Phase								
a.	Cx Agent Selection	<ul style="list-style-type: none"> Develop an RFP for commissioning services. RFP should follow the NEBB format for qualifications based selection. If interviews are conducted, the recommended scoring system should be used to evaluate qualifications of proposing firms. 	<ul style="list-style-type: none"> RFP Format Scope of Work Matrix Scoring Matrix 	<ul style="list-style-type: none"> Cx Agent selection should occur as early the Design process as possible. However, whenever the Cx Agent is selected, the selection should follow the proscribed process. 	<ul style="list-style-type: none"> RFP Define Scope of Work Score Matrix 	<ul style="list-style-type: none"> Format RFP if requested. Provide Scope of Work Matrix and scoring criteria matrix if requested 		
b.	Cx Project Contract	<ul style="list-style-type: none"> Negotiate, prepare and execute a commissioning contract. 	<ul style="list-style-type: none"> Commissioning Contract 		<ul style="list-style-type: none"> Commissioning Contract 	<ul style="list-style-type: none"> Provide sample Commissioning contract if requested. 		
Design Phase Commissioning								
1.	Design Team Kickoff Meeting	<ul style="list-style-type: none"> Conduct an initial "Kickoff Meeting" with the Design Team. The purpose of the meeting will be to establish the purpose and proposed process for commissioning this facility and to establish the individual roles of each participating commissioning team member. 	<ul style="list-style-type: none"> Design Development Design Commissioning Plan Meeting Agenda Meeting Minutes 	<ul style="list-style-type: none"> Identify Contacts and Responsibilities for Commissioning Team Members 	<ul style="list-style-type: none"> Facilitate Kickoff Meeting 	<ul style="list-style-type: none"> Meeting Agenda Meeting Minutes 	<ul style="list-style-type: none"> Identify design team members and their Responsibilities 	
2.	Owners Performance Requirements (OPR)	<ul style="list-style-type: none"> In cooperation with the Owner and, if available, the Owner's Design Team, the Cx Agent shall prepare a design intent summary document. This document will serve as the basis for all design, inspection, commissioning and acceptance testing for the project. 	<ul style="list-style-type: none"> Owners Performance Requirements (OPR) Summary 	<ul style="list-style-type: none"> Establishes criteria for basis of design 	<ul style="list-style-type: none"> Provide input for performance requirements. 	<ul style="list-style-type: none"> Design Intent Summary containing all OPR's. 	<ul style="list-style-type: none"> Provide input for performance requirements. 	



Task	Description	Documents	Comments	Commissioning Responsibility				
				Owner	Cx	Designer	Contractors	
3.	Basis of Design	<ul style="list-style-type: none"> The design team shall prepare a Basis of Design document in response to the OPR previously established. 	<ul style="list-style-type: none"> Draft Basis of Design 	<ul style="list-style-type: none"> Basis of design shall include Engineering Calculations & load data, System selection, system rejection reasoning, Equipment Selection, equipment rejection, failure modes, and critical sequence of operations. 		<ul style="list-style-type: none"> Review Basis of design document 	<ul style="list-style-type: none"> Create Basis of Design document 	
4.	Commissioning Plan	<ul style="list-style-type: none"> The Draft Commissioning Plan describes the design phase commissioning activities 	<ul style="list-style-type: none"> Draft Commissioning Plan 		<ul style="list-style-type: none"> Approve commissioning plan 	<ul style="list-style-type: none"> Create Commissioning Plan 	<ul style="list-style-type: none"> Review & Comment on commissioning plan 	
5.	Commissioning Specifications	<ul style="list-style-type: none"> Commissioning specifications shall be included in the design specifications 	<ul style="list-style-type: none"> Commissioning provider spec. Contractor commissioning responsibility spec. 	<ul style="list-style-type: none"> Specifications shall describe the Cx and the contractors responsibilities. 	<ul style="list-style-type: none"> Approve Specification 	<ul style="list-style-type: none"> Create Specification 	<ul style="list-style-type: none"> Include specifications in design documents 	
6.	35% Plan Review	<ul style="list-style-type: none"> Complete a thorough review of the 35% plan documents and submitted criteria to establish the systems to be designed and installed in compliance with the OPR. 35% documents shall include, Engineering Calculations, System selection and major Component selection. 	<ul style="list-style-type: none"> Engineering Calculations Load Data System Selection Major Component Selections Flow Sheets Mechanical Room Layouts Mechanical shaft Layouts Ceiling cuts Commissioning Review Log 	<ul style="list-style-type: none"> Review Basis of Design submittal from the design team. Resolution of any issues. 	<ul style="list-style-type: none"> Review Basis of Design submittal from the design team. Resolution of any issues. 	<ul style="list-style-type: none"> Review and comment on 35% Design Review Log, issue resolution and Preliminary Commissioning Plan 	<ul style="list-style-type: none"> Basis of Design Document Engineering Calculations Major Component Selections Design Review Log Responses 	



Task	Description	Documents	Comments	Commissioning Responsibility			
				Owner	Cx	Designer	Contractors
7. 65% Plan Review	<ul style="list-style-type: none"> Review 65% Design Documents Draft Preliminary Construction Commissioning Plan, Commissioning Specifications and Supplemental Commissioning Language for other specification sections. 65% documents shall include zoning requirements, specifications, typical room layouts, system main layouts, riser layouts, standard details, schedules and coordination requirements. 	<ul style="list-style-type: none"> 65% Plans & Specifications Updated Basis of Design Preliminary Draft Commissioning Plan Commissioning Specifications Commissioning Review Log 	<ul style="list-style-type: none"> Zoning requirements, typical room layouts, main ducts, piping mains, risers, standard details, equipment schedules, and coordination of disciplines. 	<ul style="list-style-type: none"> Owner will review all project submittal documents, assist in resolution of project issues and accept complete submittal. 	<ul style="list-style-type: none"> Preliminary Commissioning Plan Commissioning Specifications Design Review Log 	<ul style="list-style-type: none"> 65% Plans & Specifications Design Review Log Responses Update Basis of Design 	
8. 95% Plan Review	<ul style="list-style-type: none"> Review 95% Design Documents Updated Commissioning Plan, Final Commissioning Specifications and Supplemental Commissioning Language for other specification sections. 95% plans shall be essentially 100% complete except for coordination and review issues. 	<ul style="list-style-type: none"> 100% Plans & Specifications from design team. Updated Basis of Design Commissioning Specifications Updated Draft Construction Commissioning Plan Commissioning Review Log Update/Finalize OPR 	<ul style="list-style-type: none"> Submittal Review & Acceptance Plans & Specifications are to be 100% complete 	<ul style="list-style-type: none"> Owner will review all project documents and assist in resolution of project issues and accept completed documents. 	<ul style="list-style-type: none"> Final Commissioning Specifications Updated Commissioning Plan Design Review Log 	<ul style="list-style-type: none"> 95% Plans & Specifications Update Basis of Design 	



Task	Description	Documents	Comments	Commissioning Responsibility				
				Owner	Cx	Designer	Contractors	
9.	Pre-bid Meeting and Assistance During Bidding process.	<ul style="list-style-type: none"> Pre-bid meeting to assist contractors in answering any questions about the systems or the commissioning process or work that may come up at that time. Provide assistance in answering written questions (in the form of clarifications or addendum recommendations) during the bidding process. 	<ul style="list-style-type: none"> Written Responses or Recommendations 		<ul style="list-style-type: none"> Hold pre-bid meeting. 	<ul style="list-style-type: none"> Attend pre-bid meeting to answer commissioning questions. 	<ul style="list-style-type: none"> Attend pre-bid meeting to answer system questions. 	<ul style="list-style-type: none"> Attend pre-bid meeting.
Construction Phase Commissioning								
10.	Construction Commissioning Kick Off meeting	<ul style="list-style-type: none"> Conduct an initial commissioning meeting with all contractors and commissioning team members. The purpose of the meeting will be to establish the purpose and proposed process for commissioning this facility in the construction, acceptance and warranties phases of the project. Review the individual roles and responsibilities of each participating commissioning team member as specified in the Construction Documents. 	<ul style="list-style-type: none"> Meeting Minutes Final Commissioning Plan with specific individual responsibilities identified. 		<ul style="list-style-type: none"> Facilitate commissioning kick off meeting. 	<ul style="list-style-type: none"> Conduct initial commissioning kick off meeting. Meeting Minutes Updated Commissioning Plan 		<ul style="list-style-type: none"> Identify Contacts and Responsibilities for Commissioning Team Members
11.	Prepare Duration Schedule for Commissioning Activities	<ul style="list-style-type: none"> Based on the final commissioning plan, Prepare a duration schedule for the contractors for the commissioning activities required by the commissioning plan. This duration schedule should be incorporated into the contractor's project schedule to track all commissioning activities of the commissioning team. 	<ul style="list-style-type: none"> Duration Schedule 		<ul style="list-style-type: none"> Facilitate Schedule Coordination and Approve Construction Schedule 	<ul style="list-style-type: none"> Create and coordinate Cx duration schedule 		<ul style="list-style-type: none"> Provide construction schedule for coordination with commissioning schedule. Incorporate Commissioning Activities into CPM Project Schedule



Task	Description	Documents	Comments	Commissioning Responsibility			
				Owner	Cx	Designer	Contractors
12. Submittal & Shop Drawing Review	<ul style="list-style-type: none"> Review all pertinent approved shop drawings to support the Commissioning Process. Review of the shop drawings is for the purpose of developing appropriate PFT (FIV, OPT) and FPT documents. Submittals & Shop drawings shall be reviewed for commissionability, maintainability and for compliance to the OPR. Note any issues identified in the Shop Drawing Review that might compromise the final commissioned system on the 'Commissioning Review Log' and submit comment to the Design Team for resolution. 	<ul style="list-style-type: none"> Commissioning Review Log 	<ul style="list-style-type: none"> Cx reviews submittals & shop drawings that have already been reviewed/approved by the design team. 	<ul style="list-style-type: none"> Assist in resolution of project issues if required. 	<ul style="list-style-type: none"> Review approved shop drawings. Create Design Review Log 	<ul style="list-style-type: none"> Design Review Log Responses 	<ul style="list-style-type: none"> Incorporate shop drawing and submittal changes as directed by the design team.
13. Finalize Construction Commissioning Plan	<ul style="list-style-type: none"> Based on the work completed in the items above, we will finalize the Commissioning Plan for this project. The final commissioning plan will incorporate all changes established by review with your staff and the design team members. The final commissioning plan will also include complete PFT (FIV, OPT) and FPT protocols for each system. 	<ul style="list-style-type: none"> Final Construction Commissioning Plan Create all FIV, OPT and FPT documents. Design FPT protocols. 			<ul style="list-style-type: none"> Final commissioning plan 		
14. Site Observations (SO)	<ul style="list-style-type: none"> During the course of construction, visit the site to inspect the progress of construction with respect to the systems being commissioned. The purpose of the inspections is to verify that the construction complies with the plans & specifications and standard construction quality practices. 	<ul style="list-style-type: none"> FIV Check Sheets Observation Reprints Commissioning Issues Log 		<ul style="list-style-type: none"> Review submitted documents. Provide Response to any Owner Related Commissioning Issue 	<ul style="list-style-type: none"> FIV Check Sheets. Site Observation Reports. Daily Logs Commissioning Issues Log 	<ul style="list-style-type: none"> Review submitted commissioning issue logs. Provide Response to any Design Related issues. 	<ul style="list-style-type: none"> Review issues logs. Provide Response to any issues.



Task	Description	Documents	Comments	Commissioning Responsibility			
				Owner	Cx	Designer	Contractors
15. Commissioning Team Meetings	<ul style="list-style-type: none"> Hold commissioning meetings on a regular basis with the commissioning team to review progress of the commissioning effort and reinforce individual responsibilities. Review completed work and agree upon the acceptability of the delivered product. 	<ul style="list-style-type: none"> Meeting Minutes Commissioning Issues Log 	•	<ul style="list-style-type: none"> Attend meetings Assist in resolution of project issues if required. 	<ul style="list-style-type: none"> Hold commissioning meetings Keep commissioning issues log current. 	<ul style="list-style-type: none"> Attend meetings Assist in resolution of design issues if required. 	<ul style="list-style-type: none"> Attend meetings Assist in resolution of project issues
16. Complete all site inspections (FIV)	<ul style="list-style-type: none"> Complete all field inspection verifications. A completed FIV indicates the system or piece of equipment is ready to be started and OPT's performed. 	<ul style="list-style-type: none"> Completed FIV check sheets. Commissioning Issues Log 		<ul style="list-style-type: none"> Assist in resolution of project issues if required. 	<ul style="list-style-type: none"> Complete FIV check sheets. 	<ul style="list-style-type: none"> Assist in resolution of design issues if required. 	<ul style="list-style-type: none"> Resolve any FIV check sheet issues.
17. Pre Functional Tests (PFT)	<ul style="list-style-type: none"> Observe or facilitate all equipment and system start up procedures. The Contractor will execute all start up and point-to-point tests and the Cx will witness execution of all Operational Performance Tests (OPT). 	<ul style="list-style-type: none"> Completed OPT's. Commissioning Issues Log 	•	<ul style="list-style-type: none"> Assist in resolution of project issues if required. 	<ul style="list-style-type: none"> Observe or document all OPT tests. 	<ul style="list-style-type: none"> Assist in resolution of design issues if required. 	<ul style="list-style-type: none"> Complete all startup and OPT tests.
Acceptance Phase Commissioning							
18. Functional Performance Tests (FPT)	<ul style="list-style-type: none"> Observe and facilitate all FPT testing. FPT's shall be designed by the Cx and performed by the contractors. 	<ul style="list-style-type: none"> FPT Check Sheets Commissioning Issues Log 	•	<ul style="list-style-type: none"> Assist in resolution of project issues if required. 	<ul style="list-style-type: none"> Observe FPT tests. Keep commissioning Issues Log current. 	<ul style="list-style-type: none"> Provide Response to any Design issues if required. 	<ul style="list-style-type: none"> Perform FPT tests. Resolve any FPT check sheet issues.
19. O&M review	<ul style="list-style-type: none"> Review Operating Manuals and As Built shop drawings for accuracy and completeness Verify they are ready to hand over to the owner for operator use 	<ul style="list-style-type: none"> O&M Manual Shop Drawings 	•	<ul style="list-style-type: none"> Receives Documents 	<ul style="list-style-type: none"> Review Documents 	<ul style="list-style-type: none"> Approves documents 	<ul style="list-style-type: none"> Provides documents



Task	Description	Documents	Comments	Commissioning Responsibility			
				Owner	Cx	Designer	Contractors
20. Operator Training	<ul style="list-style-type: none"> • Work with the contractor and owner to schedule and plan training activities so that training occurs in a coordinated and coherent fashion. Assist in the development of training schedules and agendas, encourage the use of a combination of “classroom” and field training, and assist the contractors in the development of training agendas for each system or component installed in the project. • Contractors and vendors provide all training. Additional skill training can be provided as an additional scope item if desired by the owner. 	<ul style="list-style-type: none"> • Coordinated Training Agendas 		<ul style="list-style-type: none"> • Schedule operators to attend training 	<ul style="list-style-type: none"> • Schedule and coordinate training. 	<ul style="list-style-type: none"> • Participate as required by the owner. 	<ul style="list-style-type: none"> • Provide training as required.
21. Prepare Final Commissioning Report	<ul style="list-style-type: none"> • Based on the accumulated commissioning work completed as described above, we will assemble the data into a final commissioning report. The final report will incorporate the final record documents for each system, as appropriate. The report will also include a summary of commissioning that will highlight the final condition of each system commissioned. 	<ul style="list-style-type: none"> • Final Commissioning Report 	<ul style="list-style-type: none"> • If Warranty Phase commissioning or deferred testing (off season) is included in the scope of work, this report can be submitted as a draft report pending completion of final testing and inspections. 	<ul style="list-style-type: none"> • Review final report 	<ul style="list-style-type: none"> • Create report 		



Task	Description	Documents	Comments	Commissioning Responsibility			
				Owner	Cx	Designer	Contractors
Warranty Phase Commissioning							
22.	Deferred (Off season) Testing	<ul style="list-style-type: none"> • Conduct any testing required by the commissioning plan that was deferred from the acceptance period. 	<ul style="list-style-type: none"> • Warranty Commissioning Plan • FPT Test check sheets 		<ul style="list-style-type: none"> • Review report addenda. 	<ul style="list-style-type: none"> • Observe off season tests. 	<ul style="list-style-type: none"> • Conduct off season FPT tests. • Resolve any FPT check sheet issues.
23.	Ten Month Warranty Visit	<ul style="list-style-type: none"> • Cx will inspect the site and interview building operating personnel to identify any outstanding warranty failures and to identify any persistent equipment failure issues that should be handled within the warranty period. 	<ul style="list-style-type: none"> • Commissioning Warranty Issues Log • Commissioning report addenda. 		<ul style="list-style-type: none"> • Review report addenda. • Review final issues log. 	<ul style="list-style-type: none"> • Conduct warranty visit. • Follow up on any warranty repair issues. 	<ul style="list-style-type: none"> • Resolve any warranty issues.

**EXISTING BUILDING SYSTEMS
RETRO-COMMISSIONING PROCESS MATRIX**

Task	Description	Documents	Comments	Responsibilities				
				Owner	Cx	Designer	Contractors	
Contract Phase								
a.	RCx Agent Selection	<ul style="list-style-type: none"> • Direct sale to customer by Purchase order or direct contract • Develop an RFP for Retro Commissioning services. RFP should follow the NEBB format for qualifications based selection. • If interviews are conducted, the recommended scoring system should be used to evaluate qualifications of proposing firms. 	<ul style="list-style-type: none"> • RFP Format • Scope of Work Matrix • Scoring Matrix 	<ul style="list-style-type: none"> • Select highest technical qualification of retro commissioning expertise 	<ul style="list-style-type: none"> • Create RFP or Purchase Order • Conduct Interviews • Evaluate scoring system 	<ul style="list-style-type: none"> • Assist RFP process if requested 		
b.	Site Tour	<ul style="list-style-type: none"> • Tour facility for general condition and complexity 	<ul style="list-style-type: none"> • Pictures 	<ul style="list-style-type: none"> • Site conditions have an effect on project costs 	<ul style="list-style-type: none"> • Facilitate tour 	<ul style="list-style-type: none"> • Take facility tour look for building conditions and complexity 		
c.	RCx Project Contract	<ul style="list-style-type: none"> • Negotiate, prepare and execute a retro commissioning contract. 	<ul style="list-style-type: none"> • Retro Commissioning Contract 		<ul style="list-style-type: none"> • Create contract or purchase order 	<ul style="list-style-type: none"> • Develop Project Proposal 		
Pre Site Investigation Phase								
1.	RCx Plan / Scope of Work	<ul style="list-style-type: none"> • Plan for the project consisting of a detailed description of the scope of work, the project schedule, the project team and task and responsibilities of the retro-commissioning team 	<ul style="list-style-type: none"> • Rx Commissioning Plan • Rx Commissioning schedule. 	<ul style="list-style-type: none"> • Defines retro commissioning strategy and process. • Defines commissioning team members. 	<ul style="list-style-type: none"> • Facilitate Kickoff Meeting 	<ul style="list-style-type: none"> • Meeting Agenda • Meeting Minutes 		
2.	Document & Design Review	<ul style="list-style-type: none"> • Complete a thorough review of the available documents to determine what was supposed to be installed and what the design intent was. 	<ul style="list-style-type: none"> • Existing construction documents, drawings, specifications and submittals. • Design review work sheets 	<ul style="list-style-type: none"> • Review design for design and drawing errors 	<ul style="list-style-type: none"> • Provide existing construction documents 	<ul style="list-style-type: none"> • Perform document and design review 		

Task	Description	Documents	Comments	Commissioning Responsibility			
				Owner	Cx	Designer	Contractors
3. Operations Record Review	<ul style="list-style-type: none"> Review utility bills and costs Review maintenance management trouble call records 	<ul style="list-style-type: none"> Copies of utility bills Copies of trouble call logs 	<ul style="list-style-type: none"> Develop historical facility usage report Develop short list of problem areas 	<ul style="list-style-type: none"> Provide 3 years of utility bills Provide 3 years of trouble call logs 	<ul style="list-style-type: none"> Provide utility review report Provide trouble call report 		
4. Management Staff Interview	<ul style="list-style-type: none"> Interview of Facility manager to make sure they understand the process and to discover any special protocols for the facility. 	<ul style="list-style-type: none"> Interview report 		<ul style="list-style-type: none"> Facilitate interview 	<ul style="list-style-type: none"> Conduct Interview and provide report 		
5. Maintenance Staff Interview	<ul style="list-style-type: none"> Interview of Facility Maintenance Staff to determine the extent of system problems being experienced and staffs' reactions. 	<ul style="list-style-type: none"> Interview report 	<ul style="list-style-type: none"> May be factual, perceived or political issues 	<ul style="list-style-type: none"> Facilitate interview 	<ul style="list-style-type: none"> Conduct Interview and provide report 		
6. Occupant Interview	<ul style="list-style-type: none"> Interviews of the facility occupants segregated by floor/areas of special use/departments. To determine the current project requirements of the facility, current operational problems, and the proposed investigative process. The meeting will outline the purpose and scope of the facility inspection, how the inspection will be conducted, and will allow the facility occupants to share their concerns and problems. 	<ul style="list-style-type: none"> Interview report 	<ul style="list-style-type: none"> May be factual, perceived or political issues 	<ul style="list-style-type: none"> Facilitate interviews 	<ul style="list-style-type: none"> Conduct Interview and provide report 		

**EXISTING BUILDING SYSTEMS
RETRO-COMMISSIONING PROCESS MATRIX**

Task	Description	Documents	Comments	Commissioning Responsibility				
				Owner	Cx	Designer	Contractors	
Site Investigation Phase								
7.	Owner Technician RCx Training	<ul style="list-style-type: none"> • Retro Commissioning process training of owners technical staff for assistance in the process 	<ul style="list-style-type: none"> • Training Materials 	<ul style="list-style-type: none"> • Consists of two 4 hour training modules 	<ul style="list-style-type: none"> • Facilitate and attend training 	<ul style="list-style-type: none"> • Provide training seminar 		
8.	Initiate Site Investigation	<ul style="list-style-type: none"> • Survey the facility and systems to determine current conditions such as occupancy and space utilization. • Launch Data Loggers at Outset of Site Investigation to Develop a Building Baseline. 	<ul style="list-style-type: none"> • Field Survey Observation Forms • Photographs 		<ul style="list-style-type: none"> • Facilitate and/or participate in site inspections • Review and Approve CFR's 	<ul style="list-style-type: none"> • Develop Current Facility Requirements (CFR) • Launch Data Loggers 		
9.	Heat Load Study	<ul style="list-style-type: none"> • Survey the facility occupancy and equipment levels to determine if a heat load study is required. 	<ul style="list-style-type: none"> • Heat Load Study Report 	<ul style="list-style-type: none"> • Appropriate Retro-RCx Team member to perform study. (Owners staff, Retro-C_A or A/E may perform) 		<ul style="list-style-type: none"> • Provide study 		
10.	HVAC Equipment and System Investigation and Tests	<ul style="list-style-type: none"> • Survey facility and systems to determine current operating conditions, deferred maintenance issues, airflow rates, temperatures, humidity levels and pressure levels etc. • Test & Balance as required 	<ul style="list-style-type: none"> • Observation Reports • Test & Balance Report • RCx Forms and Check Sheets 		<ul style="list-style-type: none"> • Facilitate and/or participate in HVAC investigation 	<ul style="list-style-type: none"> • Perform Investigations 		
11.	Envelope Investigation	<ul style="list-style-type: none"> • Survey facility for temperature infiltration, humidity infiltration and pressurization. • Thermograph Survey 	<ul style="list-style-type: none"> • Observation Reports • RCx Forms and Check Sheets 		<ul style="list-style-type: none"> • Facilitate and/or participate in investigations 	<ul style="list-style-type: none"> • Perform Investigations 		
12.	Control Investigation	<ul style="list-style-type: none"> • Survey control systems for proper operation and proper control sequences • Control Point to Point Verification • Sensor Calibration Verification 	<ul style="list-style-type: none"> • Observation Reports • RCx Forms and Check Sheets 		<ul style="list-style-type: none"> • Facilitate and/or participate in investigations 	<ul style="list-style-type: none"> • Perform Investigations 		

Task	Description	Documents	Comments	Commissioning Responsibility				
				Owner	Cx	Designer	Contractors	
13.	Perform Quick Fixes	<ul style="list-style-type: none"> Repair issues of a minor nature, or issues that impede investigation and testing completion are repaired as they arise 	<ul style="list-style-type: none"> Listing of Quick Fixes 			<ul style="list-style-type: none"> Implement repairs Maintain Quick Fix List 		
14.	TAB	<ul style="list-style-type: none"> Test, Adjust and Balance facility to determine current operating conditions 	<ul style="list-style-type: none"> TAB Report 			<ul style="list-style-type: none"> Perform TAB as required Issue Report 		
15.	Electrical Lighting & Power	<ul style="list-style-type: none"> Survey lighting systems for potential energy savings Survey power systems ancillary to HVAC equipment and systems 	<ul style="list-style-type: none"> Observation Reports RCx Forms and Check Sheets 		<ul style="list-style-type: none"> Facilitate and/or participate in investigations 	<ul style="list-style-type: none"> Perform Investigations 		
Analysis Phase								
16.	Issue Analysis & Problem Resolution	<ul style="list-style-type: none"> Analyze problems and issues and develop recommended solutions 		<ul style="list-style-type: none"> Issue reports with problem statement and recommended solution Team members to provide input as required 		<ul style="list-style-type: none"> Produce problem analysis and solutions 	<ul style="list-style-type: none"> Assist as required for problem solutions 	<ul style="list-style-type: none"> Provide cost data for recommended solutions
17.	Report Development	<ul style="list-style-type: none"> The report shall contain observation made during the site investigations, documentation of all testing, photographs of visual deficiencies, clear definition of all findings and a budgetary cost estimate of recommended solutions 	<ul style="list-style-type: none"> Issue report 		<ul style="list-style-type: none"> Review and comment on report. 	<ul style="list-style-type: none"> Produce Report 		
18.	Presentation of Results and Solutions	<ul style="list-style-type: none"> Meeting to present findings and recommendations to appropriate parties 	<ul style="list-style-type: none"> Corrective Action Report 	<ul style="list-style-type: none"> Determine meeting participants, schedule meeting and attend meetings 	<ul style="list-style-type: none"> Facilitate Meeting 	<ul style="list-style-type: none"> Present Report and coordinate meeting 	<ul style="list-style-type: none"> Present any design recommendations 	

**EXISTING BUILDING SYSTEMS
RETRO-COMMISSIONING PROCESS MATRIX**

Task	Description	Documents	Comments	Commissioning Responsibility				
				Owner	Cx	Designer	Contractors	
Corrective Action Phase								
19.	Remedial Design	<ul style="list-style-type: none"> If needed, a remedial design of the deficient system/systems will be provided 	<ul style="list-style-type: none"> Design documents 	<ul style="list-style-type: none"> Contract with a design team to perform remedial design if needed. 	<ul style="list-style-type: none"> Authorize Design 	<ul style="list-style-type: none"> Provide remedial design or coordinate 	<ul style="list-style-type: none"> Provide remedial design 	
20.	Construction	<ul style="list-style-type: none"> Corrective measures identified during the investigation phase and approved by the owner are executed. 	<ul style="list-style-type: none"> Price Approval Contracts 	<ul style="list-style-type: none"> Contract with appropriate Team member to perform corrective actions. 	<ul style="list-style-type: none"> Approve corrective measures Contract corrective measures 	<ul style="list-style-type: none"> Manage corrective measures 		<ul style="list-style-type: none"> Construct corrective measures
21.	Project Commissioning	<ul style="list-style-type: none"> If included in RCx scope, perform Project Commissioning for all phases including: <ul style="list-style-type: none"> Design Phase Construction Phase Acceptance Phase Warranty Phase 	<ul style="list-style-type: none"> Per NEBB BSC Procedural Standards 	<ul style="list-style-type: none"> 	<ul style="list-style-type: none"> Per NEBB BSC Procedural Standards 	<ul style="list-style-type: none"> Per NEBB BSC Procedural Standards 		<ul style="list-style-type: none">
Follow Up Phase								
22.	Lessons Learned Workshop	<ul style="list-style-type: none"> Conduct a Lessons Learned Workshop at the conclusion of the project to identify areas for improvement in the future 	<ul style="list-style-type: none"> Lessons Learned Report 		<ul style="list-style-type: none"> Participate in Workshop 	<ul style="list-style-type: none"> Conduct Workshop Issue Report 	<ul style="list-style-type: none"> Participate in Workshop as required 	<ul style="list-style-type: none"> Participate in Workshop as required
23.	Performance Verification	<ul style="list-style-type: none"> Provide final project results report 	<ul style="list-style-type: none"> Final Result Report 	<ul style="list-style-type: none"> Report to verify the performance of the RCx project: IAQ, indoor comfort, energy, maintenance & operations improvements, etc. 	<ul style="list-style-type: none"> Approve final report 	<ul style="list-style-type: none"> Provide report 		