

FACILITIES CRITERIA (FC)

NAVY AND MARINE CORPS EXISTING BUILDING COMMISSIONING



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U.S. ARMY CORPS OF ENGINEERS

NAVAL FACILITIES ENGINEERING SYSTEMS COMMAND (Preparing Activity)

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FOREWORD

Facilities Criteria (FC) provide functional requirements (i.e., defined by users and operational needs of a particular facility type) for specific DoD Component(s), and are intended for use with unified technical requirements published in DoD Unified Facilities Criteria (UFC). FC are applicable only to the DoD Component(s) indicated in the title and do not represent unified DoD requirements. Differences in functional requirements between DoD Components may exist due to differences in policies and operational needs.

All construction outside of the United States is also governed by Status of Forces Agreements (SOFA), Host Nation Funded Construction Agreements (HNFA), and in some instances, Bilateral Infrastructure Agreements (BIA). Therefore, the contracting team must ensure compliance with the most stringent of the FC, the SOFA, the HNFA, and the BIA, as applicable.

Because FC are coordinated with unified DoD technical requirements, they form an element of the DoD UFC system applicable to specific facility types. The UFC system is prescribed by MIL-STD 3007 and provides planning, design, construction, sustainment, restoration, and modernization criteria, and applicable to the Military Departments, Defense Agencies, and the DoD Field Activities in accordance with [USD \(AT&L\) memorandum](#) dated 29 May 2002. The UFC System also includes technical requirements and functional requirements for specific facility types, both published as UFC documents and FC documents.

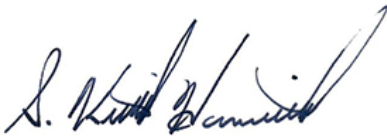
FC are living documents and will be periodically reviewed, updated, and made available to users as part of the Service's responsibility for providing criteria for military construction. Headquarters, U.S. Army Corps of Engineers (HQUSACE), Naval Facilities Engineering Systems Command (NAVFAC), and the Air Force Civil Engineer Center (AFCEC) are responsible for administration of the UFC system. Defense agencies should contact the preparing service for document interpretation and improvements. Technical content is the responsibility of the cognizant DoD working group. Recommended changes with supporting rationale should be sent to the respective service proponent office by the following electronic form: [Criteria Change Request](#). The form is also accessible from the Internet site listed below.

FC are effective upon issuance and are distributed only in electronic media from the following source:

- Whole Building Design Guide website <https://www.wbdg.org/ffc/dod>.

Refer to UFC 1-200-01, *DoD Building Code*, for implementation of new issuances on projects.

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CHAPTER 1 INTRODUCTION

1-1 BACKGROUND.

[42 USC 8253](#), as modified by the [Energy Independence and Security Act of 2007](#) (EISA 2007) and the Energy Act of 2020, requires a comprehensive energy and water evaluation be completed on Federal buildings that constitute at least 75 percent of building energy use every four years; these evaluations include identifying and assessing recommissioning or retrocommissioning measures. For Navy and Marine Corps buildings, the NAVFAC publication P-602, *3 Pillars of Energy Security (Reliability, Resilience, & Efficiency)*, aligns with the prior mandates in requiring comprehensive energy and water evaluations be conducted on covered facilities once every four years.

1-2 PURPOSE AND SCOPE.

This FC provides a process standard that aligns best practices with ASHRAE and industry standards for existing building commissioning (EBCx). EBCx includes both recommissioning and retrocommissioning. It is written for use by building maintenance engineers and program professionals. This document has been developed to ensure consistency of efforts and resulting deliverables from performance of EBCx services. This document outlines requirements for building systems commonly included in EBCx efforts and excludes those systems typically covered by other required inspections and not included in an EBCx scope of work (such as fire protection/sprinkler systems, fire alarm systems, cable television and closed circuit television systems, conveying systems, and cybersecurity systems).

1-3 ORGANIZATION.

This document breaks the overall EBCx process down into phases, generally following those outlined in [ASHRAE 0.2](#) as well as BCxA Existing Building Commissioning Best Practices. The EBCx phases work together; as an example, Assessment Phase results suggest the appropriate tasks in the Investigation Phase, which reveal the most beneficial Implementation Phase actions. Chapters 3 thru 8 cover each phase in depth. This document is organized as follows:

- [CHAPTER 1](#) introduces the scope of this document and overall requirements
- [CHAPTER 2](#) provides an overview of EBCx
- [CHAPTER 3](#) contains the steps within the Planning Phase
- [CHAPTER 4](#) details the steps within the Assessment Phase
- [CHAPTER 5](#) contains the Investigation Phase steps
- [CHAPTER 6](#) details the Implementation Phase steps
- [CHAPTER 7](#) details the steps within the Hand-off Phase
- [CHAPTER 8](#) contains the steps within the Ongoing Commissioning Phase

1-4 APPLICABILITY.

This document applies to DoD building assets equal to or greater than 25,000 square feet (2,323 square meters) and buildings which house energy intensive operations (such as data centers, health facilities or utility plants). This document applies where DoD is performing or managing the performance of EBCx efforts on existing buildings or systems. Existing building commissioning pays benefits on buildings where there is a focus on energy efficiency, reliability of systems, building size, greenhouse gas emissions, decarbonization, facility resiliency, buildings with subpar performance (excessive trouble calls), and mission criticality. Resiliency performance impacts include robustness, durability, maintainability, and rapid recovery following a disruption. This document does not apply to a construction project; follow the requirements of UFC 1-200-02 and related UFGS guide specifications for commissioning which seeks to verify design and performance of new construction or renovation projects.

Commissioning of existing buildings assists in enhancing “military installation resilience”; as defined in [10 USC 101\(e\)](#), this term means the capability of a military installation to avoid, prepare for, minimize the effect of, adapt to, and recover from extreme weather events, or from anticipated or unanticipated changes in environmental conditions or energy disruptions. This FC document relies on existing standards, guidelines and best practices recognized by firms and individuals that are certified to perform commissioning services. These are consensus documents developed by organizations such as the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), the Building Commissioning Association (BCxA), and the National Environmental Balancing Bureau (NEBB).

1-5 GENERAL BUILDING REQUIREMENTS.

For design and construction project-related efforts, comply with UFC 1-200-01, *DoD Building Code*. UFC 1-200-01 provides applicability of model building codes and government unique criteria for typical design disciplines and building systems, as well as for accessibility, antiterrorism, security, high performance and sustainability requirements, and safety.

1-5.1 Required Upgrades in Corrosive Environments.

When upgrades resulting from EBCx efforts are implemented, incorporate in the design systems and details to meet the environmental corrosivity conditions for the specific project location, as defined by its Environmental Severity Classification (ESC). See UFC 1-200-01 for determination of ESC for project locations. Design upgrades may also be required due to the humidity conditions; humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C, and 5C (as identified in ASHRAE 90.1).

Required corrosion-related upgrades to building systems are identified in UFC 1-200-01 and “Core” UFC’s. UFC 1-200-01 contains general requirements for corrosion-related upgrades covering multiple disciplines; UFC 3-410-01 includes requirements for heating, ventilating, and air-conditioning (HVAC) system components and UFC 3-501-

01 includes requirements for electrical system components. Upgrade requirements for other systems are found in their related UFC documents.

1-6 CYBERSECURITY.

To maintain proper cybersecurity measures, facility-related control systems (including systems separate from a utility monitoring and control system) must be planned, designed, acquired, executed, and maintained in accordance with UFC 4-010-06, and as required by individual Service Implementation Policy.

1-7 BEST PRACTICES.

APPENDIX A contains best practices which are not required but have shown to produce the best results and ensure EBCx efforts are consistent and comprehensive.

1-8 GLOSSARY.

APPENDIX B contains [acronyms](#), [abbreviations](#), and [terms](#).

1-9 REFERENCES.

APPENDIX C contains a list of references used in this document. Unless otherwise specified, the most recent edition of the referenced publication applies.

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CHAPTER 2 OVERVIEW

2-1 EBCx DEFINED.

Existing building commissioning (EBCx) is a quality-focused process for attaining the current facility requirements (CFR) of an existing building and its systems and assemblies. The process focuses on planning, investigating, implementing, verifying, and documenting that the building and its systems and assemblies are operated and maintained to meet the CFR, with a program in place to maintain the enhancements for the remaining life of the building. EBCx includes both recommissioning and retrocommissioning. Recommissioning is the application of the commissioning (Cx) process to an existing building or system that underwent the Cx Process during project delivery. Retrocommissioning applies the Cx Process to an existing building or system that was not previously commissioned.

EBCx is a process of inspecting, testing, analyzing, adjusting, and optimizing existing building systems to improve how building equipment and systems function together. EBCx often resolves problems that occurred during design or construction, or addresses expected building system performance degradation problems that have developed throughout the building's life. Properly executed, EBCx improves a building's operations and maintenance procedures and enhances overall building performance while meeting the Government's and occupant needs.

2-1.1 Scope.

The scope of EBCx may be either comprehensive or targeted on specific known issues or underperforming building systems. The building systems which may be included in comprehensive EBCx efforts are further outlined in paragraph titled [Comprehensive Commissioning](#). Clearly outline the extent of the scope in the Request for Proposal (RFP) to a Cx Provider, or in a scoping document when utilizing a Government EBCx team.

If the EBCx efforts are being undertaken to achieve compliance with the 42 USC 8253 requirements, which require a comprehensive evaluation be completed on each Federal building every four years, the scope of the EBCx must include the energy- and water-consuming building systems at a minimum. EBCx efforts targeted on only specific problematic building systems do not qualify as a comprehensive building energy evaluation required by 42 USC 8253 every four years.

2-1.2 Purpose/Intent.

The intent of EBCx is to identify a corrective process for repairing equipment and optimizing building systems and operations for energy efficiency, occupant comfort, air quality, enhanced building resiliency and extended equipment useful life. EBCx applies to buildings with no prior commissioning or where building systems no longer meet or exceed minimum requirements due to equipment failure or work-arounds, improper system adjustments, renovations or significant changes in building space utilization.

The goal of EBCx is to make building systems perform interactively to meet the Current Facility Requirements (CFR) and provide the tools to maintain the system performance over time.

2-1.3 Benefits.

Typical benefits of EBCx efforts include:

- Reduces energy and water usage
- Reduces the number of system deficiencies and inefficiencies and better focuses the maintenance efforts and resources to meet the needs of end users.
- Improves the building system's overall performance by optimizing energy-efficiency and system integration.
- Reduces building operating expenses.
- Identifies potential indoor environmental quality issues and ensures indoor air quality meets the minimum American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) requirements.
- Improves thermal comfort and reduces occupant complaints.
- Ensures that system operations meet building manager's expectations.
- Improves equipment performance and extends equipment life expectancy.
- Through training, enhances operations and maintenance (O&M) staff capabilities and expertise to operate and maintain the equipment more effectively and efficiently.
- Reduces service calls and demands on O&M staff.
- Identifies safety hazards such as unprotected electrical wiring, fall hazards, and other dangerous conditions.
- Discovers unique design and historic information about the building uncovered during drawing research.
- Identifies deficiencies in building enclosure water barrier, air barrier, thermal barrier and vapor retarder.
- Improves/updates building documentation.
- Ensures compliance with Federal building policies and directives.
- Ensures compliance with energy goals and mandates.
- Improves building resiliency by enhancing robustness, durability, maintainability, and ability to recover following a disruption.

2-2 TEAM ROLES AND RESPONSIBILITIES

The personnel required and the extent of their responsibilities differ depending on whether the EBCx is being performed by a consultant firm or an in-house Government EBCx team, as well as which building systems are included. Where EBCx is provided by a Contractor/consultant, Government personnel have support roles in assisting with coordination of the process.

2-2.1 EBCx Team Members.

The EBCx Team is responsible for executing the EBCx scope of work. Roles and responsibilities within the team may include:

- Commissioning (Cx) Provider – oversees and executes EBCx phases.
- Commissioning specialists – specialty team members based on the scope of the EBCx, such as Testing, Adjusting and Balancing (TAB) Contractor, controls specialists, equipment support vendors, energy consultant, and other specialized testing providers.
- Facilities management specialists - assists in selection of buildings, researches past/future building projects and work orders, and coordinates efforts with building manager.

2-2.2 EBCx Support.

Support roles and responsibilities to allow for completion of EBCx efforts include:

- Facilities management leadership – decision-making to assist in selection of buildings and establish EBCx goals and objectives.
- Existing building commissioning (EBCx) program management personnel – when a formalized EBCx program is in place, provides program objectives, tracks funding, and assists with selecting EBCx candidate buildings.
- Utilities management personnel – provides utility-related data for buildings, including meter data and utility rates.
- Regional Energy Program Manager (REPM) – assists with central funding and with selection of buildings.
- Installation Energy Manager (IEM) – often the primary point of contact for EBCx at the installation; coordinates public works resources.
- Building manager – acts as building representative and provides data and other requested information.
- Public works personnel – supports implementation of EBCx measures.

- Architectural and engineering technical support personnel – provides reachback support for complex technical concerns.
- Installation shops maintenance personnel – provides access to secured mechanical spaces, assists with location and operational condition of equipment, and assists in identification of known deficiencies.
- Preventive maintenance (PM) personnel – assists with deferred maintenance; provides maintenance logs.
- Controls shop – responsible for proper operations of energy and water control systems (Cx Provider will need to coordinate with this shop when testing control sequences)

2-3 REQUIRED CERTIFICATIONS AND TRAINING.

2-3.1 Lead EBCx Specialist Certification Requirements.

Individuals that serve as a Lead EBCx Specialist and are in responsible charge of executing EBCx efforts, either in-house or as part of a consultant team, must have obtained one of the commissioning professional certifications identified in Table 2-1; individuals with certifications that are not specific to Existing Building Commissioning must have five years of experience in leading efforts on commissioning existing buildings of similar size and complexity. Individuals which assist with EBCx activities are not required to have these certifications but must be directly supervised by a certified individual.

Table 2-1 Lead EBCx Specialist Required Certification

Organization	Certification
National Environmental Balancing Bureau (NEBB) (www.nebb.org)	Retro-Commissioning of Existing Buildings Certified Professional (RCx CP)
Association of Energy Engineers (AEE) (www.aeecenter.org)	Certified Building Commissioning Professional (CBCP®)
Association of Energy Engineers (AEE) (www.aeecenter.org)	*Existing Building Commissioning Professional (EBCP®)
Associated Air Balancing Council (AABC) Commissioning Group (ACG) (www.commissioning.org)	Certified Commissioning Authority (CxA)
American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) (www.ashrae.org)	Building Commissioning Professional (BCxP)
University of Wisconsin-Madison (www.pdc.wisc.edu)	Qualified Commissioning Process Provider (QCxP)
Building Commissioning Certification Board (www.bccbonline.org)	Certified Commissioning Professional (CCP)

*Note: EBCP certifications are no longer being issued but are still active.

2-3.2 Building Enclosure Commissioning Certification Requirements.

Individuals that perform EBCx activities on the building enclosure system, either in-house or as part of a consultant team, must have obtained one of the professional certifications listed in Table 2-2.

Table 2-2 Building Enclosure Required Certification

Organization	Certification
National Environmental Balancing Bureau (NEBB) (www.nebb.org)	Building Enclosure Testing Certified Professional (BET CP)
University of Wisconsin-Madison (www.pdc.wisc.edu)	Building Enclosure Commissioning Process Provider (BECxP)
	Accredited Commissioning Authority + Building Enclosure (CxA+BE)
International Institute of Building Enclosure Consultants (IIBEC) (www.iibec.org)	Certified Building Enclosure Commissioning Provider (CBECxP®)

2-3.3 Training Resources.

For individuals who desire to increase their knowledge on specific EBCx processes and activities, training is available from the organizations listed in Table 2-3.

Table 2-3 Training Resources

Organization	Website
Building Commissioning Certification Board (BCCB)	www.bccbonline.org
Association of Energy Engineers (AEE)	www.aeecenter.org
American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)	www.ashrae.org
National Environmental Balancing Bureau (NEBB)	www.nebb.org
AABC Commissioning Group (ACG)	www.commissioning.org
International Facility Management Association (IFMA)	www.ifma.org or www.fm.training

International Institute of Building Enclosure Consultants (IIBEC)	www.iibec.org
American Society for Health Care Engineering (ASHE)	www.ashe.org

2-4 EXTENT OF COMMISSIONING.

Existing building commissioning may be either comprehensive or targeted on specific known issues or underperforming systems. In either case, the funding and level of effort is based on the building systems that need to be evaluated or improved to meet the goals and objectives of the tenant organization. The most common EBCx scope focuses on the energy- and water-consuming systems in a building, plus other systems that are known to have documented operational or maintenance issues.

2-4.1 Targeted Commissioning.

In existing buildings, not every system requires commissioning to provide a return on the investment. Additionally, the level of effort and the associated cost to carry out the EBCx process on all building systems could exceed the funding available. Thus, in many instances, the EBCx process is targeted on specific systems within a building to address specific known issues and to meet the specified goals or objectives of the tenant organization. It should be noted that EBCx efforts targeted on only specific problematic building systems do not qualify as a comprehensive building energy evaluation required by 42 USC 8253 every four years.

2-4.2 Comprehensive Commissioning.

A comprehensive EBCx task order might include the following building systems:

- HVAC and refrigeration systems and associated controls
- Air-curtain systems
- Domestic water heating and distribution systems
- Domestic water treatment systems
- Sanitary sewer systems
- Building envelope (walls and roofing)
- Structural system
- Electrical power distribution systems (panelboards/switchgear plus known problem areas)
- Emergency and standby power
- Energy storage systems
- Lighting and control systems

- Solar photovoltaic and renewable energy systems
- Security and intrusion detection systems
- Landscape watering systems
- Telephone and intercommunications systems

The following systems are typically covered by other required inspections and are not included in an existing building commissioning scope of work:

- Fire protection/sprinkler system
- Fire alarm system
- Cable television (TV) and closed-circuit television (CCTV) systems
- Conveying systems
- Cybersecurity systems

2-5 THE COMMISSIONING TEAM SKILLS.

The EBCx Team must be led by a certified individual as outlined in paragraph titled [Required Certifications and Training](#). The overall assembled EBCx team must have the following skills and experience:

- Project management
- Project team supervision
- System testing techniques and use of instrumentation
- System troubleshooting
- System analysis
- Energy and water conservation techniques
- Energy and water calculation procedures
- Working knowledge of control systems and sequence strategies
- Capability to train operators
- Good communication skills

2-6 COMMISSIONING EQUIPMENT.

The National Environmental Balancing Bureau (NEBB) maintains an Approved Instruments Requirements list for performing EBCx services (<https://nebb.org/firm-certification/instrument-requirements/>). This list includes the range and accuracy requirements for instruments based on their testing function, and also designates calibration intervals for these instruments. Duplicate equipment may be required for some items to allow for periods when equipment fails or is not available while being calibrated. Firms or Government teams that conduct EBCx efforts must provide proof to

the Government Project Manager that equipment being used has been calibrated according to the manufacturer's or industry standards for each piece of equipment and the date it was last calibrated.

2-7 PHASES OF COMMISSIONING.

The EBCx process as outlined in this document is broken down into phases, generally following those outlined in [ASHRAE 0.2](#) as well as BCxA Existing Building Commissioning Best Practices. The Phases may be performed by separate entities, as described in this document. The remaining Chapters in this document are organized by these Phases, which are as follows:

- Planning
- Assessment
- Investigation
- Implementation
- Hand-off
- Ongoing Commissioning

CHAPTER 3 PLANNING PHASE

3-1 OBJECTIVES.

The Planning Phase is implemented when the EBCx process is being considered for a single building or multiple buildings. When considering EBCx for multiple buildings, this Phase assists in identifying the buildings that are the best candidates for benefitting from the EBCx process. When a decision has been made to perform EBCx on a single building (the building has been confirmed as a good candidate for these services), the Planning Phase is abbreviated. While each phase could be contracted, it is recommended that the Planning Phase and a portion of the Assessment Phase be performed in-house to better establish the scope for execution in subsequent phases. The objectives of this phase are to clarify the scope and expectations of the EBCx process, and to develop a strategy to guide the execution of the efforts.

3-2 PLANNING PHASE FOR MULTIPLE BUILDINGS.

When considering the application of EBCx on multiple buildings, follow these Planning Phase steps:

- a. Assemble EBCx program planning team
- b. Conduct program planning meeting and workshop (develops EBCx goals and screens buildings)
- c. Gather documents
- d. Building walk-through
- e. Engage a Cx Provider
- f. Develop EBCx program plan

3-3 PLANNING PHASE FOR A SINGLE BUILDING.

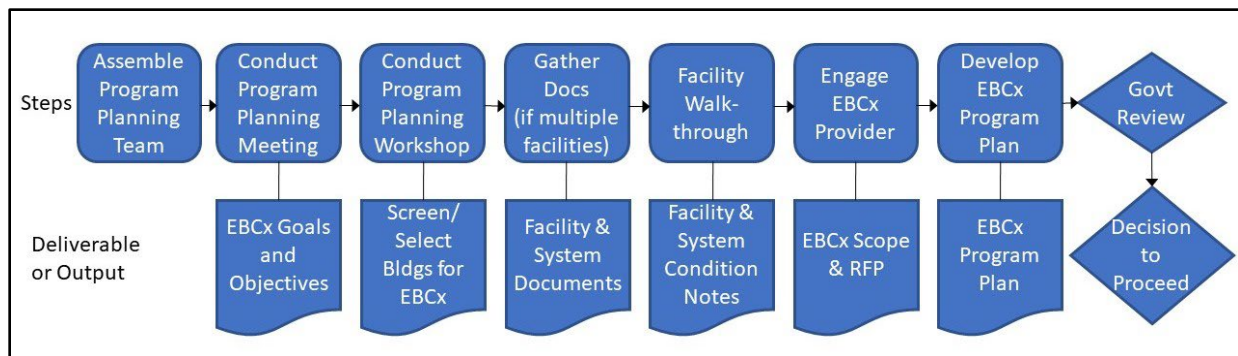
When a decision has been made to perform EBCx on a single building (the building has been confirmed as a good candidate for these services), the Planning Phase is somewhat shortened as follows:

- a. Confirm/Document EBCx goals and objectives
- b. Initial walk-through of building
- c. Engage a Cx Provider

3-4 PLANNING PHASE STEPS.

The following planning phase steps are undertaken to clarify the scope and expectations of the EBCx process. Some of these are only undertaken when considering multiple buildings, and others are undertaken when planning EBCx for a single building or multiple buildings.

Figure 3-1 Planning Phase Process and Deliverables/Outputs



3-4.1 EBCx Program Planning Team.

An installation may have a formal program and organization for conducting EBCx. If no formal program exists, a program is defined within the Planning Phase when conducting EBCx on multiple buildings. When conducting planning sessions on EBCx for multiple buildings, assemble an EBCx Program Planning Team. This Planning Team consists of facilities management leadership, utilities management personnel, engineering management staff, the installation energy managers and the facility-related control systems (FRCS) manager. As a part of initiating the planning process, this team conducts the following primary activities:

- Determine funding availability for EBCx efforts and develop a funding plan based on the funding source.
- Determine contract availability if aspects of the work are to be performed through an outside contractor. Determine whether in-house Cx resources are available or if an outside Contractor is required.

3-4.2 EBCx Program Planning Meeting and Workshop.

When considering EBCx on multiple buildings, conduct a planning workshop to discuss/confirm the overall goals of the program and orient the team on the EBCx process. An overview meeting is conducted to review the concepts listed below, then an extended workshop is held to complete these steps after information is compiled, such as the data required to conduct the building screening/selection process. Cover the following topics at a minimum (see ASHRAE 0.2 Multiple-Facility Planning Phase section titled “Conduct EBCx Program Planning Meeting” for information to discuss on each of these topics):

- EBCx goals and objectives (see paragraph titled [EBCx Goals and Objectives](#))
- EBCx process overview, including types of systems included, and potential benefits expected.
- Identify buildings considered as candidates for the program.

- What building systems are included in EBCx assessments.
- The building screening/selection process (see paragraph titled [Screen/Select Buildings for EBCx Viability](#))
- Determine measurement and verification (M&V) standards and performance metrics
- Identify the training needed for building managers and O&M staff
- Confirm personnel resources available in-house for EBCx efforts vs. those that need to be performed via outside contract
- Confirm funding sources, contract mechanisms and available funds
- Expected benefits of EBCx
- Preferred timeframe for EBCx execution

3-4.2.1 EBCx Goals and Objectives.

For single buildings or multiple-building EBCx efforts, the Planning Team confirms the desired objectives of the EBCx efforts so these expectations can be conveyed to all parties involved. Objectives may include one or more of the following:

- Bring equipment to its proper operational state.
- Reduce energy and demand cost, increase equipment life.
- Improve indoor environmental quality and increase tenant satisfaction.
- Improve building operation and maintenance.
- Reduce overall complaints.
- Reduce staff time spent on emergency calls.

The Government Project Manager must convey assessment parameters for specialized objectives other than energy and water savings. Objectives beyond traditional EBCx might include system expansion capability, enhanced building resiliency, emissions reduction, or enhanced electrification. EBCx teams are made up of disciplines which can assess these issues; however, it is important to clearly state these objectives in the EBCx scope of work.

3-4.2.2 Screen/Select Buildings for EBCx Viability.

When considering multiple buildings for EBCx, some existing buildings or groups of buildings make better candidates for EBCx than others. Assemble the EBCx Program Planning Team and the Building Managers for the buildings under consideration for EBCx to screen the buildings and identify those that are the preferred candidates for the EBCx Program. The goal of the screening process is to perform EBCx efforts on those buildings which provide the highest returns, such as reductions in energy or operational costs, as well as ensuring continuity of operations for those buildings which are deemed as mission critical. These efforts require compiling data on each candidate building,

such as checking planned project lists and reviewing maintenance records; to gain the best information; a brief walk-through of each building and talking with occupants and maintenance personnel are best practices.

Follow these steps in screening buildings for the EBCx Program (see Appendix A, paragraph titled [Navy and Marine Corps Templates](#) for location of a best practice template available for use in the screening process):

- Step 1 – Confirm it is a “building” and it is a DoD asset:
 - Per UFC 1-300-08, a building is “A roofed and floored facility enclosed by exterior walls and consisting of one or more levels that is suitable for single or multiple functions.”
 - Through available asset data, confirm the building is a DoD asset (and not locally owned).
- Step 2 – Consider the following criteria when making a building selection:
 - Buildings equal to or greater than 25,000 square feet (2,323 square meters) and buildings which house energy intensive operations (such as data centers, health facilities or utility plants).
 - Buildings which are not scheduled for demolition.
 - Buildings with prior energy audits that recommend EBCx as an Energy Conservation Measure (ECM) (note: A building is not required to have a prior energy audit to be considered a good candidate for EBCx).
 - Buildings with a Condition Index (CI) greater than 60.
 - Buildings with high energy use index (EUI) that cannot be explained or unexplained increases in energy consumption. Compare the EUI for the candidate building to similar buildings using benchmarking. Benchmarking can be done using a tool such as the Commercial Buildings Energy Consumption Survey (CBECS): www.eia.gov/consumption/commercial/
 - Buildings with persistent failure of building equipment, control systems, or both (note: failed control systems make it difficult to diagnose systems and test performance).
 - Buildings with access to a Direct Digital Control (DDC) operator workstation, where DDC controls are present
 - Buildings whose current use or configuration have been modified from the original design intent.
 - Buildings with occupant complaints about temperature, airflow, and comfort.

- Buildings that do not have deferred maintenance based on Preventive Maintenance (PM) and Service Call records to ensure that important maintenance tickets have been addressed.
- Buildings that are not scheduled for capital improvements (which replace EBCx systems before the payback period had elapsed and equipment has reached its useful life).
- Buildings with Building Automation System (BAS) control systems or complex mechanical systems.
- Buildings with unexplained increases in numbers of work orders/services requests.
- Buildings with meters (electric, water, gas, or steam) installed prior to EBCx.
- Step 3 – Where funding is not available to perform EBCx on all candidate buildings, prioritize buildings by mission criticality and known issues affecting resiliency:
 - Prioritize buildings which are critical to performing the Installation’s mission. For additional information on criticality, contact Installation Facilities Management (IFM) or the Installation Energy Management (IEM) office for a list of existing critical buildings that may require commissioning.
 - Prioritize buildings with known issues affecting their resiliency, defined as having lessened ability to provide for mission in the face of all hazards, including extreme weather events or changes in environmental conditions, or recover operations quickly after a disruption in operation (such as having known power reliability issues, a mission critical building with an inoperable backup power generation system, HVAC systems with difficulties operating in expected extreme hot or cold conditions, building enclosures in occupied spaces with gaps which allow external air flows in extreme conditions).

3-4.3 Gather Documentation.

When considering multiple buildings for EBCx, gather documentation during the follow-on Assessment Phase. For EBCx on an individual building, obtain documentation in the Planning Phase to understand the condition of the systems, where potential issues exist, and to establish the scope of work for the Cx Provider, whether they are in-house or contracted. Gather the following documents:

- Original “as-built” construction drawings
- Original construction specifications
- Renovation construction drawings

- Minimum one year of utility bills or usage and cost data (including electrical, natural gas, water, wastewater, fuel, steam Hot Water (HW) or Chilled Water (CW))
- Utility rates
- Previous energy audit, commissioning, or EBCx reports
- TAB reports for HVAC system
- Existing equipment submittals or shop drawings
- Controls systems “as-built” submittals
- Copies of written control sequences or diagrams
- Copies of existing building operations and maintenance guides
- One-year summary report of maintenance and repair records
- Six months of HVAC BAS/DDC trend data alarms as available
- Equipment replacement records

3-4.4 Building Initial Walk-through.

The initial walk-through of the building helps to gain an understanding of the condition of the spaces and state of the building and systems. Collect information on the types and quantities of equipment, and if there is pending corrective repair work. Discuss with the maintenance personnel where known issues are and speak with occupants regarding current thermal comfort issues.

3-4.5 Engage Commissioning Provider.

While each phase could be contracted, it is recommended that the Planning Phase and a portion of the Assessment Phase be performed in-house to better establish the scope for execution in subsequent phases. Performing a portion of the Assessment Phase will help to understand enough about the building(s) to develop an initial scope and budget for the EBCx task. For the EBCx Team, whether being performed in-house or via Contractor personnel, clearly define the scope of the EBCx assessment, the parameters of the building(s) being evaluated, and assistance being provided by installation or building personnel. Parameters needed to enable a well-defined scope of work include the following at a minimum (see Appendix A, paragraph titled [Navy and Marine Corps Templates](#), for the location of a best practice template for the EBCx Contractor scope of work):

- EBCx project objectives
- Whether Government provides the CFR or Contractor develops
- List and quantity of building equipment and systems to be evaluated
- Condition of equipment and known outstanding repairs

- List of problem areas or known issues
- State if electrical, gas and water meters are installed and operational
- State if approximate costs for energy and water use are available
- Specific procedures required, or emphasis on specific spaces (such as systems supporting data/IT systems or mission critical spaces)
- Existing controls systems; capabilities of the BAS for trending and reporting
- Clarify if Cx Provider provides controls Contractor or Government
- Allowed work hours
- Instructions for coordination of building availability
- List of documents that will be provided, and whether they'll be provided electronically or may only be viewed on-site
- Description of support to expect from operations staff for interviews and answering questions
- Required sample size and pass rate
- List the installation security access requirements
- List the building access requirements (badging, escort)
- Identify security requirements regarding use of cell phone cameras, standalone cameras, and thermal imaging cameras
- Requirements for deliverables, including draft and final reports
- What extent, if any, of Implementation Phase or Ongoing Commissioning Phase activities are conducted by the Cx Provider
- Desired schedule, including milestones or check-in points
- Potential measurement and verification (M&V) plan
- Which party develops Performance Verification Tests
- List of deliverables required and format
- Requirement for out-briefing or Post-EBCx presentation
- List of points of contact (building utilities, control system vendors, building access coordination, building maintenance)

3-4.6 EBCx Program Plan.

For Planning Phases when considering multiple buildings for EBCx, develop the information resulting from the EBCx Program Planning Meeting and Workshop in a cohesive planning document (see paragraph titled [EBCx Program Planning Meeting and Workshop](#)). Topics in this plan include the following at a minimum:

- EBCx goals and objectives
- Buildings considered as candidates for the program.
- Building systems included in EBCx assessments.
- The building screening/selection process utilized, including ranking metrics
- Prioritized/selected list of buildings
- Measurement and verification (M&V) requirements
- Training needed for building managers and O&M staff
- Personnel resources available in-house for EBCx efforts and those that require performance via outside contract
- Budget, funding sources, and contract mechanisms
- Expected benefits of EBCx
- Schedule for EBCx execution
- EBCx program planning team

3-4.7 Government Review and Decision to Proceed.

For Planning Phases when considering multiple buildings for EBCx, submit the developed EBCx Program Plan for review and approval. This review evaluates the process followed for screening the buildings and the decision/selection of buildings planned for EBCx. Additionally, the planned method of performing EBCx efforts is assessed, whether through in-house teams or contracted resources; potential contracting mechanisms are also confirmed.

3-5 PLANNING PHASE DELIVERABLES.

The Planning Phase deliverables consist of the following:

- EBCx Program Plan
- Compiled building documentation
- Contractor RFP scope of work

CHAPTER 4 ASSESSMENT PHASE

4-1 OBJECTIVES.

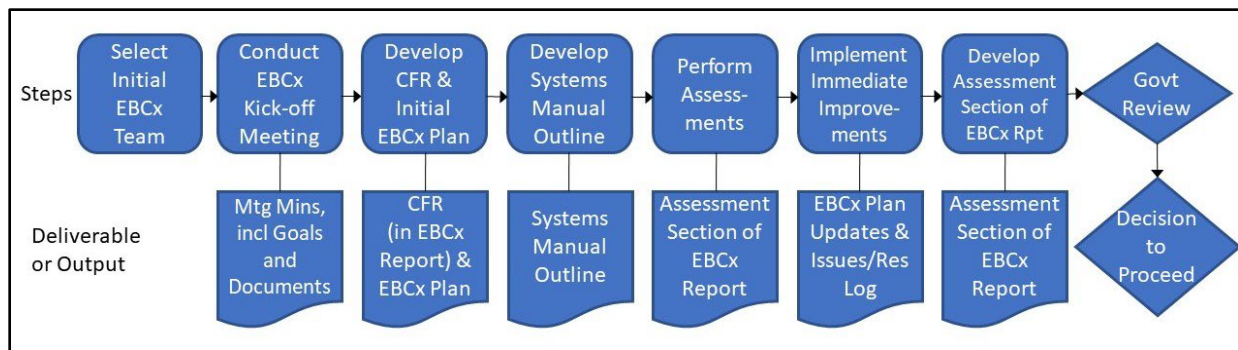
The Assessment Phase consists of performing preparatory activities in developing the Current Facility Requirements (CFR) and an EBCx Plan for a single building, and performing an assessment of the building. It is not a full evaluation but rather a cursory data gathering and brief walk-through of the building. The goal of the on-site Assessment Phase is to record building system conditions, identify obvious performance issues, and flag potential opportunities for more in-depth analysis. The Assessment Phase approach must align with the Government's objectives and goals for the overall EBCx efforts (such as energy reduction, enhancing occupant comfort, or reducing service calls). The objectives of this phase are to gain enough of an understanding about the individual building to develop an initial scope, schedule, budget, and approach for the follow-on Investigation Phase, as well as an estimate of the potential improvements to the building's performance.

4-2 ASSESSMENT PHASE STEPS.

There is some overlap in the Planning and Assessment Phases. And Assessment Phase steps may be performed by a different entity than the Planning Phase, thus some initial steps are used to confirm the scope and expectations for the EBCx process. Assessment Phase steps are as follows:

- a. Select the initial EBCx Team
- b. Conduct an EBCx kick-off meeting
- c. Develop CFR
- d. Develop the initial EBCx Plan
- e. Establish the Systems Manual outline
- f. Perform assessments
- g. Implement immediate improvements
- h. Develop Assessment Report portion of EBCx Report
- i. Obtain Government review and decision to proceed

Figure 4-1 Assessment Phase Process and Deliverables/Outputs



4-2.1 The Initial EBCx Team.

Define the EBCx Team to oversee and accomplish the Cx activities. To what extent a Contractor is responsible for the activities is affected largely by the resources available at the installation. The initial team consists of the Government representatives, the Commissioning Provider, and additional team members based on the EBCx goals and the building systems included in the scope. After responses are received from Contractor support requests, decisions are made for securing the services of the most appropriate team and procuring these services utilizing available contracting mechanisms.

4-2.2 Kick-off Meeting.

Following issuance of Notices to Proceed to Contractors, or an agreement to utilize a Government in-house team, conduct a kick-off meeting to develop an understanding of the planned EBCx processes and coordinate the work activities. The focus of this pre-assessment meeting is to determine which EBCx members are required to support the assessment, which requested documents remain outstanding, and what the access needs will be during the assessment. Also review assessment strategies and deliverables during the meeting. Required attendees include Government and Contractor personnel playing a key role in the EBCx activities. Topics for the kick-off meeting include the following:

- Confirm EBCx goals and objectives
- Confirm documentation requested
- Introduce EBCx team members
- Confirm EBCx roles, including local support
- Communication and coordination plan
 - Site visit security requirements and coordination
 - Planned meetings
- Specific EBCx plan/activities

- Outline of activities
- Building systems being evaluated
- Approach to measurement and verification
- Planned assessments/tests
- Access required
- Impacts to operations
- Government staff participation/assistance
- Training approach
- Deliverables/Submittals
- Planned EBCx schedule

Following the meeting, develop formal meeting minutes and issue to attendees as well as stakeholders who were unable to attend.

4-2.2.1 EBCx Goals and Objectives.

If a different entity is involved in the Assessment Phase from the Planning Phase, confirm the goals and objectives of the EBCx efforts. Confirmation of the goals and objectives as designated in the scope of work is important prior to proceeding with the activities of this phase because these determine the appropriate assessment methods and level of testing. A list of potential objectives for EBCx efforts is included in [Chapter 3](#) of this document.

4-2.2.2 Documentation Requested.

At the kick-off meeting, confirm if the list of documentation from [Chapter 3](#) has been provided. The Government identifies items that do not exist for the building being assessed.

4-2.3 Current Facility Requirements (CFR).

The CFR is the foundational information for the EBCx efforts in that it defines the specific operating parameters for the building to support its' mission. Establishing these CFR parameters is critical to understanding how an existing building is performing when compared to its' intended design, and establishes the targets for successful EBCx results. A CFR must reflect the current needs and requirements of the users or occupants. For example, functional uses may have changed since the building was originally constructed; these space renovations may have resulted in revising the operation of building systems. For buildings that were commissioned during construction/renovation, or that have had prior retrocommissioning efforts, the EBCx efforts involve updating the Owner's Project Requirements (OPR) established during the original commissioning process. For existing buildings with no prior commissioning efforts, developing the requirements defined within the CFR require input from building staff, occupants, users, maintenance personnel and management; thus, obtaining this

information typically requires facilitation of a series of meetings or a workshop as well as interviews and surveys.

The minimum content requirements for the CFR are stated in ASHRAE 0.2, Assessment Phase section titled “Develop CFR”. ASHRAE 1.2 provides an in-depth outline of CFR information for HVAC systems; provide similar information for other building systems included in the scope. Annex I of ASHRAE 0.2 provides a best practice approach for conducting a workshop to obtain information for the CFR; the Commissioning Provider facilitates this workshop. Annex J of ASHRAE 0.2 provides an example format for the CFR.

4-2.4 The Initial EBCx Plan.

The EBCx Plan outlines a strategic method of assessment that attempts to identify indicators of poor performance and opportunities for improved building system optimization. This plan provides the basis from which the follow-on Investigation and Implementation Phases proceed. The minimum content requirements for the EBCx Plan are stated in ASHRAE 0.2, Assessment Phase section titled “Develop the EBCx Plan”. This same section in ASHRAE 1.2 provides an in-depth outline of EBCx Plan information for HVAC systems; provide similar information for other building systems included in the scope. Include strategies and activities in the EBCx Plan to meet each CFR item.

4-2.5 Systems Manual Outline.

The Systems Manual contains the information needed to understand, operate and maintain the building systems that are included in the EBCx scope. If the building has not been commissioned in the past, the Assessment Phase efforts include beginning to develop the sections for the complete Systems Manual. If a Systems Manual exists from prior commissioning efforts, the Cx Provider reviews it for accuracy and completeness, and updates and adds information as necessary. ASHRAE 0.2, Assessment Phase section titled “Establish the Systems Manual Outline”, identifies required topics in the Systems Manual, with an example outline included in Annex M of ASHRAE 0.2.

4-2.6 Building and System Assessments.

The assessment of the building provides the first opportunity for the EBCx Team to document baseline performance of the systems and assemblies. Baselines are documented assessments of current operation for items such as energy use, energy demand reduction, ability to provide occupant comfort, frequency and type of service calls, and reliability of building systems and equipment. Utilize the assessment strategies as outlined in the EBCx Plan. This assessment seeks to provide a good understanding of the building systems and assemblies, their state and condition, and the operational parameters currently in place. Ensure this information is well documented as it provides the initial comparison of building performance against the criteria defined in the CFR. This baseline information is used to measure anticipated

benefits and performance improvements obtained through the EBCx process. Where needed, these assessments are performed in more detail during the follow-on Investigation Phase.

4-2.6.1 System Assessments.

Perform the following assessment activities on systems in the EBCx scope (additional details on specific building systems are included below):

- a. Determine if assessments will address all equipment or a sample of equipment.
- b. Identify procedures, requirements, and schedule, to gain access to areas of the building. Determine accessibility to equipment, systems, and components for inspection and testing.
- c. Perform a visual inspection of major equipment. Review documents as needed (such as O&M records and on-site systems documents).
- d. Document observed deferred maintenance and O&M issues.
- e. Evaluate building performance in accordance with benchmarking methods defined in the CFR and document maintenance and operational issues.
- f. Determine change of use or function of systems, assemblies, or components with initial design.
- g. Document occupant and user issues discovered during walk-throughs or surveys.
- h. Document safety hazards observed during building walk-throughs (such as unprotected electrical wiring, fall hazards, and other dangerous conditions).
- i. Identify known resources, such as operations and maintenance support personnel.
- j. Identify subject areas where additional training needs are necessary, based on both the complexity of systems and the personnel's expertise in operating and maintaining them.
- k. Record the general condition of the systems, including age, maintenance issues, observed damage, and design or installation flaws.
- l. Perform additional walk-through observations or interviews/surveys as necessary to gain a general understanding of the baseline condition of existing building systems and assemblies.

4-2.6.2 HVAC & Refrigeration System Assessments.

Perform Assessment Phase activities on HVAC&R systems in accordance with ASHRAE 1.2, Assessment Phase Section titled "Perform Assessment".

4-2.6.3 Building Enclosure System Assessments.

Perform initial assessment of building enclosure systems through review of documentation, interviews, and visual assessments as follows.

4-2.6.3.1 Review of Building Enclosure Documentation.

Review the original design plans of the building and renovation drawings, as well as records of changes or previous condition surveys, to assess the following which may affect the performance of the building enclosure:

- Air barrier continuity
- Materials used and known life cycle issues
- Original performance expected
- Inherent thermal bridging issues
- Identify clearly the four control layers for the building enclosure: a) rain/moisture control layer, b) air control layer, c) vapor control layer, and d) thermal control layer
- Determine if non-occupied areas such as crawl spaces and attics are designed as vented or non-vented spaces, or the design is unclear and they are operating as unintended hybrid systems (which harm building performance).

4-2.6.3.2 Interviews with Building Manager and Occupants.

Interview the building manager, maintenance personnel and building occupants regarding the following issues:

- Changes to purpose or function of the building (such as warehouse to office space)
- Known water penetration issues, observed high humidity, or deteriorated interior finishes
- Air movement detected around windows or doors
- Glare problems
- Temperature issues in spaces
- Unpleasant odors
- Excessive background noise in spaces

4-2.6.3.3 Visual Inspections of Building.

Perform visual inspection of the building to assess the following for conditions adversely affecting building performance:

- Topography slopes with the potential for ponding water against the building
- Deterioration issues (such as sealants, masonry pointing and spalling, window gaskets)
- Evidence of excessive dampness, vegetative growth, or staining on the building exterior
- Roof issues (such as deterioration of membranes or flashings, poor adhesion, tenting of membranes, ponding, vegetative growth, or evidence of roof drain overflows)
- Corrosion issues
- Evidence of foundation movement (such as cracks or displaced or out of plane elements)
- Obvious changes of cladding materials or changes in building footprint as compared to record original and renovation construction drawings
- Crawl space issues:
 - Evidence of condensation or water penetration into the space
 - For ventilated crawl spaces, check sub-floor insulation for continuity
 - At a minimum, crawl spaces must have a vapor barrier sealed at laps, exterior walls, and penetrations.
- Evidence of exterior wall issues observed from the interior:
 - Obvious signs of water entry, especially around windows, doors, foundation walls, and at the roof-to-wall connection. Signs may include stains, mold, peeling paint, efflorescence, peeling drywall tape, or standing water or dampness.
 - Fogging on the inside of insulated glass panels.
 - Dark stains on the exterior wall around light switches and receptacles and other penetrations in the drywall (common indications of air infiltration).
 - “Ghosting” (dark stains) at drywall screw heads or metal studs, resulting from drywall with a high moisture content. This is often caused by thermal bridging, by a lack of exterior insulation, or incorrectly installed vapor barrier resulting in a dew point condition within the wall cavity. A lack of an air barrier also results in dew point issues in the wall cavity.
 - Check seals around windows and doors for continuity and resilience.
- Evidence of issues above ceilings:
 - Stains on the ceiling drywall or acoustical tile (caused by roof leaks or by condensation dripping from building systems above the ceiling).

- Excessive rusting on bar joists or structural steel (may indicate condensation caused by air infiltration, often at the roof-to-wall interface).
- Carpet or floor tile may indicate the presence of water by discoloration or loss of adhesion (caused by water infiltration or condensation on insufficiently insulated slabs-on-grade).
- Air curtains with operational issues

4-2.6.4 Electrical System Assessments.

Perform initial assessment of electrical systems through review of documentation and interviews as follows.

4-2.6.4.1 Review of Electrical System Documentation.

Review the original design plans of the building and renovation drawings, as well as records of changes or previous condition surveys, to assess the following which may adversely affect the performance of the electrical systems:

- Current systems installed
- Materials used and known life cycle issues
- Original performance expected
- Inherent increased energy usage issues
- Current stage in life cycle of existing equipment for continued use opportunity
- Bulb/lamp type replacement vs. fixture replacement

4-2.6.4.2 Interviews with Building Manager and Occupants.

Conduct interviews to determine how the building is being used, identify known system issues, and confirm how the building is serving the occupant's needs. Interview the building manager, maintenance personnel and building occupants regarding the following issues:

- Past changes to purpose or function of the building (such as warehouse to office space)
- Known electrical issues, or high cost of maintenance on equipment
- Nuisance tripping of circuit breakers
- Generator (Emergency Power)
 - Excessive fuel costs (equipment running poorly)
 - Nuisance breakdowns (frequency of and cost for repairs)

- Life Cycle (expected equipment life vs. current age)
- Adequacy of fuel storage capacity (if function/mission of building has changed, new function may have additional energy demand that requires increased fuel storage)
- Current Lighting Systems
 - Fixture types (examples include incandescent, fluorescents, and light-emitting diode (LED))
 - Lighting Controls (examples include switches, occupancy sensors, time clocks, and building management system (BMS))
- Renewable Energy Systems
 - Solar Arrays, wind turbines
 - Life cycle (expected equipment life vs. current age)

4-2.7 Issues and Resolution Log.

Create an initial Issues and Resolution Log which contains detailed descriptions of the findings and recommendations from the initial assessments. This log contains information outlined in the ASHRAE 0.2, Assessment Phase section titled “Issues and Resolution Log”. The log contains issues found, recommendations for corrective actions, estimated costs and benefits, implementation actions and status, and hand-off activities such as training and actions for maintaining performance improvements. Maintain/update this log through the entire EBCx process.

4-2.8 Implement Immediate Improvements.

Bring to the attention of the Building Manager issues found, especially those related to safety, security, health, or operational issues that can be easily remedied and do not require further evaluation (will obviously not adversely impact other systems). Corrective actions that do not incur costs and provide immediate payback can be implemented during the EBCx process; however, do not implement corrective actions without coordinating with maintenance staff responsible for upkeep on the building due to the possibility of creating unintended adverse issues (for example, opening a valve may improve the operation of the mechanical system, but the maintenance staff may have closed the valve temporarily until repairs can be performed on a system leak).

For minor improvements that require installation maintenance staff involvement, coordinate with installation personnel such that work orders are submitted for correcting these issues. Document and include in both the EBCx Report and the Issues and Resolution Log these immediately implemented modifications and corrective actions, along with their projected benefits.

4-2.9 Assessment Report Portion of EBCx Report.

The EBCx Report begins with the creation of the Assessment Report. The Assessment Report becomes the initial chapter of the EBCx Report and documents the findings and results of the Assessment Phase activities. The minimum content requirements for the Assessment Report portion of the EBCx Report are stated in ASHRAE 0.2, Assessment Phase section titled “Initiate EBCx Report with Assessment Report”. This same section in ASHRAE 1.2 identifies information required for HVAC systems. Provide the information outlined in ASHRAE 0.2 for the building systems included in the EBCx scope.

4-2.10 Government Review and Decision to Proceed.

Government representatives will review the Assessment Phase deliverables to determine if the Assessment Phase activities are complete and they concur with the planned approach for proceeding into the Investigation Phase. Review comments are submitted to the Cx Provider and submittals are revised and re-submitted as necessary. For projects considering multiple buildings for EBCx, the Government will review the revised EBCx Program Plan for concurrence with recommendations on the buildings planned for subsequent evaluation.

4-3 ASSESSMENT PHASE DELIVERABLES.

The Assessment Phase deliverables consist of the following:

- CFR (included in EBCx Report)
- EBCx Plan
- Initial EBCx Report, including the Assessment Section
- Systems Manual Outline
- Updated EBCx Program Plan (if applicable to multiple building projects)
- Initial Issues and Resolution Log

4-3.1 EBCx Plan.

The fully developed EBCx Plan has multiple report sections which outline the strategies for executing the EBCx phases. Sections are initially developed in one phase and are updated as the EBCx efforts progress into subsequent phases. The minimum content requirements for the EBCx Plan are stated in ASHRAE 0.2, Assessment Phase section titled “Develop the EBCx Plan”. Sections of the overall EBCx Plan and the phase in which they are developed are as follows (refer to the referenced phase within this document for the requirements of plan report section contents; see [Appendix A](#) for the location of best practice templates for the EBCx Program Plan and the EBCx Plan):

- EBCx Program Plan – developed for multiple-building EBCx efforts; initially developed in Planning Phase and updated in Assessment Phase

- Initial EBCx Plan – created in the Assessment Phase
- Measurement and Verification (M&V) Plan – initial approach is developed in Initial EBCx Plan during Assessment Phase, then plan is updated in subsequent phases for the detailed M&V of the recommendations that are implemented. M&V Plan includes the details for both baseline and post-implementation performance period testing required for quantifying the performance and achieved benefits of the process.
- Training Plan – included in the Initial EBCx Plan during Assessment Phase, then plan is updated in subsequent phases based on personnel needs and system complexity
- Investigation Plan – added to the EBCx Plan during the Investigation Phase
- Implementation Plan – added to the EBCx Plan during the Implementation Phase
- OCx Plan – developed in the Hand-off Phase, then updated in the OCx Phase.

4-3.2 EBCx Report.

The full EBCx Report has multiple report sections which document the activities undertaken and results of the EBCx process. Sections of the overall EBCx Report and the phase in which they are developed are as follows (refer to the referenced phase within this document for the requirements of the report section contents; see [Appendix A](#) for the location of best practice templates for the EBCx Report):

- Initial EBCx Report with Assessment Report – created in the Assessment Phase, includes initially recommended CFR and initial Issues and Resolution Log.
- Investigation Report section – added to EBCx Report during Investigation Phase, including results and findings, and updated content.
- Implementation Report section – added to EBCx Report during Implementation Phase, including work undertaken and implementation results. Other content includes test documentation, updated Issues and Resolution Log, site visit records, verification documentation, M&V documentation, and training documentation.
- Final EBCx Report, including Lessons Learned Report section – created in the Hand-off Phase to include lessons learned, necessary updates to prior content, final training and verification documentation.

The OCx Report is a separate report from the EBCx Report and is developed during the OCx Phase. It is most common for the Government to be responsible for OCx Phase efforts, either utilizing installation maintenance resources or installation support contracts.

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CHAPTER 5 INVESTIGATION PHASE

5-1 OBJECTIVES.

The Investigation Phase consists of detailed site investigations, which compare the actual as-is building conditions and system performance with the Current Facility Requirements (CFR). This phase reveals existing conditions in the building, evaluates the need for change, and identifies requirements for additional systems, assemblies, or additions. The benefits and expected payback of each recommended change are derived. The objectives of the Investigation Phase are to understand and document existing conditions and performance to identify improvements needed to bring the building into compliance with the CFR.

This phase concludes with the completion of the Investigation Report section of the EBCx Report, which identifies scope and benefits of recommended building modifications and improvements as well as quick fix improvements already implemented during the Investigation. This is the data intensive portion of EBCx and may be most appropriate for contracting to EBCx specialists. When contracting, the issues and opportunities identified in the Assessment Phase determine the type of specialist needed; for example, if issues are broad and widespread across systems, an Energy Services Contractor (ESCO) may be the best fit, but if the issues are controls-specific a local controls vendor/Contractor may be the right team member.

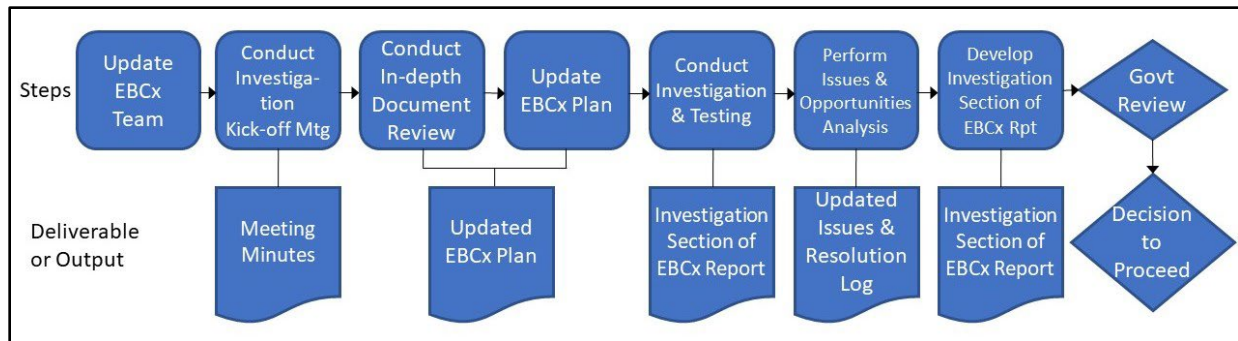
5-2 INVESTIGATION PHASE STEPS.

The Investigation Phase involves performing detailed testing and analysis of specific building systems, discovering operational characteristics, verifying needed modifications, and quantifying implementations needed and improvements expected.

Investigation Phase steps are as follows:

- a. Update EBCx Team
- b. Conduct Investigation Phase kick-off meeting
- c. Conduct in-depth building documentation review
- d. Update EBCx Plan
- e. Perform site Investigations and testing
- f. Perform issues and opportunities analysis
- g. Update EBCx Report with Investigation Report
- h. Present recommendations to Government and adjust plans
- i. Obtain Government review and decision to proceed

Figure 5-1 Investigation Phase Process and Deliverables/Outputs



5-2.1 Updated EBCx Team.

Based on the results of the evaluations conducted in the Assessment Phase, which identify the testing and inspections required in the Investigation Phase, the EBCx Team may require additional specialists or support. Identify these new team members and their roles and responsibilities in a revised version of the EBCx Plan.

5-2.2 Investigation Phase Kick-off Meeting.

Conduct an Investigation Phase kick-off meeting to provide an overview of the EBCx Plan, review findings from the Assessment Phase, and coordinate the upcoming work activities. Also review investigation tests/inspections and deliverables during the meeting. Required attendees include Government and Contractor personnel playing a key role in the Investigation Phase activities, as well as building operations and maintenance staff. Topics for this meeting include the following:

- EBCx goals and objectives
- Introduction of new EBCx team members
- Confirmation of EBCx roles, including local support
- Review of communication and coordination plan
 - Security requirements and coordination
 - Planned meetings
- Specific Investigation Phase Plan/Activities
 - Outline of activities
 - Building systems being evaluated
 - Approach to measurement and verification (M&V), with special focus on baseline testing
 - Planned Functional Performance Tests (FPT's)/inspections
 - Access required

- Impacts to operations
- Government staff participation/assistance
- Training approach
- Deliverables/Submittals
- Planned EBCx schedule

Following the meeting, develop formal meeting minutes and issue to attendees as well as stakeholders who were unable to attend.

5-2.3 In-Depth Building Documentation Review.

Conduct a more detailed review of the documentation gathered during the Assessment Phase. This detailed review and analysis assists in identifying which tests and inspections are the most appropriate for the Investigation Phase efforts. This review seeks to reveal information about the intended original basis of design, the existing baseline design, as well as the current operational procedures. With this information, the Cx Provider seeks to determine the deviations between current operations, the original building/systems design, and the current facility requirements (CFR). Goals of this review include:

- Gaining a complete picture of equipment and assemblies included in the EBCx scope
- Identifying potential problem areas to investigate
- Understanding the intended design of building systems and assemblies
- Creating a list of specific equipment and assemblies to evaluate during the Investigation Phase and the appropriate methods of testing and inspection

At a minimum, the detailed review includes the following:

- Evaluation of original and new drawings, specifications, historical utility records, and previous CFRs and commissioning records
- Interactions between building systems and assemblies (such as building envelope components that impact HVAC system performance)
- Prior building evaluation reports, such as energy performance analysis, roof inspections, architectural studies, energy audit reports, TAB reports, capital planning documents, sustainability assessments, safety/health reports, Cx reports, or similar documents to determine what has already been evaluated, recommended for improvements, improved, or not yet implemented
- Building/systems operations and maintenance manuals, with special focus on controls systems (such as those related to HVAC, lighting, security, and fire alarm)

- Maintenance records to assess preventive maintenance and identify potential systems issues

5-2.4 Updated EBCx Plan.

Update the EBCx Plan to include an Investigation Plan. The Investigation Plan is a detailed outline of the planned processes for analyzing existing building conditions and identifying upgrades and improvements needed to meet the Government's CFR. The plan addresses every system and assembly included in the EBCx scope of work. The Government will review and accept the Investigation Plan prior to on-site investigation activities being performed.

The Investigation Plan must include, at a minimum, the information outlined in ASHRAE 0.2 Investigation Phase section titled "Update EBCx Plan".

5-2.5 Site Investigations and Testing.

Carry out physical inspections and tests to evaluate condition and performance as detailed in the reviewed and accepted EBCx Investigation Plan, and record observations and data. The two elements of physical site investigation are condition evaluation and performance evaluation. Condition evaluation includes an assessment of the installed condition of the equipment, systems, and assemblies, such as appearance, physical damage, deterioration of condition, upgraded features, and change of use. Performance evaluation includes an assessment of how the equipment, systems, and assemblies are operated and how they are performing relative to expected performance and the CFR.

During the physical site investigation, evaluate and document the condition and performance of the equipment, systems, and assemblies, as identified in the Investigation Plan. Performance evaluation may include active and passive testing. Execute the tests and repeat as necessary to obtain conclusive information about the performance of systems. During execution of the Investigation Plan, issues may be uncovered that lead to expansion of the plan or to the elimination of specific planned activities. When revisions of an accepted Investigation Plan are required, submit the revised plan to the Government for formal acceptance before proceeding with execution of an altered plan. Conduct on-site investigations in accordance with ASHRAE 0.2 Investigation Phase section titled "Perform Site Investigation and Testing", as well as additional information contained within this document.

5-2.5.1 Detailed Site Survey.

The detailed site survey involves evaluating and documenting the condition and performance of the equipment, systems, and assemblies, as included in the EBCx scope of work and identified in the Investigation Plan. This survey focuses on areas of concern revealed from interviews/surveys, document reviews, and prior brief walk-throughs of the building. The detailed site survey includes assessments to evaluate condition and performance, involving the following actions at a minimum:

- Assess condition, including damage, and noting age of equipment and expected remaining life
- Identify indications of deferred maintenance which could be affecting performance
- Note new features or changes in use of equipment
- Denote issues that affect the equipment's ability to be appropriately operated or maintained (such as lack of adequate access)
- Compare how system/components are operated vs. CFR or good practice
 - Set-points
 - Modes of operation (such as daytime, 24/7, or seasonal)
 - Load

5-2.5.2 Calibrations of BAS-Trended Points.

If BAS systems are operating, verify the accuracy of sensors, valves and actuators and statuses to ensure precision of BAS screen shots and trend data. At a minimum, perform this on the devices that impact control and BAS points. Complete calibration prior to initiating trends – coordinate with building manager prior to performing calibration.

If controls are obsolete or non-functioning, include in the EBCx improvements corrective actions to repair or replace the controls. If the BAS/DDC system has been modified from the original design, interview the O&M staff to investigate why the change was made.

5-2.5.3 Energy Usage and Building Performance Baseline.

Establish an energy usage baseline early in the project and track improvements as corrective actions are identified and implemented. Compare this current energy usage to benchmark buildings to identify the potential for improvement. In addition to energy use, available performance data may also include maintenance work orders, comfort complaint logs, indoor air quality parameters, occupant/user satisfaction survey results, and BAS trend data or data logger data. Obtaining this information establishes a performance baseline prior to implementation actions and helps determine the positive impact of EBCx efforts and the benefits gained.

5-2.5.4 System and Equipment Performance Monitoring.

The EBCx Team executes the system and equipment monitoring as outlined in the Investigation Plan section of the EBCx Plan. This involves gathering data through diagnostic monitoring methods to identify poor performance and potential improvements. For example, to monitor HVAC systems, diagnostic monitoring methods include BAS trending, portable data logger trending, and energy and weather data

collection. Perform similar diagnostic testing to assess performance of other building systems included in the EBCx scope.

5-2.5.5 Additional Building Personnel and Occupant Interviews.

Conduct additional interviews with the Building Manager, O&M personnel and building occupants to gain a more in-depth picture of the current use of the building and operation of its systems. While surveys can serve the purpose of gathering initial feedback from the building occupants/users, also conduct formal interviews with building managers and O&M personnel. The goals of obtaining this information are to identify current problem issues, uncover potential improvement opportunities and confirm the CFR. See [Appendix A](#) for the location of best practice templates for the building occupant questionnaire.

5-2.5.6 Building Automation Controls System Reviews.

Conduct a thorough and detailed review of the building automation system, focusing on establishing the current sequence of operations, identifying/confirming accurate graphics, and evaluating unit alarms/settings. Review building automation system graphic screens, alarm logs, and schedules for each piece of HVAC equipment, including a complete review of setpoints or reset parameters. Identify conditions which result in wasted energy use. Document the “as-found” conditions and the current operation of the systems (information is critical for subsequent measurement and verification activities). Record identified problems and improvement recommendations to the sequence of operations in the Issues and Resolutions Log.

5-2.5.7 Functional Performance Test (FPT) Procedures.

Develop functional performance test (FPT) procedures for the systems identified in the EBCx scope of work. Functional testing is often necessary to determine how systems react to key operating conditions. Test plans for energy efficiency focused projects both confirm existing system operation to identify improvements, and test or confirm ideas for improvement. Develop the FPT’s with the goal of verifying that EBCx efforts, after system improvements, aid in the building achieving the CFR parameters. The information to be included in a thorough test procedure and test form is outlined in ASHRAE 0.2 Investigation Phase section titled “Update EBCx Plan”. The developed FPT’s are included in the Investigation Phase portion of the EBCx Plan which is submitted to the Government for acceptance of the procedures prior to scheduling testing.

5-2.5.8 System Functional Testing.

Following Government acceptance of the FPT’s, functional testing is conducted to evaluate existing systems performance and identify areas requiring improvements to meet the CFR. Issues identified in the Assessment Phase or early in the Investigation Phase are considered for more in-depth evaluation during system testing to determine root causes and potential solutions. Ensure required equipment and personnel, both

EBCx Team and Government support, are on-site prior to commencing testing. Schedule tests with building management staff so that disruptions to normal operations are avoided or minimized. Schedule testing which requires outages or operations impacts with adequate notice and communicate to the building manager, O&M personnel, and occupants/users. Testing may need to be deferred based on climate conditions, occupancy situations or planned events. Additional testing guidelines for specific systems are included below.

5-2.5.8.1 HVAC & Refrigeration System Investigation and Testing.

Perform testing of HVAC&R systems in accordance with ASHRAE 1.2, Investigation Phase section titled “Perform Site Investigation and Testing”.

5-2.5.8.2 Building Enclosure Investigation and Testing.

Conduct further investigation and testing of building enclosure issues in accordance with the following:

- Test for air movement through the enclosure in accordance with ASTM E1186. This standard covers multiple test methods. For initially testing large surface areas, infrared scanning allows for rapid surveying; for follow-up leak detection testing of local areas, the smoke tracer, theatrical fog, anemometer, sound detection, bubble detection, and tracer gas techniques are typically more appropriate methods.
- Test for air leakage in accordance with either ASTM E779 or ASTM E1827.
- Test for water infiltration through building walls in accordance with ASTM E2128.
- Test for continuity of insulation by use of infrared imaging in accordance with ASTM C1060.
- Test for roof leaks in accordance with ASTM D8231 and ASTM C1153.

5-2.5.8.3 Electrical Systems Investigation and Testing.

Conduct further investigation and testing of electrical systems in accordance with the following (Note: It is important to note that the local Authority Having Jurisdiction may have more stringent requirements for operational requirements; these must be confirmed.):

- Emergency and Stand-by Power Systems:
 - Perform inspections and operational testing in accordance with UFC 3-540-07, NFPA 110 section titled “Operational Inspection and Testing”, and the manufacturer’s instructions.

- Lighting Control Systems:
 - Test lighting controls in accordance with IECC (C405 & C408.3 – Lighting system functional Testing), NEMA 410 – (Performance testing for lighting controls and switching devices), and manufacturer’s installation and operation instructions (sequence of operations).
- Power and distribution systems:
 - Conduct infrared camera thermography tests on equipment in accordance with ISO 18251-1: Non-destructive Testing – Infrared Thermography – Part 1, Characteristics of System and Equipment; and ANSI/NETA MTS, Standard for Maintenance Testing Specifications for Electrical Power Equipment and Systems. Follow the required safety protocols of NFPA 70E, Standard for Electrical Safety in the Workplace.
- Renewable energy systems:
 - Photovoltaic (solar arrays): test functionality in accordance with NFPA 70; and IEC (International Electrotechnical Commission) 62446-1, Photovoltaic systems – Requirements for testing, documentation, and maintenance Part 1: Grid connected systems – documentation, commissioning tests, and inspection.
- Energy storage systems:
 - Uninterruptable power supply (UPS): test functionality in accordance with NFPA 70; and IEC (International Electrotechnical Commission) 62040-3 Uninterruptable Power Systems – Part 3 Performance and testing requirements – UPS.

5-2.5.9 Data for Energy Calculations and Implementation.

Gather data for savings calculations and detailed implementation recommendations. This includes documenting current energy usage for a system or piece of equipment being recommended for repairs or replacement. If electrical data measurement is not allowed or practical, electrical usage may be derived using data such as equipment sizes and run times.

5-2.5.10 Simple Repairs.

Corrective actions that are discovered by the EBCx Team during the Investigation Phase and provide immediate payback through no or low costs can be implemented during the EBCx process; however, do not implement corrective actions without coordinating with maintenance staff responsible for upkeep on the building due to the possibility of creating unintended adverse issues (for example, opening a valve may improve the operation of the mechanical system, but the maintenance staff may have closed the valve temporarily until repairs can be performed on a system leak). For minor improvements that require installation maintenance staff involvement, coordinate with installation personnel such that work orders are submitted for correcting these

issues. Document and include in both the EBCx Report and the Issues and Resolution Log these immediately implemented modifications and corrective actions, along with their projected benefits. ASHRAE 1.2 lists examples of these quick fixes as follows:

- Systems control calibration/repairs: air-distribution component repairs, water/steam distribution component repairs, variable air volume (VAV) or constant volume (CV) box calibration
- Mechanical system repairs: blockage from air-distribution devices, connecting broken flex duct from a duct tap or diffuser, replacing a broken fan belt, damper linkage, resetting dampers, resetting air handling unit (AHU) or fan coil unit (FCU) air flows with significant variance from design
- Plumbing systems: fixture and appliance repair, water system repair, water pressure and hot water temperature adjustment corrections
- Electrical repairs: such as loose terminations or lighting repairs, lighting schedule adjustments
- Correcting systems operating schedules: system running 24/365
- Turning off equipment that does not need to be operating.
- Releasing overridden control set points and parameters.
- Returning equipment to automatic mode
- Deferred maintenance issues: filter replacement, coil cleaning, clean pipe strainers/tower screens, adjust fan belts, replace failed components

5-2.6 Issues and Opportunities Analysis.

Analyze issues, conditions, and performance information acquired from site investigation and testing to identify possible solutions and corrective action recommendations. Review information gathered from previous commissioning activities to increase understanding of issues that adversely affect the building and system conditions and performance. Update the Issues and Resolution Log with identified issues and related recommendations for improvement.

5-2.6.1 Data Analysis.

The off-site portion of the Investigation Phase involves evaluating the data collected during on-site inspections and tests to draw conclusions about existing or potential system performance. Data analysis forms the basis for the recommendations for improving the building and systems condition and performance. Keep in mind that these recommendations must, at a minimum, identify those improvements required to achieve the CFR, plus those corrective actions required to address poor conditions and are leading to subpar performance of the building and its' systems.

5-2.6.2 Energy Impacts and Cost Calculations.

During the Investigation Phase, each recommendation which impacts energy usage included in the Issues and Resolution Log requires developing a simplified Life Cycle Cost Analysis (LCCA). While some commissioning activities will result in reduced energy usage, some activities will increase energy usage. A negative payback or LCCA may result from these situations and should be captured. The LCCA requires development of the cost of repairs/upgrades and the expected annual energy impacts. Develop the estimated construction costs for each recommendation utilizing traditional cost estimating techniques (as outlined in UFC 3-740-05) and include the mark-ups necessary to reflect a total cost if undertaken as a standalone project. The construction costs developed during the Investigation Phase can be rough order of magnitude costs based on the EBCx Team's recent projects; the follow-on Implementation Phase requires more detailed costing efforts of each accepted recommendation prior to procuring the upgrades.

The LCCA requires comparing the current energy usage to the energy use estimated for the new equipment, or estimating the change in energy use resulting from the current condition being corrected. Obtain the local installation's utility rates to derive the energy costs. Develop a simple payback period, in years, for each energy saving recommendation to identify the time required to recover the initial costs of the recommended improvement. For the simple payback, divide the total cost of the improvement recommendation by the projected annual energy savings. The Federal Energy Management Program (FEMP) has online energy- and water-savings calculators that are simple to use and cover specific types of equipment (such as boilers, water heaters, and lighting fixtures). These calculators and other resources can be found at <https://www.energy.gov/femp/federal-energy-management-tools>. See [Appendix A](#) for best practice template for performing savings calculations.

5-2.6.3 List of Findings and Recommendations.

Using the Investigation Phase results, including on-site testing/inspections and analysis of the data, create a list of recommendations. This list is derived from the Issues and Resolution Log. The list includes key information useful for the Government to select recommendations for implementation. The in-depth supporting data is included in the Issues and Resolution Log (included in the Investigation Report portion of the EBCx Report). For the content of the List of Findings and Recommendations, include the information outlined in ASHRAE 0.2 Investigation Phase section titled "List of Findings and Recommendations". Include separate recommendation lists for those that are quick fixes and can be implemented by O&M personnel or installation work orders, and others that are more extensive and require execution as capital projects.

As a basis for classifying recommendations, ASHRAE 1.2 recommends that improvements with a simple payback of less than two years be implemented, and those with a simple payback greater than two years be considered for implementation as a capital improvement project. Keep in mind that some recommendations may be more attractive based on qualitative impacts, rather than their savings gained from the

improvement; for example, a key qualitative benefit often achieved is the ability for the tenant to fully support its' mission. The list of findings and recommendations must clearly identify qualitative benefits. Additionally, state the associated greenhouse gas emissions impact related to the implementation of each energy-saving recommendation (in tons of CO₂ emissions avoided). Coordinate with the Installation Energy Manager for local greenhouse gas conversion factors to utilize; in the absence of specific direction from the Installation Energy Manager, utilize the regional conversion factors published on the U.S. Environmental Protection Agency's Avoided Emissions and Generation Tool (AVERT) website (<https://www.epa.gov/avert/avoided-emission-rates-generated-avert>).

5-2.7 Investigation Report Portion of EBCx Report.

Develop and add to the EBCx Report the Investigation Report portion which documents the findings and results of the Investigation Phase activities. The minimum content requirements for the Investigation Report portion of the EBCx Report are stated in ASHRAE 0.2, Investigation Phase section titled "Update EBCx Report with Investigation Report". This same section in ASHRAE 1.2 identifies information required for HVAC systems. Provide the information outlined in ASHRAE 0.2 for the building systems included in the EBCx scope.

5-2.8 Recommendations and Plan Adjustments.

Conduct a meeting to present the recommendations resulting from the Investigation Phase. Based on these discussions, make adjustments based on the most likely means of implementing the recommendations. For example, at an installation with sufficient resources and access to contracting mechanisms to implement specific types of repairs or upgrades, those recommendations could be prioritized for early completion and other recommendations deferred to a later timeframe. These deferred recommendations could be implemented as a capital project involving similar upgrades at other buildings.

Recommendations may be prioritized for early implementation based on the following parameters, from highest to lowest priority:

- Life safety or code compliance issue that requires immediate action (note: safety evaluations are not included in the scope of standard EBCx efforts, but identify safety issues discovered in the normal course of EBCx activities in the corrective actions list; examples include electrical boxes with exposed faceplates, exposed wiring, and obvious fall hazards).
- Deferred maintenance issue with easy implementation
- No cost to implement
- Common repair/adjustment through installation work order or service contract

- Corrective action that enhances resiliency of a mission critical building (such as an inoperable backup power generation system), or reduces the risk of a building being able to support its' mission
- Corrective action that provides quality of life improvement (such as restoring operations of the HVAC system to provide proper occupant comfort or indoor environmental quality)
- Capital improvement project (requires design and construction) with high energy savings, low cost, or short payback period
- Capital improvement project with higher cost or extended payback period

5-2.9 Government Review and Decision to Proceed.

Government representatives will review the Investigation Phase deliverables to determine if the activities are complete and they concur with the planned approach for proceeding into the Implementation Phase. Review comments are submitted to the Cx Provider and submittals are revised and re-submitted as necessary.

When a recommendation involves design and construction efforts such as replacement of an entire building system, these are not performed as part of EBCx efforts but follow the Government's design process. Follow-on commissioning efforts to verify design and performance of new construction or renovation projects will then follow the requirements of UFC 1-200-02 and related UFGS guide specifications.

5-3 INVESTIGATION PHASE DELIVERABLES.

The Investigation Phase deliverables consist of the following:

- Updated EBCx Plan
- Updated EBCx Report, including the Investigation Report

CHAPTER 6 IMPLEMENTATION PHASE

6-1 OBJECTIVES.

During the Implementation Phase, the Government decides which Investigation Phase recommendations to implement and how they will be accomplished. The selected recommendations are implemented and evaluated to verify they achieve the expected benefits and satisfy the Current Facility Requirements (CFR). The objectives of the Implementation Phase are to execute the recommendations selected from the Investigation Phase, verify performance meets the CFR, and report the results of implementation. It is important to emphasize that the main benefits of EBCx, such as achieving energy savings and optimizing system performance, are not realized until corrective actions are implemented.

The Assessment, Investigation, and Implementation Phases are typically iterative processes. If during investigation it is found that a repair can be easily made, or a change/repair is required to complete the investigation, this item can be implemented during the Investigation Phase. An iterative implementation might occur when a repair needs to take place before the system can be fully investigated or when changes made need verifying and modifying multiple times before the targeted results are achieved. This phase concludes with the verification of the system's performance and the updating of the Systems Manuals.

6-2 IMPLEMENTATION PHASE STEPS.

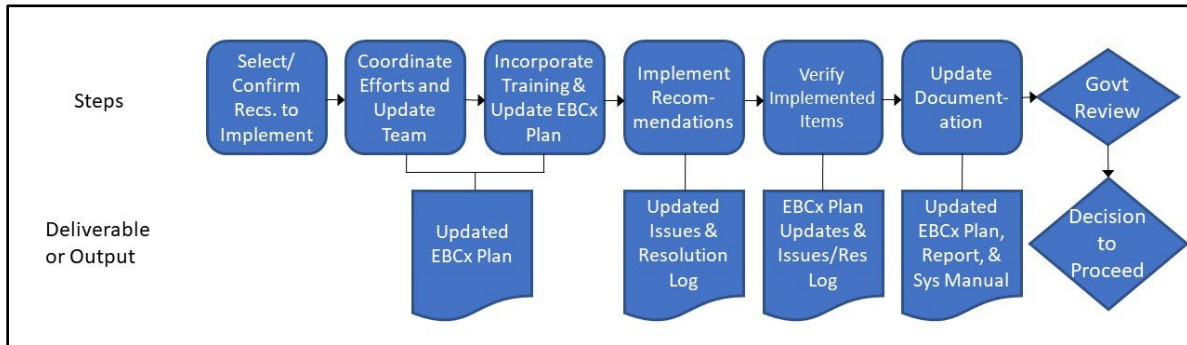
Recommendations from the Investigation Phase can be grouped into Implementation Phase packages completed through different execution routes. Depending on their complexity and cost, these can be executed through installation public works resources, installation service contracts, or if extensive and costly, may require some level of design and construction procurement. Thus, the Implementation Phase involves oversight of construction or service contract work in the building(s). The goals of the Implementation Phase are to select the most beneficial recommendations to achieving the established goals and objectives of the EBCx project, select the execution route, implement the selected measures, and verify or performance test that these measures achieve the expected benefits. The Implementation and Hand-off Phases are conducted by the same project delivery team whether it is an in-house or contracted group.

Implementation Phase steps are as follows:

- a. Select/Confirm recommendations to implement
- b. Coordinate implementation
- c. Update EBCx Team
- d. Incorporate informal training
- e. Update EBCx Plan

- f. Implement recommendations
- g. Verify completed recommendations and performance
- h. Update EBCx documentation
- i. Obtain Government review and decision to proceed

Figure 6-1 Implementation Phase Process and Deliverables/Outputs



6-2.1 Implementation Recommendations Selection/Confirmation.

This step involves identifying those improvements planned for the Implementation Phase and others deferred with a timetable for planned implementation as capital improvement projects. The ultimate goal of this phase is having the systems perform efficiently to meet the CFR. Involve the O&M staff in the implementation decision process. At the completion of the prior Investigation Phase, a meeting is held to review recommendations and set priorities for implementation based on the installation resources and contracting mechanisms available. The Implementation Phase then begins with reviewing these priorities and timeframes and confirming the recommendations that were selected for implementation.

6-2.2 Implementation Coordination.

The Cx Provider assists with coordinating the completion of the selected recommendations. For recommendations that can be handled through installation resources or service contracts, or through a modification to the EBCx contract, the Cx Provider acts as a third-party commissioning resource to ensure the resulting improvements meet the CFR (provided if Implementation Phase services are included in the Cx Provider's scope of work).

Recommendations from EBCx efforts requiring involvement of design and construction are typically handled as projects separate from the EBCx process. However, these projects require third-party commissioning efforts in accordance with UFGS 01 91 00.15 BUILDING COMMISSIONING.

6-2.3 Updated EBCx Team.

The EBCx team members for the Implementation Phase typically change based on the recommendations planned for implementation. The team may include building operations staff, installation O&M personnel, subcontractors, system vendors, or other specialists contracted directly to the Government or to the Cx Provider.

6-2.4 Informal Training.

The Cx Provider coordinates the Implementation Phase to allow for involvement in implementation and verification testing by the installation or building O&M staff (depending on which party is responsible for maintaining the system). This involvement serves as informal hands-on training for operating and maintaining the systems after the improvements are in place. This involvement also establishes an understanding of the expected system performance and aids in identifying performance degradation and ensuring extended equipment life. The level of involvement depends on the types of recommendations implemented and the methods chosen for implementation (contracted vs. in-house implementation).

6-2.5 Updated EBCx Plan.

This step involves developing the portions of the EBCx Plan associated with the Implementation Phase. The EBCx Plan portions developed or updated in this phase are as follows:

- Implementation Plan
- Implementation Verification Plan
- Updated Training Plan
- Updated Measurement and Verification (M&V) Plan

6-2.5.1 Implementation Plan.

Develop an Implementation Plan containing the detailed roles and responsibilities of EBCx team members, including identification of new team members. Include a communication plan for the new team structure. In addition, incorporate any necessary Plan changes to the execution process based on updates to local resource availability conveyed from the Government to the Cx Provider. Also include the details of the planned implementation of recommendations. Submit to the Government for review and acceptance. Once the Implementation Plan is accepted by the Government, implementation activities can be performed.

For each recommendation accepted by the Government for implementation, the Implementation Plan includes the following information:

- a. EBCx team members involved in the implementation and their roles and responsibilities.

- b. Planned schedule of implementation as coordinated with occupants, building security, custodians, and utility services. Clearly communicate and coordinate any operational impacts including outages and shutdowns.
- c. Detailed scope of work, including implementation methods, work required for sustained performance improvement, and verification procedures with roles/responsibilities. Implementations involving HVAC systems must include additional scope actions as outlined in ASHRAE 1.2, Implementation Phase section titled “Create Implementation Plan”

6-2.5.2 Implementation Verification Plan.

Update the EBCx Plan to include an Implementation Verification Plan. This outlines the detailed implementation verification tests and physical inspection procedures, as well as forms and checklists utilized for each selected recommendation. These tests and inspections represent those required to ensure that corrections and improvements were successfully implemented such that systems meet the CFR. Submit the Plan to the Government for review and acceptance. Once the Implementation Verification Plan is accepted by the Government, verification activities can be performed.

The Implementation Verification Plan includes the following information:

- a. Roles and responsibilities of EBCx team members, including new verification specialists.
- b. Verification tests and inspection procedures are required to ensure that implemented recommendations are installed and functioning in accordance with the CFR. Verification Plans for implementations involving HVAC systems must follow ASHRAE 1.2, Implementation Phase section titled “Develop Implementation Verification Plan”. Plans for other building systems must include similar information, with tests and inspections following the standards for those systems as outlined in Chapter 5 of this document.

6-2.5.3 Updated Training Plan.

Update or further develop the formal Training Plan developed in prior phases to include necessary changes based on Implementation Phase activities. Ensure the training addresses the implemented recommendations and changes to the operating procedures.

6-2.5.4 Updated Measurement and Verification (M&V) Plan.

Update the M&V Plan based on the known scope of work for recommendations planned for implementation. While the Implementation Verification Plan included the test and inspection procedures required for verification of the implemented recommendation, this updated M&V Plan includes the details for both baseline and post-implementation performance period testing required for quantifying the performance and achieved benefits of the process. Where specific M&V protocols are required, include the specific

means and methods necessary to comply with the requirements of the chosen protocol. Submit to the Government for review and acceptance. Once the updated M&V Plan is accepted by the Government, implementation activities can be performed.

6-2.6 Recommendations Implementation.

The Cx Provider implements those recommendations selected and within their scope of work. When recommendations are being performed by resources not under the Cx Provider's contract, the Provider serves as a third-party to verify proper implementation such that CFR are achieved. Implementation activities by the Cx Provider include:

- Verifying design and submittals related to recommendations
- Conduct an implementation kick-off meeting
- Conduct site visits for verification
- Update Issues and Resolution Log

The minimum requirements for the Cx Provider during implementation are outlined in ASHRAE 0.2, Implementation Phase section titled "Implement Recommendations". Implementations involving HVAC systems must follow ASHRAE 1.2 Implementation Phase section titled "Implement Recommendations" and subsections; similar actions are required for the other systems included in the scope of work.

6-2.7 Completed Recommendations and Performance Verification.

Once installation is complete, the Cx Provider tests and inspects the completed recommendations to confirm the CFR are achieved; tests and inspections are conducted in accordance with the accepted EBCx Plan and Implementation Verification Plan. Document verification tests and physical inspections as outlined in the EBCx Plan, including tests and physical inspection data records, capture test data, observations, and M&V data. ASHRAE 1.2 Implementation Phase section titled "Verify Completed Recommendations" includes requirements specific to HVAC systems, including situations when deferred testing of systems may be necessary.

6-2.8 Documentation.

Develop or update the following documentation during the Implementation Phase:

- Update EBCx Plan on completion of tests
- Update EBCx Report to include the Implementation Report
- Update Systems Manual
- Update CFR (in EBCx Report)
- Update list of findings and recommendations (in EBCx Report)
- Test and inspection documentation (in EBCx Report)

- Update Issues and Resolution Log (in EBCx Report)
- Site visit records (in EBCx Report)
- Verification documentation (in EBCx Report)
- M&V documentation (in EBCx Report)
- Training documentation (in EBCx Report)

The minimum Implementation Phase documentation requirements are outlined in ASHRAE 0.2, Implementation Phase section titled “Update the EBCx Documentation”.

6-2.9 Government Review and Decision to Proceed.

Government representatives will review the Implementation Phase deliverables to determine if the activities were completed. The EBCx Plan and EBCx Report sections for this Phase are initially developed by the Cx Provider and submitted to the Government for review and acceptance. Review comments are submitted to the Cx Provider and submittals are revised and re-submitted as necessary. Once the EBCx Plan and EBCx Report sections for this Phase are accepted by the Government, Hand-off Phase activities may proceed.

6-3 IMPLEMENTATION PHASE DELIVERABLES.

The Implementation Phase deliverables consist of the following:

- Updated EBCx Plan
- Updated EBCx Report, including the Implementation Report
- Updated Systems Manual materials

CHAPTER 7 HAND-OFF PHASE

7-1 OBJECTIVES.

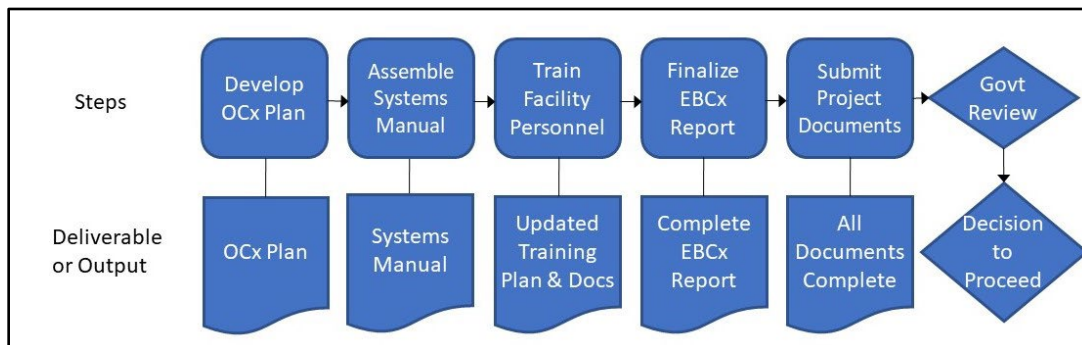
The Hand-off Phase represents the transition between the EBCx Team and the personnel responsible for operating and maintaining the systems. The goals are to provide the O&M team with the information, training, and procedures to ensure persistence of benefits. While many phases of EBCx may be independently performed by in-house or contractor teams, the Implementation and Hand-off of individual upgrade measures must be conducted by the same project delivery team whether it is an in-house or contracted group. During the Hand-Off Phase, the EBCx Team works to ensure the required documentation in the EBCx Report has been completed and is aligned with the EBCx Program (if one exists) and the EBCx Plan. This phase includes the development of the Ongoing Commissioning (OCx) Plan, the finalizing of the required systems documentation, and the submittal of completed deliverables. The objectives of the Hand-Off Phase are to provide the completed documents from the Cx Provider to the Government and provide training to the Government's personnel.

7-2 HAND-OFF PHASE STEPS.

Hand-Off Phase steps are as follows:

- a. Develop OCx Plan
- b. Assemble Systems Manual
- c. Train building personnel
- d. Finalize EBCx Report
- e. Provide project documents to Government
- f. Obtain Government review and decision to proceed

Figure 7-1 Hand-off Phase Process and Deliverables/Outputs



7-2.1 OCx Plan.

The OCx Plan documents how the building performance will be monitored going forward, what systems are included, what parameters are tracked, and how identified issues are corrected. It is most common for the Government to be responsible for ongoing commissioning activities, either utilizing installation maintenance personnel or installation support contracts. Develop the OCx Plan based on the knowledge of which resources will be utilized. The minimum content required in the OCx Plan is outlined in ASHRAE 0.2, Hand-off Phase section titled “Develop OCx Plan”.

7-2.2 Systems Manual.

Assemble the Systems Manual to incorporate changes to assemblies and systems that occurred during EBCx activities. Also incorporate documentation generated during and after the Implementation Phase into the Systems Manual. Update the Facility Guide, a component of the Systems Manual, to reflect changes to assemblies and systems. Add training documentation to the Systems Manual as training is performed. A comprehensive list of requirements for the Systems Manual is outlined in ASHRAE 0.2, Assessment Phase section titled “Establish the Systems Manual Outline”. Annex M of ASHRAE 0.2 provides an example outline of a Systems Manual.

7-2.3 Building Personnel Training.

Train building personnel based on the Training Plan developed as a part of the EBCx Plan. Training is most effective when consisting of a combination of classroom style and in-the-field type instruction. Training sessions are separated into topics targeted for building staff and O&M personnel. Refer to ASHRAE 0.2, Hand-off Phase section titled “Train Facility Personnel” for procedures and the training topics required for each personnel group.

7-2.4 Final EBCx Report.

Update the EBCx Report to reflect necessary changes to the EBCx Program Plan and OCx Plan. Update the EBCx Report to include the final training documentation and verification.

7-2.5 Government Review and Decision to Proceed.

Government representatives will review the Hand-Off Phase deliverables to determine if the Hand-Off Phase activities are complete and they concur with the planned approach for proceeding into the Ongoing Commissioning Phase (if the EBCx Contract includes the OCx Phase). Review comments are submitted to the Cx Provider and submittals are revised and re-submitted as necessary.

7-3 HAND-OFF PHASE DELIVERABLES.

The Hand-Off Phase deliverables consist of the following:

- Updated EBCx Report
- Systems Manual, including the Facility Guide
- OCx Plan

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CHAPTER 8 ONGOING COMMISSIONING PHASE

8-1 OBJECTIVES.

Whether this phase is included in the initial EBCx contract is resource-dependent. The Ongoing Commissioning (OCx) phase is typically conducted with separate resources from the EBCx Team involved in prior phases, either utilizing installation maintenance resources or contracted through installation support contracts.

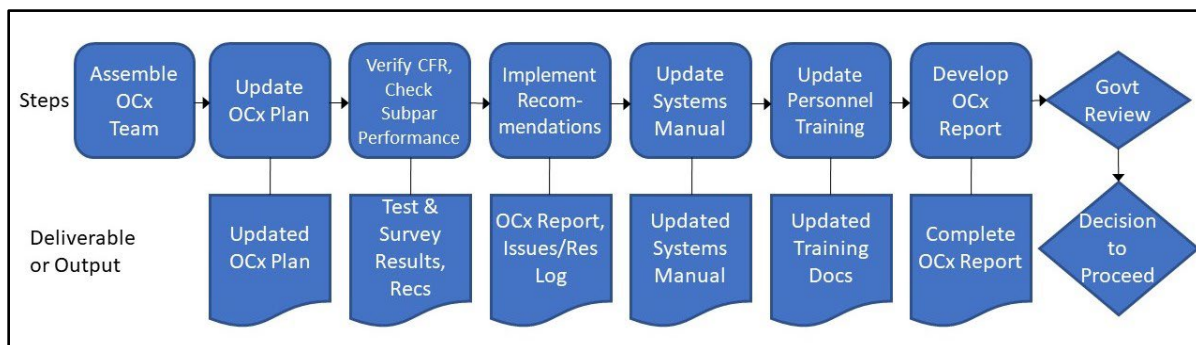
The OCx Phase is a program that consists of Cx Process activities that repeat regularly throughout the life of the building subsequent to the Hand-Off Phase. An OCx program repeats the EBCx activities on a scheduled, periodic basis to ensure the systems are continuously evaluated against the updated CFR. This phase is ongoing and involves developing an OCx Plan, continuously verifying the achievement of CFR's, and updating Systems Manuals and personnel training as needed. The overall objective of the OCx Program is to ensure that the benefits obtained from the EBCx Plan and other building improvements are sustained over time and improved if possible.

8-2 ONGOING COMMISSIONING PHASE STEPS.

Ongoing Commissioning Phase steps are as follows:

- a. Assemble the OCx Team
- b. Update the OCx Plan
- c. Verify achievement of CFR
- d. Investigate unacceptable performance or outcome
- e. Implement recommendations
- f. Update Systems Manual
- g. Update building personnel training
- h. Develop OCx Report
- i. Obtain Government review

Figure 8-1 OCx Phase Process and Deliverables/Outputs



8-2.1 OCx Team.

The OCx Phase tasks may be performed in-house or contracted utilizing a service or Indefinite Delivery Indefinite Quantity (IDIQ) contract. It is most common for the Government to be responsible for OCx activities, either utilizing installation maintenance personnel or installation support contracts. The make-up of the OCx Team varies based on which building systems require ongoing commissioning. The Government must identify a person with clear responsibility for ensuring the OCx efforts are carried out on the building systems included in the scope and take place at the required intervals to ensure sustained optimal performance of the systems.

8-2.2 Updated OCx Plan.

Update the OCx plan as developed in the Hand-off Phase with the knowledge of the resources planned for these efforts. OCx Plan updates are made to ensure parameters which require monitoring are defined along with metrics for determining compliance with the CFR. The minimum content required in the OCx Plan is outlined in ASHRAE 0.2, Hand-off Phase section titled “Develop OCx Plan”. OCx Plan updates include:

- Review scope of OCx activities, including determining that assigned resources have the availability and capabilities needed for each activity.
- Ensure frequency of OCx activities are clearly defined and reviewed by the OCx Team.
- Clearly define remaining scope items from the EBCx Report, including deferred inspections/testing and recommendations that have not yet been implemented.

8-2.3 CFR Verification.

The initial iteration of the OCx process includes verifying that the building and system performance is acceptable to the Government, as defined during Implementation and Hand-off Phases, is still being achieved and is correctly defined. Sustaining this performance becomes the primary focus of the ongoing OCx Program and can be demonstrated by defining, tracking, and evaluating various aspects of building condition or performance, such as operations, maintenance procedures, and occupant/user satisfaction and needs. Thus, these OCx Program activities involve monitoring the actual condition or performance of the defined CFR parameters and providing feedback to the OCx Team of deviations that require corrective action.

The OCx Team may conduct periodic workshops to update information in the CFR to identify improvement opportunities and select the appropriate corrective actions. To gain feedback, the OCx Team may also conduct periodic interviews with O&M personnel and building occupant/user surveys. These OCx efforts seek to measure the current building performance against the CFR with the goal of sustaining the improvements gained through the EBCx process.

8-2.4 Unacceptable Performance Investigation.

Whenever the OCx process discovers significant negative deviations from the intended CFR baseline or parameters, the cause of the performance or condition degradation must be identified to specify a solution. This requires condition assessment, testing, and analysis of the results to determine the extent of the subpar performance or degree of deviation from desired results. The OCx Team follows the same activities as outlined in the Assessment and Investigation Phases of this document, including on-site detailed inspections and performance testing of the systems and assemblies.

Once the issue is confirmed and the appropriate corrective actions are identified, enter this information on the Issues and Resolution Log, including the estimated costs and expected resulting benefits. Similar to the approach for the EBCx Implementation Phase, include methods in the recommendations to maintain the improvements made and benefits realized.

8-2.5 Recommendations/Corrective Action Implementation.

The OCx Team develops a written plan for implementing the recommendations, including planned schedules and responsible parties. Clearly identify corrective actions which require outages or building operations impacts. Following coordination with the building manager and building occupants, implement the accepted recommendations in accordance with that plan. Upon completion of the corrective action, verify that the expected improvements have been achieved. Document lessons learned to prevent a recurrence of the issue, develop a cost-benefit analysis, and include these in the OCx Report.

Bring to the attention of the Building Manager issues, especially those related to safety, security, health, or operational issues, that can be easily remedied and do not require further evaluation (will obviously not adversely impact other systems). Those Corrective actions that do not incur costs and provide immediate payback can be implemented during the OCx process; however, do not implement corrective actions without coordinating with maintenance staff responsible for upkeep on the building due to the possibility of creating unintended adverse issues (for example, opening a valve may improve the operation of the mechanical system, but the maintenance staff may have closed the valve temporarily until repairs can be performed on a system leak). For minor improvements that require installation maintenance staff involvement, coordinate with installation personnel such that a work order is submitted for correcting these issues. Document and include in both the OCx Report and the Issues and Resolution Log these immediately implemented modifications and corrective actions, along with their projected benefits.

8-2.6 Updated Systems Manual.

Review the building Systems Manual at regular intervals and make updates to ensure information is current. Update the Systems Manual with key performance parameters and building operating procedures whenever they are changed. Establish monitoring

procedures to compare building performance against the baseline at frequent intervals to ensure performance improvements are maintained. In addition, revise the Systems Manual when changes in occupancy, use, or renovations require changes to the CFR.

8-2.7 Updated Building Personnel Training.

Include in the OCx Program updated or refresher training of operations and maintenance personnel at regular intervals to ensure the procedures required to maintain building performance are followed to meet the CFR and ensure persistence of benefits. Prior training sessions may require updating in the case of building/system or operational changes. Additionally, ensure training addresses implemented recommendations, lessons-learned, and changes to the operating procedures.

8-2.8 OCx Report.

Develop and update the OCx Report at regular intervals to document the performance of the building/systems and the benefits/results of the OCx efforts. The OCx Report must contain, at a minimum, the content outlined in ASHRAE 0.2, OCx Phase section titled "Write/Deliver OCx Report".

8-2.9 Government Review.

Government representatives will review the OCx Phase deliverables to determine if activities are complete. Review and acceptance of the OCx Plan takes place before the EBCx efforts proceed further into the OCx Phase (note that the Government is most often responsible for the OCx Phase). Review comments are submitted to the Cx Provider and submittals are revised and re-submitted as necessary.

8-3 ONGOING COMMISSIONING PHASE DELIVERABLES.

The OCx Phase deliverables consist of the following:

- Updated OCx Plan
- Updated CFR
- Updated Systems Manual
- OCx Report (submitted periodically)

APPENDIX A BEST PRACTICES

A-1 EBCx TEMPLATES.

The following templates are available for use and should be utilized to ensure efforts are consistent and comprehensive.

A-1.1 Industry Templates

The following templates or formats are available for use from industry resources and can be utilized for EBCx efforts:

- EBCx Program Plan: Annex H of ASHRAE 0.2 includes planning templates for multiple-building EBCx efforts.
- EBCx Plan: sections are outlined in ASHRAE 0.2, Assessment Phase section titled “Develop the EBCx Plan”. Annex G attachments to ASHRAE 0.2 contains example EBCx Plans.
- EBCx Report: Annex L attachments to ASHRAE 0.2 contains example EBCx Reports.
- EBCx building occupant questionnaire form – can utilize the template developed by the Army and posted on the WBDG website (<https://www.wbdg.org/building-commissioning/additional-commissioning-resources/army-templates>).

A-1.2 Navy and Marine Corps Templates

The following templates have been developed specifically for Navy and Marine Corps EBCx efforts:

- Navy and Marine Corps EBCx building selection and scoring or ranking
- Savings calculations for repair, replacement or maintenance items
- Navy and Marine Corps EBCx contractor support contract scope of work

These are available on the Whole Building Design Guide (WBDG) website resource page for “Building Commissioning” under “Additional Commissioning Resources” (<https://www.wbdg.org/building-commissioning/additional-commissioning-resources>).

A-2 BEST PRACTICES FOR ENHANCED RESILIENCY.

Building resiliency is defined in this document as the ability to provide for mission in the face of all hazards or recover operations quickly after a disruption in operation (such as having known power reliability issues, HVAC systems with difficulties operating in expected extreme hot or cold conditions, or building enclosures in occupied spaces with gaps which allow external air flows in extreme conditions). Where the EBCx scope includes assessment for building resiliency, efforts should include the following systems issues at a minimum.

A-2.1 Mechanical Systems.

Assess mechanical systems for issues such as the following:

- HVAC systems with difficulties operating in expected extreme hot or cold conditions
- Ensuring controls are designed for systems to return to operation following non-normal operating conditions or power outage
- Verifying that support systems operate in non-normal operations (such as chillers or boilers not operating to support air handler requiring chilled or hot water)
- Other mechanical, controls or plumbing systems issues that are adversely impacting the occupant's ability to perform their mission

A-2.2 Electrical Systems.

Assess electrical systems for issues such as the following:

- Testing backup generators, including “black start”
- Load bank testing
- Power monitoring (to determine the presence of, or need for, surge protection to address “dirty power” issues)
- Assessing that critical issues for mission are on backup power

A-2.3 Building Enclosure Systems.

Assess building enclosure systems for issues such as the following:

- Building enclosures in occupied spaces with gaps which allow external air flows in extreme weather conditions
- Leaks from roofs or exterior walls affecting use of occupied spaces

A-3 ADDITIONAL RESOURCES.

The following organizations have developed additional resources such as templates and other guidelines for conducting EBCx efforts:

- ASHRAE (www.ashrae.org)
- BCxA (www.bcxa.org)
- NEBB (www.nebb.org)

A-4 LESSONS LEARNED.

The following are lessons learned which can provide benefits in ensuring a comprehensive evaluation of systems and lead to optimized performance of building systems.

A-4.1 Hand-off Phase Best Practices.

The following have shown to provide improved training results and retention of information, as well as improving future EBCx efforts through incorporating lessons learned.

A-4.1.1 Training Effectiveness Verification.

Verify the effectiveness of training within a reasonable period of the completion of each training program. The intent of this testing is to verify that the trainees were provided with pertinent information and can demonstrate their ability to operate and maintain the building to meet the CFR and ensure persistence of benefits. Example training verification methodologies are provided in Annex L5 of ASHRAE 0.2.

A-4.1.2 Lessons-Learned Workshop.

Conduct a lessons-learned workshop after the completion of the training and the update of the Systems Manual. The intent of the discussion is to determine improvements in both the EBCx process and building operations. These lessons learned are recorded in the EBCx Report, especially when the EBCx efforts may have corrected issues resulting from an action during the planning, design, or construction phases – recording this information allows the EBCx Report to serve as a feedback loop to allow for avoiding future deficiencies in design and construction.

Attendees of the lessons-learned workshop include the key participants and stakeholders of the EBCx process. Example approaches to the lessons-learned workshop are provided in Annex L6 of ASHRAE 0.2.

A-4.2 BCxA Existing Building Commissioning Best Practices.

The BCxA document titled “Existing Building Commissioning Best Practices” contains content resulting from lessons learned on conducting EBCx efforts. It is recommended that EBCx teams utilize it as a resource when conducting EBCx on Government buildings.

A-4.3 ANSI/NEBB Standard S120.

ANSI/NEBB S120, Appendix H, includes lessons learned on areas that commonly present issues on a typical EBCx project. It is recommended that EBCx teams review these areas in projects.

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APPENDIX B GLOSSARY

B-1 ACRONYMS.

AABC	Associated Air Balancing Council
ACG	AABC Commissioning Group
AEE	Association of Energy Engineers
AFCEC	Air Force Civil Engineer Center
AHU	Air Handling Unit
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BAS	Building Automation System
BCCB	Building Commissioning Certification Board
BCxA	Building Commissioning Association
BIA	Bilateral Infrastructure Agreement
BMS	Building Management System
CBECS	Commercial Buildings Energy Consumption Survey
CCR	Criteria Change Request
CCTV	Closed Circuit Television
CFR	Current Facility Requirements
CI	Condition Index
CP	Certified Professional
CV	Constant Volume
CW	Chilled Water
Cx	Commissioning
DDC	Direct Digital Control
DoD	Department of Defense
EBCx	Existing Building Commissioning

ECM	Energy Conservation Measure
EISA	Energy Independence and Security Act
ESCO	Energy Services Contractor
EUI	Energy Use Index
FC	Facilities Criteria
FCU	Fan Coil Unit
FEMP	Federal Energy Management Program
FPT	Functional Performance Test
FRCS	Facility-Related Control Systems
HQUSACE	Headquarters, U.S. Army Corps of Engineers
HNFA	Host Nation Funded Construction Agreements
HVAC	Heating, Ventilating and Air-Conditioning
HVAC&R	Heating, Ventilating, Air-Conditioning and Refrigerating
HW	Hot Water
IDIQ	Indefinite Delivery Indefinite Quantity
IEC	International Electrotechnical Commission
IECC	International Energy Conservation Code
IEM	Installation Energy Manager/Management
IFM	Installation Facilities Management
IFMA	International Facility Management Association
IIBEC	International Institute of Building Enclosure Professionals
IT	Information Technology
LCCA	Life Cycle Cost Analysis
LED	Light Emitting Diode
M&V	Measurement and Verification

NAVFAC	Naval Facilities Engineering Systems Command
NEBB	National Environmental Balancing Bureau
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NIST	National Institute of Standards and Technology
O&M	Operations and Maintenance
OCx	Ongoing Commissioning
OPR	Owner's Project Requirements
PM	Preventive Maintenance
RCx	Retrocommissioning
REPM	Regional Energy Program Manager
RFP	Request for Proposal
SOFA	Status of Forces Agreements
TAB	Testing, Adjusting and Balancing
TV	Television
UFC	Unified Facilities Criteria
UFGS	Unified Facilities Guide Specification
U.S.	United States
VAV	Variable Air Volume

B-2 DEFINITION OF TERMS.

Except where indicated otherwise, definitions below match those used in ASHRAE documents for Commissioning and Existing Building Commissioning.

Acceptance: a formal action taken by a person with appropriate authority (which may or may not be contractually defined) to declare that some aspect of the project meets defined requirements, thus permitting subsequent activities to proceed.

Commissioning (Cx): a quality-focused process for enhancing the delivery of a project. The process focuses on verifying and documenting that the facility and all of its systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet the Owner's Project Requirements (OPR).

Current Facility Requirements (CFR): a written document in which the Owner details the current functional requirements of a facility and the expectations of how it should be used and operated. This may include goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information to meet the requirements of occupants, users, and Owner(s) of the facility.

Existing Building Commissioning (EBCx) Plan: a document that outlines the organization, goals, schedule, allocation of resources, and documentation requirements of the EBCx Process.

Existing Building Commissioning (EBCx) Process: a quality-focused process for attaining the CFR of an existing building and its systems and assemblies. The process focuses on planning, investigating, implementing, verifying, and documenting that the facility and its systems and assemblies are operated and maintained to meet the CFR, with a program in place to maintain the enhancements for the remaining life of the facility. Existing Building Commissioning includes both Recommissioning and Retrocommissioning.

Existing Building Commissioning (EBCx) Team: individuals who through coordinated actions are responsible for implementing the EBCx Process.

Facility guide (FG): a basic building systems description and operating plan with general procedures and confirmed facility operating conditions, setpoints, schedules, and operating procedures to properly operate the facility.

Functional test procedures (FPT): a written collection of tests that, when executed in the test process, allow verification of the performance of a system or assembly.

Issues and Resolution Log: a formal and ongoing record of problems or concerns and their resolution that have been raised by members of the Cx Team during the course of the Cx Process.

Measurement and Verification (M&V) Plan: a plan for gathering relevant data over time to evaluate performance and benefits. M&V Plan includes the details for both

baseline and post-implementation performance period testing required for quantifying the performance and achieved benefits of the process.

Ongoing Commissioning (OCx) Process: a continuation of the Cx Process after the Hand-Off Phase to verify that a facility continues to meet current and evolving CFR (OPR for new construction). OCx Process Activities occur throughout the life of the facility; some of these will be close to continuous in implementation and others will be either scheduled or unscheduled (as needed).

Recommissioning: an application of the Cx Process requirements to an existing facility or system that underwent the Cx Process during project delivery (see Existing-Building Commissioning [EBCx] Process).

Retrocommissioning: the Cx Process applied to an existing building or system that was not previously commissioned (see Existing Building Commissioning [EBCx] Process).

Simple Payback: as used in NIST Handbook 135, “simple payback” is a measure of the length of time required for the cumulative savings from a project to recover its initial investment cost and other accrued costs, without considering the time value of money.

Systems Manual: a system-focused composite document that includes the design and construction documentation, FG and operation manual, maintenance information, training information, Cx Process records, and additional information of use to the Owner during occupancy and operation.

Test procedure: a written protocol that defines methods, personnel, and expectations for tests conducted on components, equipment, assemblies, systems, and interfaces among systems.

Training Plan: a written document that details the expectations, schedule, budget, and deliverables of EBCx process activities related to training of project operations and maintenance personnel, users, and occupants.

Verification: the process by which specific documents, components, equipment, assemblies, systems, and interfaces among systems are confirmed to comply with the criteria described in the CFR.

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APPENDIX C REFERENCES

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

<https://www.ashrae.org/>

NOTE: Include all references Errata, except Errata for Addenda. Include Interpretations, except Interpretations for Addenda. Do not include Addenda.

ASHRAE 0.2, *Commissioning Process for Existing Systems and Assemblies*

ASHRAE 1.2, *Technical Requirements for the Commissioning Process for Existing HVAC&R Systems and Assemblies*

ANSI/ASHRAE/IES Standard 90.1 (ASHRAE 90.1), *Energy Standards for Buildings Except Low Rise Residential Buildings* (refer to UFC 1-200-02 for the version that applies)

AMERICAN SOCIETY OF TESTING AND MATERIALS (ASTM)

<https://www.astm.org/>

ASTM C1060, *Standard Practice for Thermographic Inspection of Insulation Installations in Envelope Cavities of Frame Buildings*

ASTM C1153, *Standard Practice for Location of Wet Insulation in Roofing Systems Using Infrared Imaging*

ASTM D8231, *Standard Practice for the Use of a Low Voltage Electronic Scanning System for Detecting and Locating Breaches in Roofing and Waterproofing Membranes*

ASTM E779, *Standard Test Method for Determining Air Leakage Rate by Fan Pressurization*

ASTM E1186, *Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems*

ASTM E1827, *Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door*

ASTM E2128, *Standard Guide for Evaluating Water Leakage of Building Walls*

BUILDING COMMISSIONING ASSOCIATION (BCxA)

<https://www.bcxa.org/>

BCxA, *Existing Building Commissioning Best Practices*

ENVIRONMENTAL PROTECTION AGENCY (EPA)

EISA 2007, *Energy Independence and Security Act*, 19 December 2007

<https://www.epa.gov/laws-regulations/summary-energy-independence-and-security-act>

INTERNATIONAL CODE COUNCIL (ICC)

<https://www.iccsafe.org/>

IECC, *International Energy Conservation Code, 2021*

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

<https://www.netaworld.org>

ANSI/NETA MTS, *Standard for Maintenance Testing Specifications for Electrical Power Equipment and Systems*

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

<https://www.iec.ch/homepage>

IEC 62446-1, *Photovoltaic (PV) Systems*

IEC 62040-3, *Uninterruptible Power Systems (UPS)*

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

<https://www.iso.org>

ISO 18251-1, *Non-destructive Testing – Infrared Thermography – Part 1: Characteristics of System and Equipment*

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

<https://www.nema.org/>

NEMA 410, *Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts*

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

<https://nebb.org/>

ANSI/NEBB S120, *Technical Retro-Commissioning of Existing Buildings*

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

<https://www.nfpa.org/>

NFPA 70, *National Electrical Code*

NFPA 70E, *Standard for Electrical Safety in the Workplace*

NFPA 110, *Standard for Emergency and Standby Power Systems*

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

<https://www.nist.gov/>

NIST Handbook 135, *Life Cycle Costing Manual for the Federal Energy Management Program*

NAVAL FACILITIES ENGINEERING SYSTEMS COMMAND (NAVFAC)

<https://www.wbdg.org/ffc/navy-navfac/p-publications>

P-602, 3 Pillars of Energy Security (Reliability, Resilience, & Efficiency)

UNIFIED FACILITIES CRITERIA

<https://www.wbdg.org/ffc/dod/unified-facilities-criteria-ufc>

UFC 1-200-01, *DoD Building Code*

UFC 1-200-02, *High Performance and Sustainable Building Requirements*

UFC 1-300-08, *Criteria for Transfer and Acceptance of DoD Real Property*

UFC 3-410-01, *Heating, Ventilating, and Air Conditioning Systems*

UFC 3-501-01, *Electrical Engineering*

UFC 3-540-07, *Operation and Maintenance (O&M): Generators*

UFC 3-740-05, *Construction Cost Estimating*

UFC 4-010-06, *Cybersecurity of Facility-Related Control Systems (FRCS)*

UNIFIED FACILITIES GUIDE SPECIFICATIONS

<https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs>

UFGS 01 91 00.15, *Building Commissioning*

UNITED STATES CODE

<http://uscode.house.gov>

10 USC 101(e), *Definitions, Facilities and Operations*

42 USC 8253, *Energy and water management requirements*

UNITED STATES GOVERNMENT POLICY

<https://science.house.gov/2020/12/energy-act-of-2020>

Energy Act of 2020