BCxA® Building Commissioning Association

ONGOING COMMISSIONING

BEST PRACTICES

This page intentionally left blank.

CONTENTS

Introduction

Ongoing Commissioning (OCx) is not new to the building industry. In the past it has commonly been used as a means to provide sustained performance from New and Existing Building Commissioning as well as an approach for applying technology-based solutions for optimizing building performance. As the commissioning industry continues to evolve — and as technology becomes more prolific in its ability to manage building performance data — OCx has likewise become a more common practice of commissioning providers. The Building Commissioning Association (BCxA) has identified the market and technical need for a set of Best Practices to guide the application and approach of OCx. The purpose is to provide further clarity for commissioning stakeholders, in order to educate and maintain the benchmark of standards for planning and implementing ongoing commissioning.

The methods and approach of OCx for sustaining building performance have a close correlation to other building performance services, including technology-based solutions, (e.g., monitoring-based commissioning that utilizes energy management and information systems) and in the sustaining performance phases of New and Existing Building Commissioning.

For clarification, OCx is differentiated from other services by those best practices as a specific process of monitoring, investigating, evaluating, and improving systems' performance to maintain the current functional requirements and performance standards of the built infrastructure. The distinction of OCx from other forms of commissioning lies in its application as the **continuing, sustaining process** of investigation, evaluation, monitoring, and implementation of facility performance measures over time, even as long as the life of the building.

OCx Best Practices are closely tied to New Construction Commissioning and Existing Building Commissioning (NCCx and EBCx), as it relates to sustaining building performance. In fact, implementing OCx might itself be regarded as a best practice for those commissioning services. For clarity, OCx Best Practices are implemented in conjunction with NCCx and EBCx Best Practices when the typical commissioning period for those particular commissioning services is over, generally one year in duration. This ensures that the commissioning stakeholders are implementing the additional detailed Best Practices, defined here, when the commissioning period is of sufficient length to warrant the additional focus and standards of an OCx-specific approach.

Relationship of OCx to Existing Building Commissioning (EBCx)
The close relationship between OCx and EBCx is evident. As technology plays a larger role in OCx and EBCx, continuous monitoring and evaluation of systems performance is increasingly commonplace. This document offers clarification for the appropriate definition in the overall approach to OCx, including starting the OCx process within the EBCx process or after NCCx.

Generally, OCx begins with the completion of EBCx, after the Current Facility Requirements (CFRs) were defined and the systems were tested and corrected to support the CFRs. TO ensure the ongoing sustained performance of the facility to meet the CFR requirements, it's appropriate *during* the EBCx process to start planning for an OCx process.

When considering timing and scale of a sustainable commissioning effort, if active commissioning of an existing building extends for less than about a year, then EBCx Best Practices generally provide the guidance necessary for this shorter duration of commissioning. This is completed in the Hand-Off Phase of EBCx or during a similar plan during the first year of occupancy in NCCx with the use of performance tracking. For longer-term sustained performance results, a formal OCx approach is utilized.

As Best Practices are applied, it is important to understand that OCx is a professional service that uses a variety of tools, technologies, and approaches for improving and sustaining building performance. The OCx process is not in itself a technology-specific solution for facilities.

In addition to the timeline of OCx Planning, which should occur within the NCCx and/or EBCx processes (depending on whether you're starting within an existing facility or following new construction, OCx often incorporates processes such as Monitoring-Based Commissioning (MBCx), including technology-specific Fault Detection and Diagnostics (FDD), Energy management and information systems (EMIS) and other performance tracking and analytics solutions, set up for which also occurs during the EBCx or NCCx process. It's important to distinguish that OCx is a process that is applied by a commissioning provider in collaboration with the building Owner, operators, and other stakeholders, while technology-centric tools are just that: tools that aid the process.

OCx can be applied to any number of facility types, sizes, and ages - using the existing facility technology available as well as implementing additional technology solutions to aid in data collection, management, analytics and monitoring. However, OCx is not limited only to facilities with existing building automation systems (BAS) or similar controls technology.

As an example, the process of applying a periodic regular review and verification of sustained facility performance for a building with pneumatic systems can be done with the application of the OCx Best Practices, without the express need of any additional monitoring or data collection tools. However, as is identified within the OCx Best Practices, data collection, monitoring, and analytics can provide significant value as tools supporting the OCx process. As such, the OCx Best Practices identify key stakeholders that aid in the design and implementation of supporting technology solutions and provide direction for the use of BAS and various other data sources in the OCx approach.

While the OCx process is applied to all facility performance aspects, including maintenance and comfort, energy performance is a key aspect of optimizing and sustaining performance of the facility. Specific to energy performance, the technology solution leveraged by OCx often includes the EMIS, including the Energy Information System (EIS) analytics at the meter level and FDD analytics at the systems level. Using an EMIS as part of the OCx project can significantly help with the ongoing tracking and evaluation of the facility performance as part of the OCx project because the visualization of data and identification of faults or opportunities for improved performance are automated through the software.

*This Best Practices document uses additional **sidebars** to identify how to implement and leverage technology solutions in the OCx project. These tools for OCx are "enablers." The Best Practices are not intended to imply that these technology solutions are required for the OCx approach to be successful, but when MBCx, FDD or EMIS technologies are available and within the budget, and staffing limitations of projects are of sufficient size, they are considered best practice.*

As facility technology continues to advance, including the increased use of MBCx-related tools, including EMIS and its subset, EIS, the OCx Best Practices will be reviewed and updated to ensure the process and methods remain current with the use of these tools.

BCxA Best Practices Portfolio

The Building Commissioning Association (BCxA) is composed of Owners, engineers, architects, contractors, commissioning providers and users of commissioning services in their day-to-day operations. Members represent a broad cross-section of interests and are associated with many sectors of the facilities and construction community.

As an organization dedicated to furthering our industry's understanding and maintaining the highest possible quality of building commissioning, the BCxA is committed to defining the Best Practices for Commissioning.

BCxA is implementing an evaluation strategy to ensure appropriate and effective evaluation of all commissioning standards and guidelines at all levels. Recognizing that each project might require a different approach depending on the circumstances, the BCxA emphasizes that the list of Best Practices does not indicate mandates.

To meet our commitment to remain the leading authority and clearinghouse for commissioning professional services, the BCxA Best Practices criteria were developed from diverse industry resources, input from experienced professional providers and vendors supporting OCx solutions, among others. Subsequent to finalizing this document, the public and members of the BCxA Board and Chapters were asked to comment and make suggestions.

This BCxA Best Practices document, therefore, presents the first-of-its-kind, practical contribution to the Building Commissioning profession as a whole. This report also draws extensively upon years of real-world experience by the authors, editors and reviewers as a result of managing a wide array of OCx projects. These Best Practices are intended to promote high quality, consistency, efficiency and flexibility in the OCx industry.

In conjunction with the New Construction and Existing Building Commissioning Best Practices, the following Best Practices for Ongoing Commissioning (OCx) are provided as a reference for commissioning providers and stakeholders throughout the building industry.

Suggestions from other related industry and commissioning organizations are invited.

Acknowledgments

The Building Commissioning Association (BCxA) is fortunate to have access to numerous commissioning and industry professionals who practice state-of-the-art building commissioning every day. We are grateful for their time and intense effort to bring this Ongoing Commissioning Best Practices update into being. These subject matter experts have authored, reviewed, edited, and built the Best Practices document for reference to our industry. The OCx Best Practices Subcommittee acknowledges the thoughtful and essential contributions made by members of BCxA, providing invaluable input and comment on the various drafts as we worked to complete this document. Their insight and vast experience in the field reinforce the building industry's recognition of Best Practices in commissioning. Thank you!

Content and Editorial: OCx Best Practices Subcommittee
Janelle Griffin, RTI International
Kelsey Leslie, Paladin Inc.
Jesse Sycuro, BGIS
Diana Bjornskov, Building Commissioning Association

Industry Contributors: Review and Commentary
Hannah Kramer, Lawrence Berkeley National Laboratory
Ian Meredith, Natural Resources Canada
Bruce Pitts, BCxA Professional Development Committee Chair

Editorial: BCxA Best Practices Committee
Karl Stum, Summit Building Engineering
Kent Barber, Keithly Barber Associates
Jim Feeney, Grumman/Butkus Associates
A.J. Kindya, Colliers
David Lewis, Clayco, Inc.
Jack Schirpke, Total Mechanical
Wade Berner, Massachusetts Institute of Technology

Editorial: Selected BCxA International Board of Directors

BCxA Staff Contributors
Liz Fischer, Executive Director
Sheri Adams, Member Relations Manager
Nicole Gardner, Marketing and Events Manager

Executive Summary

The term Best Practices generally refers to a procedure that has been shown by research and experience to produce optimal results and that is established or proposed as a standard suitable for widespread adoption. This document describes the current best practices approach to Ongoing Commissioning (OCx), identifies the steps and why they are best practices for continuous quality performance improvement across the building industry.

The OCx objective is to make the building systems perform in an integrated manner to meet the current facility requirements (CFRs), and Owner goals and objectives for the facility …over the long term.

Definition of Ongoing Commissioning (OCx)

Ongoing Commissioning is the means and process of investigation, evaluation, monitoring, and implementation of improvement measures related to facility performance on a continuous basis to maintain the built infrastructure to the performance standards of the Current Facility Requirements.

As a continuation of the Commissioning (Cx) Process typically implemented following NCCx or EBCx, OCx verifies that a facility continues to meet current and evolving CFR (or Owner's Project Requirements for new construction). Performance improvement process activities occur throughout the life of the facility; some of these are continuous or close to continuous in implementation (OCx), others are scheduled as needed (periodic EBCx).

Scope and Purpose of OCx

The scope of OCx includes existing buildings, systems and assemblies, which typically would be planned for/scoped/set up in the Occupancy and Operations Phase of NCCx or the Hand-Off Phase of EBCx. Where it has been confirmed through assessment that the existing building(s), systems and assemblies are performing at or near the performance levels of the CFR, OCx may be applied directly with or without previously having been commissioned.

Buildings not working well can still have the sustaining OCx process applied after FDD has identified issues and they have been updated/upgraded to meet the Owners' CFR. The scope of OCx may be limited to specific systems and assemblies, like energy-using equipment, or broadened to the whole building performance (e.g., comfort and temperature control, building enclosure, critical environment availability, industrial processes, and/or life safety system performance).

The purpose of OCx is to maintain and continuously improve building performance for:

1. Evolving CFRs due to change in facility use, system changes, and/or building renovations.
2. Energy use reduction/containment while maintaining environmental condition requirements.
3. Proactively identifying degradation in system performance for correction prior to occupant impact.
4. Proactively identifying degradation in system performance for correction prior to operational (maintenance) or efficiency impact.
5. Providing measurement and verification of energy savings and performance validation following facility and system updates.

OCx addresses these performance goals by following a specifically designed, complete, and methodical process. One step of that process introduces a corollary to the functional/system testing plan of the new construction and existing building commissioning processes—the **Diagnostic Plan**. The Diagnostic Plan is an outline version, or representation, of the regular commissioning activities that will be performed to satisfy the monitoring and evaluation goals required to meet the scope of the project.

Key process elements of OCx include the following, which provide the means to assess and manage building performance on an ongoing basis:

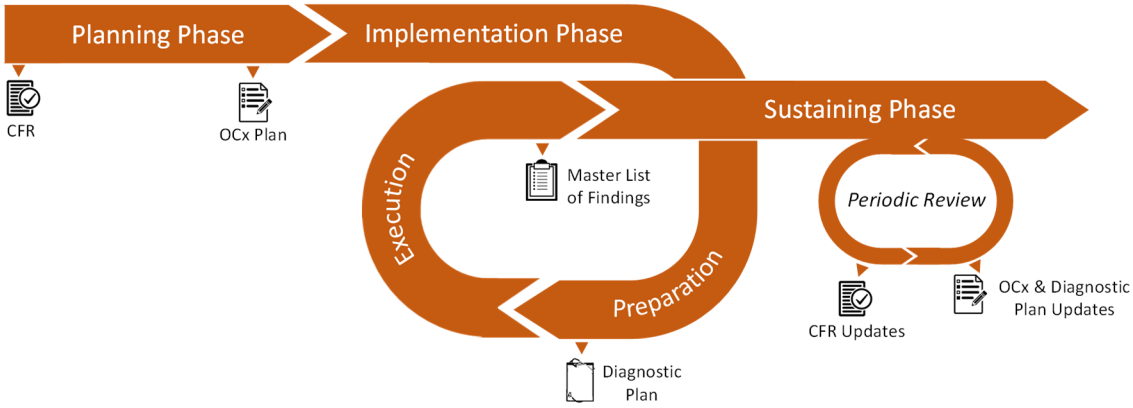
- Regularly updating the CFRs based on a schedule, or evolving facility and facility use changes
- Evaluating current facility and systems performance in alignment to the CFRs
- Physically monitoring system and assembly performance in comparison to CFRs
- Identifying performance trends with correction to system degradation
- Leveraging technology (and regularly checking that it's use is coordinated with the CFR) to enable performance monitoring and optimization of systems

Phases of OCx

OCx comprises the following sequential phases. Each phase is discussed in a separate section of this document.

1. **Planning**. Initial team formation, communication planning and facility condition assessment. Includes documenting Owner's goals and objectives (confirming performance criteria and/or indicators) to guide the OCx scope of work; updating CFRs; evaluating existing technology to identify (additional) metering and software requirements to enable the OCx process. An outcome of the Planning Phase is the OCx Plan that guides the implementation and ongoing sustainability for optimizing and maintaining facility performance.
2. **Implementation**. Implementation of people and technology as applicable to enable the OCx process. Includes preparation of stakeholders, documentation and processes; identification of performance findings in a Master List of Findings for correction; operating team coordination for integration into preventive maintenance planning, system operation, and ongoing system monitoring for transition of OCx to operating standards.
3. **Sustaining**. Means and methods to transition OCx monitoring and sustained building performance to building operator and Owner core responsibilities. Ongoing management of CFR changes for continuity of OCx process in response to changing building use and conditions.

Figure 1. Ongoing Commissioning Process



Planning Phase

Engage Commissioning Provider (CxP)
Define and Document Owner's OCx Goals and Objectives
Conduct Preliminary Cost Benefit Analysis
Identify and Form Multi-Disciplinary Team
Perform Condition Assessment, documenting preliminary Master List of Findings
Review Current Facility Requirements (CFR)
Conduct Gap Analysis of Existing Technology Infrastructure
Determine Technology Use and Design
Develop Steps for Implementation of Findings
Develop and Formalize OCx Plan

Implementation Phase

Preparation Sub-Phase
Engage OCx Team Selected During Planning
Create Diagnostic Plan
Align Data Monitoring with Diagnostic Plan
Implement Diagnostic Plan
Create or Update Facility Guide
Execution Sub-Phase
Coordinate Preventive Maintenance
Conduct Technical/Technology Application Training
Update, Prioritize Master List of Findings
Establish Communication/Coordination Methods and Procedures
Take Corrective Actions
Track Building Performance
Update OCx Plan

Sustaining Phase

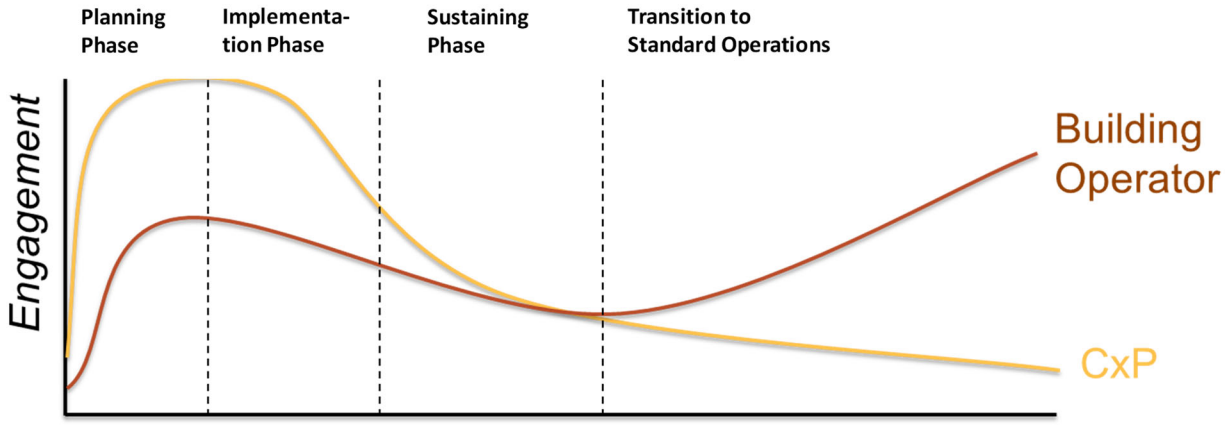
Implement Operating and Maintenance Procedures
Transition to Stable Operations
Monitor and Report Results

Independent Third-Party Commissioning Provider

As a Best Practice, it is advisable for most Owners to hire an independent third party to provide commissioning services that acts directly as the Owner's advocate as the Commissioning Provider (CxP). The CxP organizes and implements the OCx process, with the building Owner and operators being a critical part of the OCx team throughout the phases of OCx. As the OCx process moves through the Sustaining Phase, building operators further increase their engagement and take the lead on ongoing sustained performance management using the OCx process in the Sustaining Phase. Once fully transitioned to standard operations, the CxP's role usually becomes more periodic to support OCx process updates with changes to the CFR and applicable system changes.

Figure 2 below shows the evolution of third-party commissioning provider and building staff involvement associated with the phase-by-phase incremental delivery of OCx.

Figure 2. Third-party CxP and Building Operator Engagement by Phase



1 Planning Phase

When developing a plan for OCx (ideally within the NCCx or EBCx process unless OCx is developed as a stand-alone process) the objective of the Planning Phase is to confirm and clearly document the Owner's project goals and objectives; evaluate the applicability of OCx to the project; scope, design and plan for the applicable technology tool(s) to be implemented to support the project; and document the plan for OCx.

The Planning Phase includes these activities:

- Engaging a CxP
- Defining and Documenting Owner's OCx Goals and Objectives
- Conducting a Preliminary Cost Benefit Analysis
- Identifying and Forming a Multi-Disciplinary Team
- Performing Condition Assessment, documenting the preliminary Master List of Findings
- Review the Current Facility Requirements (CFR)
- Conducting a Gap Analysis for Existing Technology Infrastructure
- Determining Technology Use and Design
- Developing and Formalizing OCx Plan including
    - Project Management Plan
    - Change Management Plan

1.1 Engage a Commissioning Provider

1.1.1 Process

Use an RFQ/P Qualifications-Based Selection (QBS) procurement process to solicit a third-party commissioning provider to lead the project. The QBS process is a professional services best practice for evaluation, scoring, and selection mandated by U.S. Congress through the Brooks Act of 1972. For more information and methodology, refer to the *BCxA/APPA Building Commissioning Handbook, third edition, Appendix 1-1, "How to Hire a Commissioning Team."*

1.1.2 Qualifications

Best practice qualifications specific to an OCx project commissioning provider include:

1. Experience and expertise with the type of building, safety, security and occupancy the project entails, i.e., vertical market segment. Commercial office, healthcare, K-12, data centers and laboratories are all examples of vertical market segments for which the CxP's experience would be a key qualification. Higher education, while often considered as a single market segment, requires experience for the specific facility types involved in the project.
2. Relevant, documented experience with commissioning the current and expected assemblies, systems, and equipment in the building.
3. Experience with long-term planning, including preventive maintenance, monitoring and emergency planning (with regards to systems and assemblies), and long-term cost-benefit or life cycle analyses.

4. Documented experience overseeing the implementation and/or self-performing implementation of the facility improvement measures (FIMs) anticipated for the OCx project.
5. Experience in overseeing technology solution implementation as applicable to the OCx project requirements (mindfulness for master-planning, asset tracking/planning, e.g.)
6. Experience navigating the challenges and mitigating risks of performing commissioning work in existing facilities, including considerations for normal operations, maintenance schedules, and even emergency procedures, over the long term.
7. Proven track record for achieving the facility performance, operational and/or energy savings when part of the project objectives.
8. Experience assembling Diagnostic Plans and OCx project scopes (including the "when" as well as the "what").

1.2 Define and Document OCx Goals and Objectives

1.2.1 Establish a Rough Order of Magnitude of Costs and Benefits

The CxP develops rough costs and benefits for the OCx process and establishes some expectations that can be used as the Owner stakeholders develop their OCx goals and objectives.

1.2.2 Develop and Document Clear Goals and Objectives.

The CxP assists the Owner stakeholders in developing and documenting the goals and objectives of the OCx program. Stakeholders who have control of facility operating budgets over time must be included in the process and their buy-in obtained, lest the OCx program die after a year or two. Likewise, those facility staff who will be responsible for using their time and staff to support the Implementation and the Sustaining Phases must be fully on-board. Beyond that, goals must include succession planning so that the OCx program is maintainable through staff turnover and annual budgeting approvals.

The OCx goals and objectives should be set as quantifiable, realistic and as concrete as possible — as early as possible. However, as the Planning Phase progresses, some goals and the methods for their achievement may change. Goals should not jeopardize parameters of the CFR or an existing OPR. For example, goals would not violate comfort or reliability requirements to improve energy saving, accommodate aggressive occupancy schedules, or require convoluted equipment programming.

The CxP works with the Owner to ensure mutual understanding of how to best apply the OCx process for the project at hand. For example, if the facilities manager is mandated to meet cost, savings, rating system or other criteria, the OCx effort is different from directives to reduce energy use or reduce the environmental footprint. If the Owner has a sustainability initiative, the OCx program integrates activities designed to meet sustainability goals.

By knowing the Owner's purpose for the project and expected outcomes, informed decisions can be made around the level of effort and investments appropriate to support the program. Engaging the Owner to establish goals for the result of the project provides direction and a constant guide for the project.

As an OCx program becomes more established, the process supports goals and objectives such as:

- Identifying potential comfort issues before impacting occupants.
- Determining what tools have better value for how a facility operates.

- Calibrating the frequency of certain monitoring or performance verification tasks (appropriate to the facility and budget).
- Informing preventative and predictive maintenance schedules based on monitored data.
- Providing automated preliminary root cause analysis of control or equipment issues to inform maintenance action.
- Enable Owner, facility management, and Operations and Maintenance (O&M) staff decision making through facility performance data and reporting.
- Training O&M staff for optimized systems performance.
- Sustaining performance with energy management and utility bill tracking.
- Modifying occupant and tenant behavior through transparency and real-time feedback tools that identify building use inefficiencies and benefits of improved facility use.

During the goals and objectives development process**,** the CxP helps the Owner identify, at a high level, what type of data gathering, data analysis, reporting and long-term engagement with the data are desired. For example, is the Owner interested in very sophisticated automated diagnostics or are they willing to perform some data gathering and analysis on their own or with consultants? Do they want a turnkey service with engagement by analytic firms or the OCx provider, or just to help with infrastructure and putting a dashboard in place?

The CxP's Role in Technology Selection
A CxP's responsibility is to guide the Owner (owner team) to understand that the OCx process is what results in better buildings. Many Owners will be interested in adopting technology for many reasons that are correlated or indirectly related to building performance but may not be direct drivers of performance improvement. This may include dashboards, automating manual energy management and utility bill reporting and analysis, or being a part of technological advancement in big data and analytics. The CxP should be able to identify the technology tools and stakeholders that will be needed to support the Owner's goals and objectives and ensure the tools selected are supporting the OCx project.

1.3 Conduct a Preliminary Cost Benefit Analysis

A preliminary cost benefit analysis should include Planning Phase, Implementation Phase and Sustaining Phase costs of third-party equipment, consulting and labor and may include the cost of in-house resources. Later, once the OCx goals and objectives are developed, another more detailed cost benefit analysis is conducted to guide the rest of the Planning Phase. The cost benefit includes first costs for all infrastructure improvements required for the OCx program, unless the improvements were needed anyway. The benefits include both quantifiable costs (energy and demand performance) and less directly sourced costs (comfort, air quality, improved control, maintenance, reliability, equipment life, etc.).

1.4 Identify and Form a Multi-Disciplinary Team

The Cx Team is composed of professionals and stakeholders who drive the project to completion and sustain the program. The specific roles and responsibilities of the team will change depending on the phase of the OCx project. The chart below describes core team roles by phase, which is followed by a more detailed description of each team member's responsibilities.

Role	Planning Phase	Implementation Phase	Sustaining Phase
Commissioning Provider (CxP)	• Update/document CFR • Develop OCx Plan • Organize OCx Team and set expectations • Perform condition assessment • Overall lead for Phase	• Develop and provide Diagnostic Plan • Design and support technology implementation • Perform Data and analytics review for Master List of Findings	• Transition OCx to standard operations • Perform Periodic review and update of CFR and OCx Plans
Systems Integrator (SI)[1]	• Review OCx Plan and OCx goals and objectives • Perform technology gap analysis • Identify technology requirements	• Design and manage technology implementation	• Manage technology solution upgrades and updates as required by periodic CFR and OCx plan changes
Owner (OCx Champion)	• Support overall OCx initiative and priority within organization • Communicate key OCx project goals and objectives • Review OCx Plan for acceptance • Communicate CFR/review CFR for updates	• Support timeline and resource requirements for implementation • Review Master List of Findings and approve applicable corrective actions	• Maintain CFR • Engage CxP periodically for ongoing updates to OCx Plan • Review OCx results and approve corrective actions for ongoing sustained facility performance
Owner's IT Representative [1]	• Identify Owner security and IT requirements for technology system design considerations	• Review design and validate implementation of technology solution • Support networking and communication requirements in line with Owner security and IT network requirements	• Maintain network, communication, and security requirements for technology solution
Facility and BAS Manager	• Communicate CFR/review CFR for updates • Support technology gap analysis for identification and utilization of existing BAS capabilities	• Support/manage BAS system requirements for data collection and management per the OCx Plan	• Act as Overall lead for ongoing Sustaining Phase
Building Operators & Engineers	• Inform the condition-assessment effort • Identify key opportunities for OCx	• Review and verify Master List of Findings • Support corrective actions • Incorporate OCx process into Preventive Maintenance Plan	• Implement OCx process into stable operations
Technology Provider(s) [1]	• Provide OCx team with system capabilities and requirements for OCx Plan consideration	• Implement technology solution at the direction of the CxP and Systems Integrator	• Provide ongoing license and solution requirements as applicable to ongoing data management and analytics requirements
Technology Maintenance Staff [1]		• Support execution of technology system for data management and analytics	• Maintain technology system firmware and upgrade requirements

[1]Technology related roles and responsibilities are dependent on the specific software and hardware tools used for OCx and are part of the OCx team as required by the technology solution identified for the project.

1.4.1 OCx Team Roles and Responsibilities

Determine availability of existing internal resources and determine the needs for sourcing for external resources to acquire the skills, experience, and expertise for the OCx project to meet the goals and objectives.

1.4.1.1 Commissioning Provider Lead

The CxP is the overall lead who plans, directs and coordinates the commissioning team and the OCx process. OCx requires a deep integration of the CxP into the Owner's O&M activities. The CxP's role is to drive the team to the intended results, guiding the use of various tools and activities along the way.

The commissioning provider serves in many capacities throughout an OCx project. The overall role of the CxP is to:

- Manage the OCx process and cadence of ongoing activities
- With the Owner, define a project scope of work
- Define the data requirements
- Guide the specification or application of technology to the OCx project scope
- Develop the OCx plan
- Oversee development of the Diagnostic Plan and execution
- Develop actionable recommendations, including development of written scopes of work or criteria**,** for documenting the work required for implementing measures
- Oversee adherence to the **project management** procedures established
- Oversee adherence to the **change management** procedures established
- Verification of implemented measures

CxPs offering technology-focused OCx experience also can undertake responsibilities related to tools, such as the EMIS, which comprises a broad family of tools and services to manage commercial building energy use. These technologies offer a mix of capabilities to store, analyze, and display energy use and system data, and in some cases, provide control. EMIS is an umbrella term that covers both meter-level and system-level EMIS, used to manage facility energy information and data including the baseline, benchmark, and ongoing tracking of utility bill, utility meter, and related submeter data. EMIS may also be integrated to the BMS/BAS for system specific data management and performance evaluation.

CxP – Owner with Existing EMIS. The CxP uses an Owner's existing EMIS as a tool for providing OCx services. The CxP provides commissioning services to interpret and investigate results presented through the EMIS. The CxP scope includes ongoing services, and may also include scoping, implementation, and commissioning of measures identified during the process.

CxP – EMIS facilitator. A more common scenario may be an Owner that has a rich data set derived from existing meters and building automation systems and is interested in deploying an EMIS to make better use of the data. The CxP assists the Owner to procure an EMIS by facilitating the development of an RFP. Like the development of an OPR for a building, this requires input from all stakeholders to facilitate decision-making on key questions in the technology deployment. The CxP, as a building systems expert, can provide the following:

- Systems to be included in analysis
- Points lists and associated data management requirements

- Analytic functions and faults required for specific systems
- How the EMIS will be used by O&M staff, features required to support their workflow
- Integration to the computerized maintenance management system (CMMS)
- Understanding of the broader organization goals, and how the EMIS can support these

CxP – EMIS Provider. Some CxPs may offer OCx with the EMIS technology bundled as a service. This turnkey scenario allows the CxP to drive the process from start to finish. It does require the CxP to also be a technology provider who takes on the project execution responsibilities and risk for completing all aspects of the deployment. Many CxPs have staff with a high level of expertise in building automation systems and system integration, which are key elements of the technology integration. In a variation of this, the CxP can partner with a technology provider to provide turnkey technology, but as a subcontractor to the CxP for a turnkey solution to the Owner.

Conflicts of Interest. In keeping with the BCxA Essential Attributes of Commissioning, when the CxP firm is also providing the EMIS or contracting with the EMIS provider, the CxP should inform the Owner of the conflict of interest in its installation and address the special assurance and control measures and verification of performance that will be enlisted to manage the conflict.

Does the OCx Commissioning Provider have to design and implement the technology solution?
The design, procurement, and installation of the technology solutions may or may not be led by the CxP. The CxP may or may not have the in-house expertise to design and implement the technology for use in OCx. However, the CxP must be able to ensure the technology proposed and installed will meet the functional requirements for use in the OCx process and ongoing building performance.

1.4.1.2 Systems Integrator (SI)

A Systems Integrator has experience and skill in setting up communication between systems to share real-time and/or historic data streams. Depending on the architecture**,** this may include utilizing common building systems communication protocols such as BACnet or Modbus, but may also include the sharing and storing of data between databases. The systems integrator must also have experience in networking, including network security and good network traffic management practices. Finally, a system**s** integrator must also have working knowledge of hardware installation and application and wiring to fully implement a solution.

For Owners without an existing EMIS, an experienced Systems Integrator often possesses the most elusive and needed skill set on the team to move the project from a great candidate for a monitoring-based approach and successful implementation of an EMIS with building data. As a practical reality of implementation, the CxP identifies this need early and facilitates the Systems Integrator being filled on the team, regardless of whether hired by the CxP, Owner, or technology provider. The overall role of the System Integrator is to:

- Provide expertise and recommendations for the use of the existing BAS controls and meters to be used in the OCx process
- Set up data transfer methods and protocols between monitoring, metering, BAS and EMIS systems
- Coordinate with Owner's IT representative to implement and maintain data management and technology communication strategies

1.4.1.3 Owner OCx Champion(s)

OCx Champions are critical to the process as project manager(s) and coordinator(s) for decision-making, coordinating commissioning activities performed by in-house personnel and service contractors hired directly by the Owner. For organizations with in-house commissioning personnel, one person or department may serve as both CxP and OCx Champion.

The overall role of the OCx Champion is to:

- Provide clear direction from the Owner for the goals and objectives of the OCx program
- Facilitate program acceptance and change management
- Facilitate decision-making and approvals from stakeholders inside the Owner's organization
- Coordinate OCx activities performed by internal staff and contractors hired by the Owner
- Serve as primary point(s) of contact for the CxP

Projects are not always limited to a single OCx Champion. Depending on the size and scope of the project and stakeholders involved, along with anticipated level of program acceptance and change management throughout the process, more than one Champion may be useful, coupled with a clear communication plan.

1.4.1.4 Owner's IT Representative

The Owner's IT representative is the Owner and decision-maker of the IT infrastructure – typically network, switches, servers, and firewall – that the technology solution may use. The Owner's IT department may also enforce data security standards and retention protocols that dictate the roll-out of a technology solution. As the IT infrastructure owner, this must be in-house or a delegated firm with decision-making authority on behalf of the Owner's infrastructure used in the process.

The overall role of the IT Representative is to:

- Provide recommendations and participate in approval process for hardware, networking, security and firewalls, and data security related to OCx activities
- Serve as liaison between OCx team and IT organization
- Provide expertise during discussion of data transfer to include current and potential bandwidth implications (like 5G now or in future), switch and router additions/reconfigurations, implementing VLANs, remote access, network cybersecurity and the hardening of any technology communicating through Owner firewall

1.4.1.5 Facility and BAS Manager

This is the person(s) most familiar with the building's control system and architecture. The overall role of the Facility and BAS Manager is to:

- Provide oversight and decision-making relative to the building automation system
- Advise OCx team on existing system limitations, vulnerabilities, and the long-term BAS technology roadmap
- Review and approve any modification or third-party system that will affect BAS system communication, resources, or server requirements
- Commit resources for implementation of measures, conducting maintenance activities, and training activities
- Provide updates for building use modifications and renovations to be incorporated into the Facility Guide

1.4.1.6 Building Operator/Engineer(s)

Building operators and engineers are integral to the OCx team; OCx cannot proceed or succeed without their involvement. The overall role of the Building Operator/Engineer(s) is to:

- Provide input to the OCx Plan and Change Management Plan
- Provide input to the Diagnostic Plan
- Assist in confirming or managing the CFR
- Discuss ideas and findings with the CxP
- Work with the CxP to implement and verify measures
- Perform simple repairs and improvements
- Observe and accept turnover of repairs completed by third party contractors
- Assume overall responsibility for OCx in the Sustaining Phase

1.4.1.7 Technology Provider/ EMIS Expert

Many Owners may hire a technology provider to install, program, and service their EMIS solution consistent with a Software-as-a-Service (SaaS) contractual agreement. In other cases, the EMIS may be delivered as a turnkey package and completely supported by an in-house person familiar with the facility and systems. The overall role of the Technology Provider/EMIS Expert is to:

- Set up the EMIS for the project
- Implement the tracking, analytics, dashboard, as required by the CxP and Diagnostic Plan

1.4.1.8 EMIS Maintenance Staff

EMIS Maintenance Staff is either an Owner's in-house representative or a third-party consulting entity, depending on the Ownership/contract structure of the EMIS. The overall role of the EMIS Maintenance Staff is to:

- Maintain and address issues with the EMIS post-implementation.
- Conduct planned maintenance associated with the EMIS including software updates, database management
- Adapt EMIS to respond to updates in the Diagnostic plan and OCx plan during Sustaining Phase

1.5 Perform Condition Assessment / Measurement Baseline

The condition assessment serves as the basis for the CxP to determine the scope of the OCx project. Conduct an initial assessment of the building physical condition, mechanical systems, control system, and relative energy consumption to form the foundation for screening candidates. Gather this information by doing a walk-through and inspection of mechanical spaces, discussion with O&M staff, investigating work order history and energy usage history.

Evaluate the capability of the BAS and any metering and monitoring systems at a high level at this stage to understand their general capabilities and limitations for supporting an OCx program.

The distinction between commissioning versus an engineering survey in most technical conversations seems to come down to the inclusion of measurements. For assessments, it's easy to pair the site observation with instantaneous measurements (like temp or running amps) as you go, or even compare or capture trends in order to establish conditions in a conclusive (measured) versus less conclusive survey (eyeballed but non-measured) check. The few seconds of time to take measurements often can provide more concrete evidence (measured data, even in part) to firm up otherwise cursory observations.

1.5.1 Scope Building and Systems and Prioritize Systems and Strategies

Develop and conduct a prioritization process for candidate systems and strategies. Take into account the systems and control strategies in place such as systems with variable frequency drives (VFD), occupancy controls, setbacks, resets and similar requirements that could allow for savings, as well as any gaps between building performance and benchmark for that building type and climate zone. In a multi-facility campus or portfolio project, consider prioritizing by system type instead of by building, which will ensure the OCx plan is applied to systems, buildings, and overall scope of work in alignment with the OCx goals and objectives. For example, look at the chilled water systems in a group of similar buildings. Leverage the condition assessment and the known project goals to scope the building systems and metering needed, to help identify performance issues and monitor improvements.

The potential OCx project building is screened to identify:

- Buildings that require significant capital upgrades to make monitoring or metering even possible
- Buildings that are in poor operating condition and warrant EBCx prior to an OCx program.
- Buildings that have insufficient operating or program budgets to conduct and maintain an OCx program

Buildings with some of these characteristics may still benefit from OCx, but it is best practice to remedy them to a significant degree before OCx is incorporated.

As the building systems and their performance are reviewed, the CxP documents their findings in the preliminary Master List of Findings (MLOF). As an initial screening of the building, the Findings Log documented here forms the preliminary actions to be taken to improve and sustain building performance. The preliminary Master List of Findings is then updated in the Implementation and Execution Phases of OCx and this list is continuously leveraged during the Sustaining Phase of OCx.

The screening process involves the following tasks:

- Condition and capability assessment
- Scoping of building and systems and prioritization of systems and strategies
- Initial identification of performance change recommendations in the preliminary Master List of Findings

The preliminary screening eliminates incorporating buildings or systems that require capital upgrades or overhaul or where data cannot be easily extracted from the automation system and where applicable, identifies the preliminary OCx findings to be implemented for improved facility performance.

1.5.2 Review and Update the Current Facility Requirements (CFRs)

During the facility Condition Assessment, the CxP will review the CFR's to ensure these requirements are documented for the building, are up to date, and/or if the facility condition indicates significant variation to the CFRs. The CFRs serve as a foundation for defining how the building systems are operated to support the purpose of the building. Should the CFRs not be defined or are out of date, the CxP will work with the OCx team to document and/or update the CFRs.

When there are significant gaps in facility use compared to the CFRs, there are significant issues with the ability of systems to meet CFRs, or there are other performance considerations for the success of the OCx project, the CxP evaluates the potential need to revise the project approach to existing building commissioning prior to commencing OCx.

When to Consider EBCx
Implementing OCx for facilities with significant systems issues can lead to poor data availability, the wrong data, and the lack of core building functions necessary to apply OCx strategies. Consider changing the project approach to incorporate EBCx. As a Best Practice, OCx should immediately follow NCCx or EBCx projects. If OCx is being implemented without prior NC/EB Cx of the facility then the Condition Assessment results must be evaluated to ensure the facility condition will support the successful implementation of OCx. Systems that are not operational, meters and sensors that are not communicating, and other critical system issues will limit the ability of OCx to identify opportunities and may lead to invalid findings from OCx. Link EBCX BP here?

1.6 Conduct a Gap Analysis of Existing Technology Infrastructure

In the Planning Phase, establish the data requirements and data availability at a high level for a Gap Analysis. A gap analysis identifies where existing data acquisition systems (BAS, utilities, other monitoring) are incapable of, or are not currently gathering, specific data streams required for the OCx process. The CxP, with support of the Systems Integrator as applicable, reviews the existing system(s) available data sources and develops the OCx project data requirements, based on the proposed OCx activities and monitoring required to meet the Owner's goals and objectives. The technology-infrastructure gap analysis will be the foundation of understanding used in designing and determining the additional technology needs to meet the OCx project requirements. These additional technologies may include additional BAS or other monitoring system points, archiving and retrieval features, analytics software and interface, remote access features, etc.

Too much of a good thing – avoiding data collection and analysis pitfalls
Avoid starting with the collection and attempt to analyze all available data at the start of the OCx project. Through the Planning Phase and Implementation Phase, the Best Practice is to approach data collection and analysis systematically to ensure data collected is data that will be used and that analytics implemented support the OCx project goals and objectives. This Best Practice avoids the pitfall of collecting and managing large amounts of miscellaneous data and data that is not used by the OCx project while also reducing the cost and time for analysis of the data.

1.6.1 Review Available Data Sources

Determine how much/what kind of data is available to use in the OCx process. Typically, the primary source of system data is the BAS and utility metering data, but may also include weather and environmental data, facility use or production, or other data that drive facility operations.

Review energy and water metering data to identify non-monitored loads. Determine whether measurement and verification will be necessary to support the results of the OCx project. Evaluate the following to establish the state of the current technology and the ability to leverage it for OCx:

- Data points available and whether historical trends are available
- Existing utility meters and data retrieval and storage
- Ability of the BAS to trend, store and allow retrieval of historical data
- BAS remaining useful life

- Accessibility across the Owner's network and offsite via the web of BAS resources and databases
- Hardware supporting the BAS server software and limitations to its capacity and expansion

1.6.2 Ascertain Data Quality and Validity

The quality and reliability of data being used in the OCx program is fundamental to its success. If the data quality is in question, by corollary so will the analysis and results.

Conduct a high-level assessment of the data sources. For instrumentation, ascertain when the latest commissioning, retro-commissioning, or calibration services were performed. Check data quality of a historical data set to identify any sensors that are out of range, or have gaps in the data.

Once the data quality is determined, the CxP must work with the technology provider(s) and Systems Integrator as applicable to incorporate data quality corrective actions in the OCx Plan, including the calibration of meters and sensors as applicable.

1.7 Determine Technology Use and Design

Utilizing the information gathered in the technology gap analysis**,** combined with the intention for technology articulated by the Owner in the goals and objectives development process**,** the appropriate type of equipment for data gathering, data storing, data analytics and retrieval is established. If using a monitoring-based approach, an EMIS is required to support activities laid out in the Diagnostic Plan established in the Implementation Phase.

If the Owner does not have an EMIS in place, the CxP leverages knowledge and expertise of the building and EMIS technologies and guides the Owner in acquiring and deploying an appropriate EMIS system. The CxP is involved in evaluating the validity of existing data to be used in data analysis. In some cases, the CxP may be an EMIS provider, systems integrator, or consultant in the technology procurement and selection process. Additional EMIS acquisition recommendations are provided under the Commissioning Provider Lead article under the "Identify and Form a Multi-Disciplinary Team" task in Article 1.4 above.

If the data quality or calibration is in question, calibration is performed on the critical instruments that will be used in the data gathering and analysis.

1.8 Develop Steps for Implementation of Findings

Establish the process and documentation by which findings from the OCx process result in effective action through implementation and are permanently integrated into the facility operation. This must include project management and role/behavior change management to outline who will do what and how the members of the team will actively engage on the project to transition OCx findings to actions that improve building performance.

1.9 Develop and Formalize OCx Plan

Develop an OCx Plan that progresses through the process and tasks, of the OCx phases. The OCx Plan includes both a **Project Management Plan** and a **Change Management Plan**. These are working

documents that evolve throughout the OCx process.[1] Give consideration to the level of involvement of all stakeholders and how the Owner and CxP work as an integrated team over time to achieve the OCx goals.

The OCx Plan documents the methods and approach to be used in the project and includes:

- Owner Goals and Objectives
- OCx Team Roles and Responsibilities
- Condition Assessment Results: Scope of Project and Prioritization
- Gap Analysis of Existing Technology Infrastructure Results
- Technology Use and Design
- Project Management Plan
- Change Management Plan
- Implementation Process
    - Diagnostic Plan
    - Set Up Data Monitoring
    - Technology use and implementation
    - Facility Improvement Measure (FIM) implementation strategy
- Sustaining Process
    - Implement O&M Procedures
    - Transition to stable operations

1.9.1 Create Project Management Plan for Implementation of Findings

The **Project Management Plan** defines the steps between the identification of a finding and subsequent correction. The plan defines the process for adding to the **Master List of Findings**, and where that document or platform will be stored and accessed. For any automation such as FDD, specify if any automated results will be used to populate the Master List of Findings. For each finding the need for additional investigation or analysis is determined and ultimately the measures and process to address the finding and the scope of implementation are documented. Engage staff for the specific type of finding for any further analysis and for implementation. The Project Management Plan will become part of the final OCx Plan.

Define what information must be included for each measure and who must approve the measure, and any key decision points such as the implementation team and funding type/source. Identify implementation teams (internal, external, or both) that can be called on. The CxP will help identify where implementation teams need to be identified for an Owner, either through internal workforce development or identification of third-party vendors. For all steps that require heavy CxP involvement, identify what tasks or activities will shift in the Sustaining Phase to the O&M team for ongoing sustained stable operations.

[1] A Monitoring-Based Commissioning Plan Template is publicly available. Retrieve from https://drive.google.com/file/d/0BzgPTwDtt6KdYkNYRDR3ZGMtUVU/view.
Building Technology and Urban Systems Division, Lawrence Berkeley National Laboratory, DOE Building Technologies Office. June 2017.

1.9.2 Create Change Management Plan for OCx-Impacted Parties

During the Planning Phase consider the actions and timeline for communication and onboarding of all parties that will be required to participate or be affected by the OCx project. This **Change Management Plan** becomes part of the final OCx Plan and will consider:

- Roles and responsibilities and gaps in filling the roles or in individual skills or ability
- Communication plan
    - Initial Roll-out: Gain buy-in and set expectations with all team members and affected parties
    - Reporting on progress to wider audience – senior management, financial officers, tenant managers, corporate sustainability officers and similar
    - Engagement of building occupants and tenants
- Workflow processes that will change and how those changes are rolled out and implemented

Besides identifying improvements to operating parameters, the OCx Master List of Findings will also identify the need for change by occupants, tenants, operators and others to reduce their impact on facility energy impacts, the need to adjust behavior to support the CFRs and system capabilities, and adjust roles and responsibilities for sustaining performance and using OCx tools and methods. The Change Management Plan will describe how the impacted parties will be enlisted to make and sustain recommended changes.

Engaging building occupants and tenants: Building occupants are key to implementing and sustaining a successful OCx project. Setting expectations of their role during the Planning Phase will maximize their opportunity and motivation to engage in the project. Specific interactions will include providing feedback to the OCx process, such as to clarify space usage and hours of operation, potential need for behavior change to optimize performance and comfort, disturbance to their work area during implementation, and changes to expect post-implementation.

1.10 Planning Phase Deliverables

- OCx Plan including
    a. Project Management Plan
    b. Change Management Plan

2 Implementation Phase

The objective of the Implementation Phase is to develop a Diagnostic Plan, apply the tasks described therein, and identify specific energy conservation measures (ECMs) and facility improvement measures (FIMs). The Implementation Phase has been divided into two sequenced sub-phases—**Preparation**, followed by **Execution**. During the Implementation Phase, Preparation and Execution sub-phases may each take several iterations until the desired outcome is achieved (prior to moving on to the Sustaining Phase).

During both sub-phases, the CxP continues to engage the OCx team especially personnel involved in O&M. The findings, recommendations, and subsequent analysis are presented to the Owner for further prioritization and selection of measures for implementation. In the Execution sub-phase, the CxP applies the documented metrics and diagnostic tasks and compiles the Master List of Findings.

The Implementation Phase includes these activities:

Implement Preparation Sub-Phase

- Engage OCx Team Selected During Planning
- Create a Diagnostic Plan
- Align Data Monitoring with Diagnostic Plan
- Implement Diagnostic Plan
- Create or Update Facility Guide

Implement Execution Sub-Phase

- Coordinate Preventive Maintenance
- Conduct Technical/Technology Application Training
- Update and Prioritize Master List of Findings
- Establish Communication/Coordination Methods and Procedures
- Take Corrective Actions
- Update OCx Plan

2.1 Preparation Sub-Phase

2.1.1 Engage OCx Team Selected During Planning

2.1.2 Create a Diagnostic Plan

The Diagnostic Plan is an outline version, or representation, of the regular commissioning activities that will be performed to satisfy the monitoring and evaluation goals required to meet the scope of the project.

Creation of the Diagnostic Plan occurs early in the Implementation Phase – prior to the setup of data monitoring systems. This enables the OCx team to be deliberate in the data monitoring setup where the number of points to monitor, frequency of data trends, and infrastructure setup are all services completed explicitly in support of the OCx analytics requirements identified in the Diagnostic Plan. This approach reduces the risk of data overload where the OCx team is unable to prioritize data due to the volume of data and potentially stressing the IT infrastructure.

Develop a Diagnostic Plan to outline the tasks and regular activities that will be performed to measure and monitor the building's performance and the criteria for identifying, classifying, and responding to issues. The building metrics, data monitoring, and analytics are reviewed and confirmed to support these tasks.

In cases where an EMIS is not being implemented as part of the OCx project, the Diagnostic plan will need to specific the means that the project team will monitor performance of building systems using available equipment readings and where possible, the BAS. This includes defining the expected performance metrics, means to analyze actual performance in comparison to expectations, and frequency that this analysis is to be completed. The resources necessary to complete a more manual approach to the diagnostic plan is to be reviewed to ensure the plan can be supported for long term implementation.

The Diagnostic Plan applies the available tools and data reporting to the Owner's standards and policies for the scope of building systems identified for Ongoing Commissioning. The tasks are intended to complement the identified goals and priorities laid out in the OCx Plan.

*The **Functional Testing Plan** featured in the New Construction or Existing Building Commissioning Plan is replaced with a similar document that dovetails into the OCx Plan called the **Diagnostic Plan**. Just as the Functional Testing Plan outlines equipment and systems for the Implementation Phase of the commissioning process, the Diagnostic Plan describes the tasks/activities for the implementation of the OCx project. This document describes the tools (physical and digital) required for the different components and lays out a sequence/checklist of steps for evaluating the building/system performance. It also spells out the necessary participants for the activity.*

2.1.2.1 Define Diagnostic Tasks and Activities

The Diagnostic Plan describes how to document/chart building and system metrics, review and analyze monitored and trended data using tools like EMIS, and collaborate with the Owner's operators and other members of the commissioning team to perform on-site investigations and testing.

For the following data sources and performance evaluation activities**,** the Diagnostic Plan fully describes the data origin(s), its sampling frequency and how (and how frequently) the data will be used to identify proper or improper performance. It also lists what party will perform each activity. The Diagnostic Plan includes tasks such as:

- Utility Meter Monitoring
- Performance benchmarking and baseline definition
- Schedule Reviews (equipment, lights, occupancy)
- Trend Analyses: load profiles, peak load, control loop and sequences of operation
- Functional Testing
- Alarm Review/Fault Detection

OCx tasks are a good opportunity to tune the building—seeking out and questioning the parameters that have been adjusted or overridden, confirming that modes or design features such as standby temperatures or morning warmup are engaging properly.

2.1.2.2 Regulate Frequency and Depth of Investigations

Define the frequency and depth of review for each task with direction for documenting and responding to the findings of these reviews. For example, the Diagnostic Plan may define the utility reviews as a monthly task and schedule reviews as quarterly activities.

How far the commissioning team will pursue any anomaly should be identified in the plan, and should be based on the size of the impact on the CFR and OCx objectives.

2.1.2.3 Define Expected Output

Identify the anticipated results of each task/activity. For example, the work product from reviewing the trending logs for the chilled water system might be as simple as a statement in a log/report that describes regular hours of operation and temperatures meeting setpoint. Outputs include the capture of both regular and irregular performance.

Describe or draft the format of the documented results including tables and charts for tracking. Consider the Owner's goals and priorities when defining the format and communication of the expected outcomes.

2.1.2.4 Establish How Issues Will be Identified

For each of the sources of building performance (utility metering, trends, EMIS, schedules, etc.) and for each of their individual data streams (building electrical use, chiller kW/ton, specifically targeted air handler coil valve position, etc.) establish what condition, state or value will constitute an issue of concern.

Set Variance Triggers for Automated Detection. For data that are automatically gathered through the BAS, EMIS including EIS and FDD, utility or stand-alone metering, the Diagnostic Plan will establish and define parameter variances that will trigger responses such as an alert or fault notice. Examples of parameters include total energy use, peak demand, equipment schedules, various equipment and component parameters like damper and valve position, temperatures, pressures, efficiencies (chiller kW/ton), etc. These trigger variances are realistic, yet not too aggressive. The plan gives provisions and process for testing and readily adjusting these variance triggers over time to prevent false positives. Refer to the article Align Data Monitoring with the Diagnostic Plan for further details.

Some examples of triggers are: If the outside air damper is open beyond minimum by 5% for 10 minutes when the economizer parameters are declaring it should be at minimum, then alert. If the monthly total building electrical use exceeds the baseline normalized for average outside air temperature by 10%, then alert. If the chiller kW/ton based on % load exceeds the baseline performance curve by 10% for more than 10 hours (accumulated), then alert.

Develop Trend Data Analysis Standards. The Diagnostic Plan documents trend analyses and the frequency of their execution. The frequency of trend analysis execution is established, which should vary with the specific system and component so as not to waste resources on something unlikely to change or be overridden or for which impacts are small. The plan describes the points to be trended together, their frequency, condition of the system and the observations to be made that will establish good or bad operation. For further details refer to Article 2.1.3, " Align Data Monitoring with the Diagnostic Plan."

2.1.2.5 Prioritize, Classify and Track Issues

Determine and document a methodology for communicating and facilitating the response to identified issues. When a diagnostic activity uncovers a variance from the expected or typical performance of a

system, then the commissioning team seeks to quantify and qualify the nature and root of the issue — i.e., is it behavioral or mechanical, isolated or systemic — and classify the issue based on severity, urgency, cost, or other prioritization factors.

During Ongoing Commissioning, the discovery of performance issues can range from postponed preventative maintenance tasks to primary equipment failures. In such cases, the resolution will likewise vary from updating preventive maintenance schedules and completing maintenance to launching a re-commissioning effort or recommending an equipment replacement project.

Issues are well-defined to provide the most opportunity for the Owner to maximize the results of OCx and plan for any capital expenditures required for corrective actions.

Set a standard practice for the documentation of an issue: when it was observed, under what conditions, supporting evidence, etc. Refer to Article 2.2.5. "Update and Prioritize Master List of Findings". for further information to include with each finding.

2.1.2.6 Define Data Monitoring Requirements and Tools

Compile the lists of required data and information that will be needed to accomplish the Diagnostic tasks. Maximize available data—create a process for incorporating the available analytics or standardize the trending reports. This process serves as an extension of the condition assessment and technology gap analysis from the Planning Phase.

The OCx Commissioning Provider will provide direction or manage the OCx team to identify the applicable tools to be used in support of the OCx project. Tools will range from the reconciliation of utility bills to complex analytics and the application of available tools from the EMIS, including:

- Energy Use Intensity (energy use per square foot, or EUI) Analysis
- Performance Comparison against Codes and Standards
- Peak Load and Load Profile Management
- FDD for actuator tuning, algorithms, and equipment runtime and short cycling reporting
- Benchmarking

Finalize the standards for the comparison between the building's current and desired performance. The Commissioning Team selects these standards to ensure consistency in what information is being reviewed and against what metrics. Further investigations may lead the CxP into developing custom trends for a deeper dive, but for regular activities, a set of reports/charts/data is established to evaluate building performance.

2.1.2.7 Identify Required Analytics

Analytics is the secondary result from all of the data that is collected in the system trending. Select which outputs of the EMIS or BAS are most valuable to the Diagnostic Tasks and incorporate the review of these outputs into the procedures of the activities.

2.1.3 Align Data Monitoring with Diagnostic Plan

2.1.4 Implement the Diagnostic Plan

The CxP's responsibility is to acquire sufficient information to be able to monitor, export, and record required data. This will include the CxP working beside the parties that control the data streams, such as the local building engineer/technicians**,** to set up the necessary historical and archived data parameters in the BAS or the maintenance management system, the accounting team to set up a regular email communication chain for receiving the utility data and the EMIS vendor to gain access to set up parameters and reports. Set up the appropriate credential profiles for the CxP with these systems.

2.1.4.1 Create Consistent Standard for Points Lists, Reports, and Metadata

- Set up building automation and energy management systems with standard nomenclature, alarming, and historical data collection parameters.
- Become familiar with the tools and features of each platform with which the systems will interface.
- Establish the best means of accessing, exporting, and routing the data.
- Confirm the points available to the documented Diagnostic Tasks/Activities.
- Determine if standard trending reports can be built with the available BAS or EMIS,
- Establish a standard point list for trends that will be monitored for each mechanical system/piece of equipment, which allows this confirmation to be consistent for all similar systems.
- At specified intervals, distribute reports for review.

Consistency is critical when creating OCx procedures and the data must be consistent to track performance accurately from one period/cycle to the next. ***Metadata*** *(a catalog of data "tags") can provide an advantage in the practice of standardization. Creating searchable tagging for point data for future database organization can be a sizeable investment that results in significant gains for scaling monitoring and performance review. Metadata can streamline the process of point identification and location. Some level of confirmation for the mapping of such points is always beneficial to ensure that the setup matches the expectations of results for the Diagnostic Task/Activity requirements.*

2.1.4.2 Determine Trending Intervals

Ensure that trending intervals identified in the Diagnostic Plan still reflect the level of detection required for the desired diagnostics. This includes fault detection where abnormal operation is identified during comparison of the equipment or system performance against acceptable tolerances or operating metrics. It can also include things such as occupancy and runtime confirmation, heating, cooling, and economizer control, and demand ventilation.

The Diagnostic Plan helps select which trends of analytic tools are going to be the most effective for determining the performance that the Owner has defined.

For comfort goals, the temperatures and airflow trends may need to be set to different intervals than energy goals, where the differential pressure control points, metering, and more VFD parameters may be more closely monitored.

The trends used for the OCx project are to be sent, stored, and managed in a system of record that can provide adequate storage of information for the project requirements. The trending requirements are to

include the backup requirements for the data and the time requirement for retention of data. The system of record chosen for the project must be accessible to the analytical tools and systems used as part of the OCx project.

2.1.4.3 Set Alarm and Notification Priorities

Determine if a setup of alarm extensions was completed prior to the initiation of the OCx process. In any case, delivery and filtration of alarms can still be supported and managed as a part of the process. If the OCx process does not play a role in determining alarm setup or prioritization, a similar application of setting priorities to alarms can be a part of alarm review and analysis.

Ascertain whether, for optimal consistency, Owner has a policy addressing the desired tolerance ranges that are acceptable for comfort and control.

Prioritize equipment and systems alarms to add another layer of filtration to how alarms are determined, and when (and which) notifications are sent. For example, a primary system loop pump failure would be given a higher priority alarm than a heat pump condensate alarm.

Create and manage notification distribution lists thoughtfully. Many building issues may require urgent responsiveness, with effective information delivered to the people who need to know. The type of space and system as well as the necessary action may help organize how this process is implemented.

Notifications must be clear, concise, and actionable to point the user in the direction of investigating and resolving the issue that they identify. One of the most common complaints in the facility maintenance community is the abundance of nuisance alarm notifications, resulting in apathy in terms of responsiveness. Prioritization of alarms can be one means of cleaning up which alarms are sent to the team as notifications. Notifications can also become more effective when the messaging is clarified. The weighted critical value of an alarm can be a means of determining how it gets issued to the team and the response. Additional factors such as frequency of alarming and the duration of an alarm can be considered for escalating the priority of less critical equipment. For example, an interior office space that is outside of comfort parameters may begin as a visual alarm on the graphic and then require a minimum duration before being issued as a notification.

2.1.4.4 Initiate Consistent Reporting Mechanisms

Maintain consistent reporting formats from one reporting cycle to the next, to include a minimum of the following information:

- General Summary of Activities and Progress
- Concise Update on Building Performance Metrics
- Updated Master List of Findings
- Updated List of recommended measures selected for implementation
- Complete diagnostic results and documentation of investigation

2.1.4.5 Deliverables

- Standard Point List
- Periodic Trending Reports
- Prioritized Alarm Notifications

2.1.5 Create or Update Facility Guide

The purpose of a Facility Guide (also known as a Systems Manual [2]) is to establish and maintain a guide to systems performance and a normal routine for reviewing building mechanical, electrical and lighting systems. It provides a reference for refreshing system users. It is also a guide for future on-boarding.

If a Facility Guide does not exist for the building, then support the creation of this document. The CFR, OCx Plan and Diagnostic Plan then become part of the Facility Guide, and the Guide also includes inspection, calibration, operating instructions, and maintenance tasks for the O&M Personnel.

If a technology application is being used, update the Facility Guide with any automated reporting that the Owner would like to review on a regular basis. Examples include override audit reports, trending of primary or critical systems, and polling the network for downed devices.

One example of a maintenance task for commercial building personnel is a building walk-through during unoccupied hours to look for lights, equipment, and appliances that may be running out of schedule, as described in this night variance audit:

The night variance audit is a biannual (or more frequent) walkthrough of the building to record any irregularities in lighting, equipment, or appliance operations during unoccupied conditions.

a. Is exterior lighting engaging as scheduled/programmed?

b. Is interior lighting shut off on schedule as a sweep or via vacancy sensing as scheduled/programmed?

c. Are any areas overridden to run to meet occupied conditions and setpoints during unoccupied hours?

1. If found, are these overrides currently needed?

d. Are any appliances being left on unnecessarily during unoccupied hours?

1. If found, are there circuits with plug load-controlled receptacles that could regulate the runtime of these appliances?

e. Are there any other conditions which may be contributing to building energy consumption that were observed during the walkthrough? (i.e., unexpected occupancy sensor triggers responding to false signals)

2.2 Execution Sub-Phase

2.2.1 Coordinate Preventive Maintenance

2.2.1.1 Improve Information and Coordinate with Facility Activities

Within the scope of the OCx and Preventive Maintenance (PM) Plans, coordinate the two teams. The PM team likely possesses critical information from experience in the building and access to the same systems. This is an opportunity to learn about anecdotal incidents that align with irregularities identified during OCx. PM Logs also informs how equipment has been maintained over time.

[2] **Facility Guide.** The Facility Guide referred to in this OCx Best Practices document, and what is sometimes referred to as a **Systems Manual** in the industry, is what ASHRAE defines as the "**Facility Guide**: a basic building systems description and operating plan with general procedures and confirmed facility operating conditions, set points, schedules, and operating procedures for use by facility operations to properly operate the facility." A well-organized and accurate Facility Guide will greatly enhance the building personnel's ability to operate the building effectively by providing all of the relevant information in a single location.

2.2.1.2 Use OCx Results and Process to Review PM Tasks

Review the PM tasks to identify common equipment. The Cx process can shed light on possible inefficiencies or provide an opportunity to schedule larger tasks (i.e., building water flushes, cooling tower maintenance).

2.2.2 Conduct Technical/Technology Application Training

Initial training includes content that familiarizes the involved parties with the navigation and features of the technology product. This reserves later trainings for more advanced tasks, possibly with fewer personnel who demonstrate interest and a skill set aligned with the specific tasks.

As described in the Planning Phase, identify OCx Champion(s) early to support and communicate the program to stakeholders. Depending on the organization, a role may already exist for personnel who oversee building management or energy analytical software. Train others who may be taking on some of the OCx responsibilities in the future.

2.2.2.1 Set up trainees with unique credentials and technology access.

Coordinate with the Facility/BAS Manager to ensure that all identified trainees have access to the software tools and any corresponding technology credentials such as virtual private networks (VPNs) per the Owner's IT policies. The Owner identifies the list of trainees based on their respective capabilities for each session's curriculum.

2.2.2.2 Provide and install software tools on trainees' local computers.

The Owner's IT Manager supports the provision and installation of the necessary software tools on the trainees' local computers and/or mobile devices as applicable.

2.2.2.3 Create Technical Training Program

Prepare an overall Technical Training Plan including scope, schedule, content outline, activity plan, testing/confirmation of learned material

Develop curriculum content, including review of the Diagnostic Plan. Tasks identified in the Diagnostic Plan can serve as part of the training content. Utility meter and load analysis, benchmarking, fault detection reviews and deep dive investigations can all be incorporated into the curriculum to maximize the practicality of the training exercises. The curriculum content should also emphasize the value that comes from using the building management and energy analysis tools.

2.2.2.4 Review Curriculum in Advance

Document and submit the curriculum plan to the OCx team for review. Ask for curriculum content review by selected OCx program stakeholders.

Obtain approval for technical training program and content from Owner.

Practical applicability is critical. Technology applications bring value when the information they provide is turned into actionable corrections and modifications. The discovery that may occur during good training must also be communicated. The means and methodology of that communication path—whether via a maintenance tracking tool, regularly scheduled meetings where issues can be reviewed and updated, or some other format—need to be incorporated into the training curriculum so that the participants in training can know how to turn their discoveries into better building performance using the software tools.

2.2.2.5 Schedule Multiple Training Sessions

Training hours can be spread across several sessions. Encourage users to practice and develop questions as they see how the application and documented procedures fit into their real work routine. Multiple sessions improve retention and prompt better engagement from personnel in training. Intervals between trainings are a good opportunity to pause for seasonal or periodic reviews and check-in on the building.

2.2.2.6 Develop A Standard for Recording Training

Record training sessions to make a legacy digital resource that can be used for future staff preparation. Optimally, these digital resources could be linked or loaded to a platform that the Owner accesses for BAS, EMIS, or another regular database.

2.2.3 Update and Prioritize Master List of Findings

Update and prioritize Master List of Findings and recommendations to include possible energy conservation measures (ECMs) and facility improvement measures (FIMs) based on the findings during the Implementation Phase.

The following information on each ECM and FIM is valuable for the Owner to have sufficient understanding of the finding, conditions, and recommendation to make an informed decision:

- Description of Finding
- Solution/Measure Description
- Implementation party and status
- Benefits
- Drawbacks/Risks
- Implementation Cost (if applicable)
- Energy, maintenance, operational savings
- Payback and/or Return on Investment (ROI) analysis (if applicable)

2.2.3.1 Document and Align Findings with Action Work Flow

2.2.3.2 Record Issues and Classify

Whenever an issue is discovered or reported, the first step is to properly record the issue in the Master List of Findings. Document the location, descriptions, timestamp, and status of the issue along with other classifications such as level of urgency, anticipated impact on system/building performance, cost (if applicable), and the nature of the issue—is it behavioral or mechanical, isolated or systemic? Pictures or screenshots can also be important to contextualize the issue for future reference or specific location identification.

2.2.3.3 Communicate Issues to the Team

Report issues to the established OCx team at the selected reporting/meeting interval as they accumulate. In the initial OCx meeting, the team can determine a recourse for issues that need urgent response and communication with the proper channels, and the timeline for communicating such concerns.

Review issues periodically; identify the recommended corrective action, then inform and schedule relevant parties involved.

2.2.4 Establish Communication/Coordination Methods and Procedures

2.2.5 Take Corrective Actions

2.2.5.1 Discuss and Review Potential Changes

The recommended corrective actions vary in the participating parties, cost, and timeline/duration. Before implementing corrective actions and modifications, acquire written approval by whatever means have been designated in the OCx Plan.

Schedule changes to create needed notifications, gather necessary tools and/or parts, with consideration of other potential impacts upon normal building operations and occupants.

Consider the scope and scale (or classification) of the issue being addressed when planning the implementation of a recommended corrective action. Some changes may be as small as a schedule modification while others may involve a part/equipment replacement.

2.2.5.2 Obtain Owner's Approval

The Owner approves and confirms means to proceed with any approved recommended actions.

2.2.5.3 Proceed with Approved Action Items

With the Owner's approval, work with the appointed team and responsible parties to carry out the recommendations from the findings and update the results by continuing to track the building's performance. OCx, by definition, is an iterative process. Adjustments, tuning, and continued tracking of building systems are expected.

Keep all facility staff aware of any changes and support updates to their preventive maintenance practices if workflows are impacted by the action items. Behavioral changes should be deployed per the Change Management Plan. Good communications during changes and transitions are key to monitoring whether the implemented actions are successful in improving building performance.

2.2.5.4 Perform Diagnostic Activities

Complete all diagnostic tasks according to the Diagnostic Plan. Document findings. Engage the Owner's O&M staff as needed to demonstrate and discuss items that can be addressed in the field. Compile picture and collected data into necessary visual results.

2.2.5.5 Collect and Document System Changes

Follow the OCx Plan to document corrective actions or modifications clearly, especially if they impact the Current Facility Requirements of the system or building.

Whenever the Current Facility Requirements for the building are adjusted, then the CFR document must also be updated during the course of the OCx process.

If corrective action results in the replacement of parts or equipment, then these changes may also require updating of other building documentation such as building equipment inventory logs or PM schedules. Confirm implementation and completion of action items using the approach defined in the OCx Plan.

2.2.5.6 Review and Report Impact of Changes

The intent of performing corrective actions or modifications to the building is to improve both system and building performance. Revisit changes during subsequent Cx review cycles to confirm that those changes have been effective. Document the outcome and update the status in the Issues Tracking Log to substantiate the success of the OCx project and possibly support future changes.

If the corrective action does not yield the expected outcome, then continue investigating the cause and nature of the issue. Follow-up may include a more extensive functional testing option, adjusting other parameters, or tracking the response for a longer period of time.

2.2.5.7 Consider Secondary/Tertiary Impacts of Changes

Be mindful of secondary effects that measures may have on performance or environmental conditions.

Monitor changes for their impact on system operation, occupant comfort, life-safety, or factors that may not have been considered when the modification was recommended and implemented. These impacts are sometimes anecdotal and may require the commissioning team to continue to engage the Owner's personnel to understand the effect.

2.2.5.8 Provide Follow-Up Reporting to Commissioning Team

If a performed change does not result in the desired improvement to the system/building, then report the outcome to the commissioning team and update the Issues Tracking Log.

2.2.6 Track Building Performance

2.2.6.1 Establish and Maintain Baseline/Benchmarks and Comparison Metrics

Establish the utility metrics used to track performance, such as a national standard or scoring systems such as Energy Star (which looks at Energy Use Intensity, EUI), or localized project metrics developed to improve peak demand and reduce utility billing charges. Ultimately, a combination of local goals and national/regional/industry metrics provides the most complete review of the building's performance.

Ideally, the CxP learns how data is input into the tracking system, particularly if an Owner has been using manual data entry. Over time, the standard metrics used for analyzing the building performance may need to be updated to adjust for utility changes, building changes, and/or code or goal changes.

2.2.6.2 Employ All Available Utility Metering and Sub-Metering

To provide a complete picture of regular energy consumption for the building and sub-systems, start by using multiple years of monthly utility meter data. Track utility invoice data to review monthly building performance. As additional sub-metering is available, document and update similar tracking of these sub-systems to compare even more frequent consumption data. Utility data consumption, peak demand, and load profile can all be valuable to the building's performance tracking.[3]

[3] [REFERENCE ASHRAE 90.1: Table 103-5B MINIMUM REQUIREMENTS FOR SEPARATION OF ELECTRICAL LOAD] Buildings installed to meet the ASHRAE 90.1 standards will equip the CxP with a robust starting point for tracking energy consumption. Per these requirements, the building metering will monitor and record lighting, receptacle, HVAC, appliance, renewable energy, water service, and industrial/commercial loads with a minimum of 50kVA. Loads larger than 250 kVA will have additional sub-metering circuits as well as aggregate loads metered. This degree of sub-metering allows for better identification of anomalous performance and seasonal load tracking.

A Measurement & Verification (M&V) plan can be a significant and useful parallel effort to Ongoing Best Practices. Upon Owner request or as a program requirement, M&V can be developed. The M&V plan can be written and updated by the CxP, incorporating the documentation and data collection of previous commissioning efforts and continuing to track energy consumption and building metrics over time.

2.2.7 Update OCx Plan

Prior to entering the Sustaining Phase, update the OCx plan established during the Planning Phase for continual use as a living document. Document the changes in processes, procedures, and scope in the OCx plan to be used for reference and future training.

2.3 Implementation Phase Deliverables

- Diagnostic Plan, Findings, Analysis and Report Document
- Updated OCx Plan
- Updated Facility Guide
- Master List of Findings

3 Sustaining Phase

The primary goal of a successful OCx project is the ongoing, sustained building performance for the long term, and ideally for the life of the building. As a process complementary to NCCx and EBCx, OCx provides the building owner with assurance that the investment in building systems and the optimization of those systems continues to operate in an optimal manner. As such, the Sustaining Phase is the critical means of moving from implementation of the OCx approach to a business-as-usual means of managing building performance.

In the Sustaining Phase, systems and improvements made are maintained over time, and the processes established for OCx are scaled down within the Cx Team and operations staff to those required to continue optimal building operation. Additionally, as with any dynamic system, maintenance procedures must be established to support the ongoing value and validity of data, analysis, and fault detection methods identified in the Diagnostic Plan.

An OCx project advances to the Sustaining Phase when the findings arising during implementation have been acted upon, and the rate of identifying new findings has been reduced significantly, therefore meeting with the Owner's goals and objectives. The building has then reached a reasonable level of stability and performance in accordance with the CFR. In addition, the Diagnostic Plan and corrective actions are now fully integrated into the Owner's workflow where OCx actions are business-as-usual for the O&M team. Technology infrastructure is fully implemented, with the technology maintenance staff making system adjustments as applicable to maintain the technology system integrity, sensor calibrations, and updates as necessary with CFR and facility changes.

The Sustaining Phase includes these activities:

- Implement Operating and Maintenance Procedures
- Transition to Stable Operations
- Monitor and Report Results

3.1 Implement Operating and Maintenance Procedures

3.1.1 Provide Regular Preventive Maintenance (PM)

All sources of data used in the OCx process are subject to data quality issues. In the Sustaining Phase, establish and conduct regular PM procedures and calibrations of the OCx related meters and instruments to ensure the validity of the monitored performance of the buildings and systems.

If a technology application is used for any system (BAS, EMIS), include a PM plan that validates and ensures the health of that system – i.e., its ability to accurately and consistently collect and manage the data supporting the OCx project. PM includes an assessment of the IT infrastructure (server hardware and software, networking, security, database management, data backups), OCx-implemented technology (software updates, license updates, configuration), and the communication or integration of data sources to the head-end platform.

The analytics (and applicable fault detection notifications) implemented as part of the diagnostic plan must also be reviewed on a regular basis (ideally monthly or quarterly) to ensure the OCx approach is accurately monitoring the building performance without generation of false indicators or superfluous notifications.

The PM approach ensures the complete end-to-end validation that the OCx methods:

- accurately measure performance parameters
- consistently collect related data
- apply the proper analytics necessary to identify performance issues.

The PM frequency applied to the above parameters depends on the specific technology in use and the product manufacturer-recommended testing frequency. An increase in false notifications or identified data monitoring errors are an indication to the OCx team that PM should be conducted on the system.

In addition to an increase in false notifications, a decrease in notifications may also be an indicator for required PM. The OCx team should refine the performance monitoring parameters to further optimize building performance, where possible, as part of a continuous improvement effort. For example, if chiller tonnage is monitored to identify load above an optimal level defined in the initial OCx implementation: should FIM approaches reduce that load below the setpoint consistently, and should the OCx team consider lowering the load setpoint for the performance notification to maintain performance at the newly achieved performance level?

3.2 Transition to Stable Operations

In the Sustaining Phase it is the objective of the OCx team to shift primary ongoing responsibilities for managing performance to the O&M Team. This transition of responsibilities is unique to the OCx approach and provides the means for facilities to maintain the OCx approach and best practices over the long term.

As OCx findings diminish, with evidence that recurrence of evaluated issues is not likely, the CxP identifies and implements a periodic schedule to review the OCx process and ensure ongoing management of the building's performance. Based on initial OCx findings, facility capital planning outlooks, and results of periodic checks, the CxP works with the building Owner and team on the

schedule for ongoing support — with the typical frequency being between quarterly and semi-annual reviews.

3.2.1 Update CFRs, OCx and Related OCx Process

During the periodic review of the OCx project, the CxP updates the OCx and Diagnostic Plan as applicable, to match building and systems activities to the efforts required to sustain performance over time. This may include providing updates to the review frequency, simplifying analyses of the top-level results and key performance indicators, and incorporating changes to the communication plan and schedule.

Ongoing engagement of the CxP ensures a level of accountability for maintaining the OCx best practices and provides an inspection of expected process methods. In addition to reviewing the OCx process and the capability of available tools to monitor performance, the CxP's review also ensure the building operators' continued ability to use the OCx process and tools to maintain building performance. Any revealed gaps in the process, tools, and capabilities of the team are evaluated and addressed by the CxP during this periodic review to ensure the continued, sustained performance expected from the OCx project. *(Continuous "Gap Analysis"?*)

3.3 Monitor and Report Results

3.3.1 Monitor Results of Documented Corrective Actions

Track and report the value of OCx to justify and validate the business case, and to support ongoing investment into the Sustaining Phase for the foreseeable future.

From the outset, the Commissioning Team decides upon the level of rigor, and how the results of OCx program actions are tracked and savings estimated.

The CxP establishes energy performance metrics for high-level performance, normalized for major external factors including weather and occupancy. Other opportunities for tracking can include cost savings estimated for each operating log item and statistics for the number of log items identified and addressed. The level of measurement and verification applied to the OCx project will depend on the contracted performance requirements for the project and client-specific business case requirements.

In addition to energy and energy cost savings, track and document operational savings and improvements. Operational savings include extended equipment life, reduced maintenance labor, safety improvements, and other benefits to the facility and maintenance organization. Also, capture and document collateral qualitative improvements to the organization, such as level of engagement of O&M employees, morale, buy-in, staff development, and reduction in employee turnover.

3.3.2 Inform Stakeholders of Performance

Regularly produce and distribute reports to identified stakeholders in a format that is meaningful, in order to ensure the OCx program is supported over time.

3.4 Sustaining Phase Deliverables

- Ongoing identification of FIMs for sustained facility performance

- Periodic update of CFR
- Periodic update of OCx Plan
- Periodic update of Diagnostic Plan
- Periodic performance reports

4 Definitions and Abbreviations

4.1 Abbreviations Used in this Document

Abbreviation	Phrase
BAS, BMS	Building Automation System, Building Management System
BCxA	Building Commissioning Association
CMMS	Computerized Maintenance Management System
Cx	Commissioning
CxP	Commissioning Provider
CFR	Current Facility Requirements
EBCx	Existing-Building Commissioning
ECM	Energy Conservation Measure
EIS	Energy Information System
EMIS	Energy management and information system
EUI	Energy Use Intensity
FDD	Fault Detection and Diagnostics
FIM	Facility Improvement Measure
FPT	Functional Performance Test
MLOF	Master List of Findings
M&V	Measurement and Verification
MBCx	Monitoring Based Commissioning
NCCx	New Construction Commissioning
OCx	Ongoing Commissioning
PM	Preventive Maintenance
QBS	Qualifications-Based Selection
ROI	Return on Investment
SaaS	Software-as-a-Service
VFD	Variable Frequency Drive
VPN	Virtual Private Network

4.2 Definitions

Phrase	Definition
Building Management System, Building Automation System	Hardware and software that provides building systems control and data management as typically applied to HVAC systems but can be integrated and/or programmed for lighting, security, and other systems control and monitoring.
Commissioning	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). Followed in EBCx by Current Facility Requirements (CFR).
Commissioning Provider	Firm or individual who, through coordinated actions, is responsible for implementing the Cx Process. Best practice recommendation: Third-Party Commissioning Providers are commissioning consultants hired directly by the building owner and are not responsible to, or affiliated with, any other member of the design and construction team.
Commissioning Team	The key members of each party involved with the project designated to provide insight and carry out tasks necessary for a successful commissioning project. Team members may include the commissioning lead, building Owner or Owner's representative, building staff, design professionals, contractors or manufacturer's representatives, testing specialists, and the rating system coordinator. The team may also consist of a group of commissioning system specialists in such areas as building enclosure, lighting controls, fire protection and more.
Current Facility Requirements	A written document that describes 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.
Diagnostic Plan	Plan that describes the methods, frequency, and application of evaluating system performance through the collection and analysis of building system data.
Existing-Building Commissioning	A quality-focused process for attaining the CFR of an existing building and/or its systems and assemblies. The process focuses on planning, investigating, implementing, verifying, and documenting that the facility and/or 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.

Phrase	Definition
Energy Information System (EIS)	The software, data acquisition hardware, and communication systems used to store, analyze, and display building energy data. An EIS often includes analysis methods such as baselining, benchmarking, utility and carbon tracking, load profiling, and energy anomaly detection. Energy Information Systems are a subset of EMIS focused on meter-level monitoring (hourly or more frequent), sometimes also called enterprise energy management systems.
Energy Management and Information System (EMIS)	Energy Management and Information Systems (EMIS) comprise a broad family of tools and services to manage commercial building energy use. These technologies offer a mix of capabilities to store, analyze, and display energy use and system data, and in some cases, provide control. EMIS is an umbrella term that covers both meter-level and system-level EMIS. Used to manage facility energy information and data including the baseline, benchmark, and ongoing tracking of utility bill, utility meter, and related submeter data. System may also be integrated to the BMS/BAS for system specific data management and performance evaluation.
Facility Guide	The Facility Guide referred to in this OCx Best Practices document, and what is sometimes referred to as a **Systems Manual** in the industry, is what ASHRAE defines as "a basic building systems description and operating plan with general procedures and confirmed facility operating conditions, set points, schedules, and operating procedures for use by facility operations to properly operate the facility."
Fault Detection and Diagnostics (FDD)	Alarm or notification of system abnormality. Typically programmed into BAS/BMS or other monitoring software for operator awareness of system faults and issues. FDD automates the process of detecting faults with physical systems and processes and diagnoses their potential causes. FDD systems for HVAC generally use a database of "expert rules" that analyzes BAS and meter data to determine fault conditions. FDD is a subset of EMIS, focused on system-level monitoring (using the BAS data).
Facility Improvement Measures	Alterations or revisions to systems or equipment planned to improve building and system performance, reduce Operations and Maintenance (O&M) costs and/or improve the indoor environmental quality as part of an EBCx or OCx process.
Functional Performance Test Protocol	A written collection of tests that, when executed in the test process, allow verification of the performance of a system or assembly. **See Diagnostic Plan**
Master List of Findings	A summary list of findings generated during the investigation process. For each finding, the list contains fields such as: finding description, type of equipment, recommended improvement, estimated energy savings and costs, simple payback, recommendations, and status of implementation. Also known as the Findings Log.

Phrase	Definition
Measurement and Verification	Methods for gathering relevant data over time to evaluate performance and benefits. Often related to performance contracting where performance measurement is needed for validation of project financial savings and operating performance requirements.
Monitoring Based Commissioning	A process to improve the operation of buildings with an emphasis on using meter-level or system-level data analysis to identify opportunities for improvements (analysis approaches may be embedded in EMIS software). The MBCx process includes initially bringing the building systems up to the owner's operating requirements through an existing building commissioning process, then performing ongoing commissioning to identify and correct degraded performance over time. Alternatively, EMIS tools can be utilized during the EBCx process to support issue identification.
New Construction Commissioning	A quality-focused process for verification of Owner's Project Requirements (OPR) and turnover of new construction to stable operations. The process includes validation of project performance through design review, construction review and functional testing, training, and turnover to operations.
Ongoing Commissioning	The means and process to optimize and sustain building performance on an ongoing basis through investigation, analyzing, and monitoring the performance of building systems. As a continuation of the Cx Process typically implemented following NCCx or EBCx, OCx verifies 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).
OCx Plan	A document that outlines the organization, goals, schedule, allocation of resources, and documentation requirements of the OCx Process. Includes a Program Management Plan, a Change Management Plan, a Diagnostic Plan and relevant process and facility operating documents.
Owner	"Owner" can refer to different actors who represent financial and performance decisionmakers regarding the building facilities.
Training Plan	A written document that details the expectations, schedule, budget, and deliverables of Cx Process Activities related to training of project team members, including facility managers, O&M personnel, users, and occupants.
Test Procedure	A written protocol that defines methods, personnel, and expectations for tests conducted on components, equipment, assemblies, systems, and interfaces among systems.
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.

5 References

ASHRAE Guideline 1.2-2019: *Technical Requirements for the Commissioning Process for Existing HVAC&R Systems and Assemblies*

ASHRAE (2015), *ASHRAE Guideline 0.2-2015: Commissioning Process for Existing Building Systems and Assemblies*

ASHRAE/Building Commissioning Association (2019), *Commissioning Stakeholder's Guide*

Building Commissioning Association (2019), *Existing Building Commissioning Best Practices*

Building Commissioning Association (2018), *New Construction Commissioning Best Practices*

Building Commissioning Association/APPA (2017), *Building Commissioning Handbook, Third Edition*

California Energy Commission/California Commissioning Collaborative (2011), *The Building Performance Tracking Handbook*

Lawrence Berkeley National Laboratory (2017), *Characterization and Survey of Automated Fault Detection and Diagnostic Tools*

Lawrence Berkeley National Laboratory (2017), *Monitoring Based Commissioning Plan Template*

Lawrence Berkeley National Laboratory/Department of Energy (2011), *Energy Information Handbook: Applications for Energy-Efficient Building Operations*

U.S. Department of Energy (2015), *M&V Guidelines: Measurement and Verification for Performance-Based Contracts Version 4.0*