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Retrocommissioning Program Manual

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Section 1: Introduction

1.1 Program Overview

Focus on Energy, Wisconsin's statewide resource for energy efficiency and renewable energy, offers assistance to eligible Wisconsin businesses and residents to install cost effective energy efficiency and renewable energy projects. Focus on Energy provides financial and technical support to customers of participating Wisconsin utilities for a wide variety of energy efficient technologies and products available today.

Most Focus on Energy financial incentives apply to energy efficiency projects with simple payback periods between 1.5 and 10 years. However, the Retrocommissioning Program (RCx Program) complements these by offering incentives for energy engineering services which identify low- and no-cost energy efficiency measures with simple payback periods of 1.5 years or less. RCx Program participants are then required to implement these identified measures at their own expense.

The RCx Program is designed to achieve gas, electric demand, and electric energy savings in commercial, industrial, school, and government facilities by optimizing existing facility systems for present building usage. In many cases, occupant comfort improvements accompany the energy efficiency gains realized through the RCx Program.

Existing facilities with a building automation system (BAS) and direct digital controls (DDC) may be eligible for the RCx Program. RCx Program applicants should have no major renovation or large capital investments pending. Additionally, the nature of many RCx Program measures requires that the building Owner and its operations and maintenance (O&M) staff are committed to achieving and maintaining RCx Program goals.

Participating Owners may receive incentives which pay for up to 85 percent of the investigation and reporting costs associated with the RCx Program if performed by a qualified RCx Trade Ally (RTA) and the terms of the program are followed. While Focus on Energy recognizes that the RCx Program is a best practice and can benefit most facilities, Focus on Energy is required to maintain a level of cost effectiveness per unit of energy savings and cannot approve all applicants for participation. Please contact your energy advisor or call 800.762.7077 for alternative programs if your facility is not accepted into the RCx Program. Focus on Energy may also provide incentives to offset implementation costs for identified measures having a simple payback period of more than 1.5 years.

1.2 Retrocommissioning and the Commissioning Process

Focus on Energy recognizes that there are many interpretations of retrocommissioning. While many of the practices in these interpretations may improve building systems and deliver energy savings, Focus on Energy prescribes its particular RCx Program as a best practice which delivers the most cost effective and consistent solutions for improving building performance. In order to promote this best practice in Wisconsin, Focus on Energy requires RTAs to follow the terms and instructions of this manual while performing RCx services.

The RCx process results in a more in-depth analysis than simple energy audits or building tune-ups. An energy audit usually entails surveying existing equipment and proposing upgrades to increase energy efficiency through increased component efficiency. However, the more detailed RCx process determines operational and equipment energy consumption and inefficiencies based on current facility requirements (CFR). This RCx process identifies equipment, system,

and operational improvements and provides the Owner with guidance on how to optimally operate and maintain the facility.

Focus on Energy has also adopted many of the recommendations made by the *Building Commissioning Association's (BCxA) Best Practices in Existing Building Commissioning*. Steps adopted from the BCxA guide are noted with a ^{BP} sign. For more information on the commissioning process, BCxA best practices, or guidance on commissioning for new construction or existing buildings, see the references provided at the RCx home page at <http://www.focusonenergy.com/rcx>

1.3 Manual Audience and Intended Use

This program manual is specifically designed for use by building Owners and RTAs working with Focus on Energy to deliver high-quality retrocommissioning services according to the RCx Program process. This manual is also intended for program participants and building Owners to fully understand the retrocommissioning process according to the Focus on Energy RCx Program. This manual provides specific information about the RCx Program and the roles and responsibilities of the RTA, building Owner, and Focus on Energy Representatives. It is intended to supplement the general program information provided in the Retrocommissioning Participant Program Guide.

Section 2: Retrocommissioning Program Overview

2.1 Program Description

The RCx Program is designed to reduce the cost of conducting an expert building analysis for the building Owner. The goal of the RCx Program is to reduce the Owner's energy consumption by identifying and implementing measures to optimize existing facility systems and satisfy CFRs. Implementation incentives may be available to reduce the costs of identified FIMs if the estimated simple payback period is greater than 1.5 years. However, Focus on Energy's Retrocommissioning Program does not provide incentives for engineering services associated with the investigation of capital equipment measures.

Capital expenditure projects may be eligible for custom incentives to cover implementation costs through other Focus on Energy incentives independent of the RCx Program.

Examples of typical FIMs identified in the RCx Program:

- Improved outside air control
- Decreased supply air pressure set point and system rebalancing
- Reduced supply air temperature and fan speed in air handling units

The RCx Program does not provide services or support for new construction projects. New construction projects may be eligible for incentives independent of the RCx Program.

Each project in the RCx Program consists of five phases:

1. Application phase
2. Planning phase
3. Investigation phase
4. Implementation phase
5. Verification phase

Detailed information about each of the five program phases is presented in corresponding sections of this manual.

Focus on Energy has developed the RCx Submittal Workbook which is intended to be the primary deliverable for the RTA. The RCx Submittal Workbook contains templates, tables, and forms corresponding with the deliverables listed in this Manual. The RCx Submittal Workbook and optional training session will be provided to the RTA upon request.

2.2 Owner Eligibility/Selection

Eligible facilities must meet the following minimum eligibility requirements before submitting an application for consideration in the RCx Program:

- The facility must be a commercial, industrial, school, or government building consuming at least \$400,000 of natural gas and/or electricity annually from energy providers which participate in Focus on Energy. Energy costs associated with manufacturing processes may not be counted towards the minimum annual energy cost. A list of participating utilities is available on the Web site at focusonenergy.com, or by calling Focus on Energy at 800.762.7077.
- The Owner must express a willingness to commit funding according to the implementation requirements defined in section 2.3.
- The facility must have a building automation system (BAS) with direct digital control (DDC).
- The facility must be free of major problems requiring costly repairs or replacements and have no planned major system renovations or retrofits.
- The facility should have accessible and up-to-date building documentation and records.
- The Owner and its O&M staff must express a commitment to be actively involved in the RCx process with a commitment of at least 40 hours by the O&M staff.
- The Owner and its O&M staff must deliver a persistence plan prior to project completion demonstrating strategies for maintaining energy savings identified in the RCx Program
- Facilities that are involved in an energy performance contract are not eligible for participation in the RCx Program.
- The project may not exceed one year. If the Owner is unable to meet their implementation obligation by one year from the project kick-off date, no incentive will be paid.

In order to maintain the cost effectiveness of the RCx Program, applications are analyzed for energy savings potential prior to being accepted in the RCx Program. Upon receiving a completed application, a Focus on Energy representative may schedule a site visit to review RCx Program guidelines and goals with facility personnel, gather additional information about the existing systems, and to estimate energy savings potential.

Many factors will be considered when reviewing an application. Facilities that are inefficient relative to facilities of similar type and size are particularly good candidates for the RCx Program. The RCx Program will also consider types of heating, cooling, and ventilation systems present, system robustness, BAS capabilities, and facility staffing. Facilities with high specific demand (peak demand, kilowatt-hours of electricity per square foot, therms of natural gas per square foot, and kilowatts per square foot) and annual energy costs are good candidates to be selected for program participation. If Focus on Energy staff is able to determine sufficient potential energy savings for acceptance in the RCx Program, the project will be approved to proceed into the planning phase.

To be eligible for an incentive, the Owner MUST agree to the terms of and complete the grant agreement PRIOR to initiation of the planning phase of the RCx Program. This grant agreement for the RCx program applies only for the planning phase. Subsequent phases of the RCx Program require additional screening and the completion of an additional grant agreement. Approval for the planning phase does not ensure subsequent phases will be included in the RCx Program.

Additional information about the application review and selection process is provided in Section 4 of this manual.

2.3 Funding and Incentives

Program funding and incentives are provided to accepted participants as follows:

- Planning phase trade ally fees are reimbursed 100%, not to exceed \$7,500 following the submission of a completed grant application and agreement for the planning phase. The incentive is dependent on successful delivery of the planning phase deliverables according to program guidelines within the timeframe allotted (typically eight weeks). Planning phase incentives are processed upon phase completion.
- Investigation phase trade ally fees are reimbursed 85%, not to exceed the investigation phase incentive limits shown in Table 2 for eligible services identified in the Retrocommissioning Program Manual. A separate grant agreement for the investigation phase must be submitted before the investigation phase is initiated. Investigation phase incentives are paid upon receipt of all deliverables, completion of the implementation requirements, verification and receipt of the Owner's persistence plan. If the Owner fails to meet all of the requirements, no incentive will be paid and the Owner will be responsible for all costs associated with the RCx Program after the planning phase.
- Implementation incentives may be provided through the standard Focus on Energy incentive programs to offset the cost of identified low-cost measures if the simple payback period of the measure exceeds 1.5 years. Focus recommends that all measures identified in the RCx Program be pursued even if the simple payback period exceeds 1.5 years. Incentives can buy-down these implementation costs for the Owner.
- Building Owner's whose annual energy costs exceed \$1,500,000 may have difficulty completing the RCx Program for the entire facility within the 1 year time frame. These facilities may apply for the RCx Program in two phases. The central plants and a majority of the floor space are investigated during the first project and the remainder of the facility is evaluated in a second project. The projects will be treated as two separate RCx Program projects by Focus and will receive incentives accordingly. Focus on Energy reserves the right to accept or reject the application for the second phase on its own merits, independent of the analysis or success of the first project.

Table 1 Incentives Summary

Phase	Costs to Owner	Maximum Incentive	Maximum Reimbursement
Planning	RTA Fees	\$7,500	100%
Investigation	RTA Fees	See Below	85%
Implementation, <1.5 year simple payback	Implementation Costs	\$0	0%
Implementation, >1.5 year simple payback	Implementation Costs	Standard Focus on Energy incentive limitations apply	Standard Focus on Energy incentive limitations apply

Table 2 Investigation Phase Incentive Limits

Total Annual Energy Cost	Implementation Requirement	Investigation Incentive Limit
\$400,000-\$749,999	\$15,000	\$12,500
\$750,000-\$999,999	\$20,000	\$22,500
≥ \$1,000,000	\$25,000	\$32,500

2.4 Facility Improvement Measures (FIMs)

The RCx Program seeks to realize the energy reduction potential of low- and no-cost opportunities in many facilities. Conversely, capital investment measures are not included or supported in the RCx Program. Rather, capital investment measures are addressed by other energy efficiency offerings from Focus on Energy. Table 3 lists FIMs which are commonly identified and implemented in the RCx Program and those which typically do not qualify.

Table 3 Example Eligible and Ineligible FIMs

Eligible FIMs
<ul style="list-style-type: none"> ■ Reduce minimum outside air flow ■ Correct economizer operation ■ Eliminate simultaneous heating and cooling ■ Repair compressed-air leaks ■ Reduce supply air static pressure set points ■ Eliminate chilled water short-circuiting ■ Improve chiller or other equipment sequencing ■ Correct refrigerant charge ■ Improve equipment scheduling ■ Reduce air flow in CV air-handling systems ■ Improve refrigeration system controls ■ Improve process controls
Ineligible FIMs
<ul style="list-style-type: none"> ■ Fuel switching ■ Measures that negatively affect occupant comfort ■ Major equipment replacement (capital expenditure) ■ Measures necessary for basic facility operation

2.5 Focus on Energy Contact Information

All questions about Focus on Energy's Retrocommissioning Program should be directed to the Focus on Energy Retrocommissioning Program manager.

Commercial participants should direct questions to:

Focus on Energy Retrocommissioning Program
10535 N Port Washington Rd, Suite 201
Mequon, WI 53092
Phone: 888.598.4376
Fax: 262.240.0825
Email: commercial@focusonenergy.com

Industrial participants should direct questions to:

Focus on Energy Retrocommissioning Program
5609 Medical Circle, Suite 201
Madison, WI 53719
Phone: 608.277.2949
Fax: 608.277.2947
Email: industrial@focusonenergy.com

School and Government participants should direct questions to:

Focus on Energy Retrocommissioning Program
725 W. Park Ave.
Chippewa Falls, WI 54729
Phone: 715.720.2130
Fax: 715.720.2070
Email: sandg@focusonenergy.com

Section 3: Retrocommissioning Trade Allies

Additional information about the RTAs' role within the RCx Program and the relationship with the Owner is provided below.

A list of RCx Program trade allies with demonstrated qualifications to perform work according to the RCx Program is provided on the RCx Program page of the Focus on Energy Web site at focusonenergy.com/rcx.

Prior to accepting a facility into the RCx Program, the RTA selected for the project must identify the RCx project team leader, also referred to as the Commissioning Authority, and sufficient support personnel for the RCx Program. The role of the Commissioning Authority is to conduct commissioning activities as according to the Focus on Energy Retrocommissioning Program Manual. Commissioning specific certifications are not required, but they are encouraged for the Commissioning Authority and team members.

3.1 RCx Team Members Defined

Owner – facility Owner sponsoring the commissioning activities and decision maker for the project

Owner's representative – RCx team member assigned by the Owner to support the commissioning process by overseeing facility team interactions, responding to requests for information and making non capital decisions for the Owner

Retrocommissioning Trade Ally (RTA) – prequalified service provider contracted to perform retrocommissioning activities by the Owner

Commissioning Authority (CxA) – Commissioning team leader assigned by the RTA to project manage the commissioning process. The CxA is responsible for creation and execution of the retrocommissioning plan.

Retrocommissioning Energy Advisor – Focus on Energy representative responsible for helping the commissioning team members navigate through the Focus on Energy Retrocommissioning program.

3.2 Contracting with Owner

The Owner selects the trade ally to perform work in the RCx Program. RTAs must submit an application for the project team identifying the CxA, qualifications, experience, examples of prior projects, and engineering support availability. Focus on Energy can provide a list of trade allies who may be able to provide RCx Program services if the customer does not have an approved RTA at time of application. RTAs must also submit applications for RCx Program teams for approval to Focus on Energy. RTAs contract directly with the Owner.

RTAs may be removed from the RCx Program at Focus on Energy's discretion. Examples of activities that will lead to removal include, but are not limited to:

- Failure to meet project timelines
- Poor deliverable quality
- False representation or marketing to Focus on Energy customers

3.3 Program Marketing and Owner Communication

RTAs play a critical role in identifying viable project opportunities for the RCx Program and facilitating the Owner application process. Extreme care must be taken to avoid creating false Owner expectations and dissatisfaction with the RCx Program or Focus on Energy, especially in light of the selective nature of the RCx Program. Therefore, RTAs are encouraged to understand the entire suite of energy efficiency program options available from Focus on Energy to determine which program is best suited to an Owner's particular needs.

The CxA should schedule bi-weekly update meetings with the Owner and Focus on Energy to review progress and update the project schedule. Focus on Energy contact information is provided in Section 2.5.

3.4 Payment for Program Services

The Owner will only receive incentives from Focus on Energy if the CxA follows the process and deliverables as stated in this manual. The Owner will only receive an incentive for services if a grant agreement has been completed and submitted **PRIOR TO SERVICES BEING PERFORMED**. No capital improvement investigations are acceptable without prior written approval by Focus on Energy. The Owner should structure a contract which explicitly requires the RTA to follow this manual.

3.5 Additional Owner Services

Focus on Energy recognizes that opportunities outside the scope of the RCx Program may be identified during the planning and investigation phases. Owners are free to pursue additional contracting with the RTA to expand the work scope (for example, identify capital improvements or other savings opportunities) and cover all RTA time and costs associated with these additional services. Addition of these services must not create an unnecessary delay in the performance of RCx Program services. Owners may request that the RTA also provide the FIM implementation services. Under these circumstances, the RTA and Owner will be responsible for all contracting activities related to providing implementation services.

Section 4: Application Phase

4.1 Application Phase Overview

A project begins with the application phase. RCx applications are completed by the Owner and RTA and submitted to Focus on Energy. Based on a review of submitted applications, Focus on Energy will select applicant facilities that meet the eligibility criteria and program goals for cost-effectiveness, energy savings, and verifiability. Focus on Energy's decision regarding selection of program applicants for the Retrocommissioning Program will be final and binding on all parties.

Applications are available by contacting the RCx Program Manager listed in Section 2.5.

4.2 Application Phase Execution

The RTA should assist the Owner in completing the RCx Application and establishing reasonable expectations during the application phase. The RTA may submit the RTA portion of RCx Application in advance in order to prequalify a project team. Any changes to the project team require reapplication. The RTA need not have identified a project location in order to prequalify a project team. The Owner holds the primary responsibility for completing and submitting an application to Focus on Energy.

4.3 Application Review

The selection criteria identified in Section 2 will be used to evaluate applicants. Focus on Energy will select facilities that meet the criteria and program goals for cost-effectiveness, energy savings, and verifiability to participate in the RCx Program. Focus on Energy's decision regarding selection of program applicants for the RCx Program will be final and binding for all parties.

4.4 Application Phase Deliverables

The RTA is responsible for filling out the trade ally application portion of the RCx application, while the Owner is responsible for filling out the remainder of the RCx application. However, the RTA may assist with the completion of the application.

Generate a Portfolio Manager™ Score – A Focus on Energy representative may create an ENERGY STAR™ benchmark for the Owner using the Portfolio Manager™ tool. This rating will establish a good baseline for the project, assist with project persistence and could lead to getting the facility ENERGY STAR™ certified. If the facility is not eligible for a Portfolio Manager™ score, a benchmark will be established using a reasonable metric (i.e. kWh/ft², therms/ft², kBtu/ft², etc.)

Utility History Analysis – A Focus on Energy representative may complete a utility history analysis. The utility history analysis is useful to determine the overall trend of a facility's energy consumption.

If completed by a Focus on Energy representative, the utility history analysis and Portfolio Manager™ Score will be presented to the Owner within two weeks of the application phase site visit.

Section 5: Planning Phase

5.1 Planning Phase Overview

Following acceptance of a project into the RCx Program, work begins to establish project scope and a timeline in the planning phase. This planning phase typically takes about four to eight weeks. The typical planning phase includes but is not limited to the key activities below.

Planning phase key activities

- Kick-off meeting
 - Operator Interview
 - Interview key O&M personnel
- Site assessment
 - Energy audit
 - Documentation survey
- Preliminary analysis
 - Develop current facility requirements (CFR)
 - Quantify preliminary findings
 - Generate preliminary FIM List
 - Generate a portfolio manager rating (ENERGY STAR™ benchmark score) Only necessary if not completed by Focus on Energy during the Application Phase
- Project planning
 - Create RCx Plan
 - Systems level testing and diagnostics plan
 - FIM investigation and diagnostics plan
 - Project timeline development
 - Determination of roles and responsibilities

At the completion of the planning phase, Focus on Energy may approve the project to move forward into the investigation phase based on the findings contained in the planning phase deliverables. The CxA may not proceed to the investigation phase without Focus on Energy's approval and the owner's completion and submission of a grant application and agreement.

5.2 Planning Phase Execution

CxA responsibilities associated with the planning phase center around completing the preliminary site assessment, identifying the current facility requirements (CFRs), and the development of the RCx Plan. Based on the findings of the planning phase, the CxA develops the RCx Plan to serve as the guiding document for the balance of the project. A viable RCx Plan is required before the Owner is approved to proceed with the investigation phase. Additional details regarding the planning phase are provided below.

5.3 Key Activities

Kick Off Meeting

The initial project kick-off meeting is held soon after acceptance of the project application. Key attendees include the Owner, facility staff, the RTA team, and Focus on Energy. The meeting is used to introduce key personnel among the RTA team, the facility staff, and Focus on Energy. During the meeting, the CxA reviews planning phase activities, facility access, and requirements of the facilities team. This meeting also sets the deadlines required for the planning phase deliverables, investigation report, and the implementation of required FIMs.

Interview Key O&M Personnel^{BP} – Interviewing personnel allows the CxA to learn from their extensive knowledge and experiences from working in the building on a daily basis. Often, deficiencies or FIMs can be identified by O&M personnel. The CxA must utilize the Operator Interview Form provided in the Focus RCx Submittal workbook.

Deliverable: Operator Interview Form (RCx Submittal Workbook)

Site Assessment

Site assessment activities often follow directly after the kick-off meeting, with the CxA conducting a preliminary site visit to understand key facility systems and their operation. Site assessment activities conducted by the CxA typically include:

Preliminary Energy Audit^{BP} – Perform a cursory walk-through of all major spaces to gain an understanding of the types of spaces, condition of spaces, occupancy levels, lighting, controls, and any other prevalence of information technology related infrastructure and equipment. Add FIMs identified as part of the walk through to the preliminary FIM list.

Documentation Survey^{BP} – The CxA should review all building documentation, such as building plans and specifications, O&M manuals, maintenance documentation records, etc. This review helps to increase understanding of the building, but the primary focus is to determine the availability of documentation for the investigation phase. Record what documentation is available, where the documentation is kept, who is responsible for the documentation and any deficiencies.

Deliverable: Documentation Survey (RCx Submittal Workbook)

^{BP} Best Practices in Commissioning Existing Buildings, Building Commissioning Association

Common FIMs Checklist – Based on the preliminary site assessment and operator interview, the CxA should have enough information to complete the checklist. The CxA should consider FIMs at this time. This checklist contains typical FIMs identified in multiple RCx projects that have proven to be cost effective to implement and can have a dramatic impact on energy consumption. The checklist is intended to be a guide for the CxA to identify FIMs based on operator interviews and the site assessment.

Deliverable: Common FIMs Checklist (RCx Submittal Workbook)

Preliminary Analysis

Preliminary analysis can be performed offsite from the data obtained from the site audit.

Develop the Current Facility Requirements (CFR)^{BP} – The process starts with a review of, and if required, an update to the CFR which defines the current operational needs and requirements of the building. For buildings that under took the new building commissioning process, the CFR is an evolution of the Owner’s Project Requirement (OPR) established during the original commissioning process. If the building has had its usage changed from the original design, or if the CFR doesn’t exist, the CxA with the assistance of the Owner should develop a detailed CFR. Items such as temperature, humidity, operating hours, filtration, sound, vibration, and/or specialty needs must be discussed and agreed upon in the CFR. The CFR should note any integrated requirements such as controls, fire and safety, personnel training, warranty review, service contract review, security systems, etc.

Deliverable: CFR (RCx Submittal Workbook)

Quantify Preliminary Findings – A master list of findings will be generated from the site audit and preliminary analysis activities above. These findings must indicate estimated kWh, kW and therms savings. While the planning phase savings calculations are not as rigorous as those performed in the investigation phase, they must be supported by field observations, actual equipment specifications, and operating conditions. Calculations based solely on rules of thumb or unsupported assumptions are not acceptable. A template for the master list of findings is provided in the RCx Submittal Workbook. The list of findings should be followed by descriptions for each measure in narrative form including technical feasibility, likely owner buy-in, and savings persistence. Measures that are too preliminary to provide savings information should be described in narrative form. Deviations from this template must be approved in writing by Focus on Energy.

For each FIM identified the CxA should develop a diagnostics and testing plan to determine the savings potential of the related FIM. Valid data collection techniques include data logging, EMS trending, and spot measurements. EMS trending must be preceded by point calibration in order to validate data. Spot measurements should only be used for static systems or where logging and trending are not applicable. Level of effort in the development of FIM testing and diagnostics plans should be in line with the potential savings realized with its implementation. The FIM testing and diagnostics planning is included in the RCx Submittal workbook as columns labeled “Investigation Approach” and “Data Collection”.

Deliverable: Preliminary FIM List (RCx Submittal Workbook)

^{BP} Best Practices in Commissioning Existing Buildings, Building Commissioning Association

RCx Plan

Based on all of the work performed above, the CxA assembles a scope of work for the investigation phase of the project. The investigation activities should be based on the CFR and the preliminary findings. Select systems may receive more in-depth investigation in order to trouble shoot a deficiency. In the case of small or recently commissioned systems, investigation activities may be reduced in order to cut costs. Since this step defines the scope of work for the project it is reasonable to quote fees separately for the planning phase when the application is submitted and quote fees for the investigation phase at this time.

Focus on Energy will *not* approve a project to move beyond the planning phase without a clearly defined scope of work for the investigation activities. Qualities associated with good retrocommissioning plans are presented below.

- Includes a detailed description, in narrative format, of investigation approach to verify compliance with CFR in all modes of operation while identifying the level of testing for each system (i.e. 100%, sample X%, all units larger than X, etc.).
- All major HVAC and control systems should be included in the RCx Plan
- Dictates success criteria (i.e. Pass/Fail) for commissioning activities and defines project completion
- Allows for additional investigation or verification activities that may arise as a result of discovery during the investigation phase

The bulk of the investigation activity involves verifying that the systems being evaluated meet the CFR. Focus has provided a testing guide and data collection forms for systems level testing. This represents the minimum level of systems level testing accepted by the RCx Program. The RTA and Owner may agree to do more extensive testing as part of the project and include the cost of these activities in the RCx study cost that is eligible for reimbursement.

Deliverable: RCx Plan (RCx Submittal Workbook)

Project Timeline Documentation^{BP} – A detailed schedule of activities is developed to ensure project completion in a timely manner. A template has been provided in the RCx Submittal workbook if the CxA does not utilize other project management software.

Deliverable: Project Timeline (RCx Submittal Workbook)

Establish Roles and Responsibilities – Document roles and responsibilities of parties involved in the RCx process. This is an important step that prevents confusion and delays later in the process.

Deliverable: Roles and Responsibilities (RCx Submittal Workbook)

^{BP} Best Practices in Commissioning Existing Buildings, Building Commissioning Association

5.4 Plan Presentation

Planning phase deliverables must be submitted to Focus on Energy for approval prior to being submitted to the Owner. Iterations may occur as directed by Focus on Energy. Upon Focus on Energy approval of the planning phase deliverables, a meeting will be held to present the results with the Owner. Provided a viable RCx Plan has been developed, and the project displays potential (see below), Focus on Energy will approve the project to move forward into the investigation phase.

5.5 Focus Funding Justification

To help ensure that the project will result in cost-effective savings, Focus on Energy will compare the proposed RCx Program incentive against a theoretical tier two custom incentive for identified FIMs computed at rates of \$0.45 per therm, \$0.045 per kWh, and \$150 per peak kW. For projects where preliminary RCx Program savings estimates fail to meet the tier two equivalent calculations, Focus on Energy may require the Owner to revise the work scope with the RTA. Alternatively, the project may be redirected towards another Focus on Energy program. If the project is not approved to move beyond the planning phase, an incentive of \$7,500 not to exceed 100% of the planning phase costs will be issued. No additional work will be performed under the RCx Program or payments made.

5.6 Planning Phase Deliverables

The CxA is responsible for the deliverables listed in the sections above. The CxA shall submit the RCx Submittal Workbook to the RCx Energy Advisor upon completion of the planning phase deliverables. The target timeline for completion of the planning phase is approximately four weeks for a typical project.

Section 6: Investigation Phase

6.1 Investigation Phase Overview

During this phase, the CxA carries out detailed investigation activities. This phase lasts approximately 12 weeks and is conducted during times when affected building systems are operational (e.g. not during the winter for most HVAC related FIMs). It involves the detailed investigation of the systems identified in the RCx Plan and further investigation to identify additional FIMs. Final results are summarized in the investigation report and presented to the Owner to identify an implementation plan. A typical investigation phase will contain but not be limited to the key activities listed below.

Investigation Phase Key Activities

- Basis of operation review
 - Documentation review
 - Facility performance analysis
 - Detailed site assessment
- Systems diagnostic monitoring
- Systems performance testing
- Develop master list of findings
- Develop M&V plan

6.2 Investigation Phase Execution

During the investigation phase, the CxA, with assistance from the facility engineering staff, will expand on the site assessment activities completed during the planning phase to develop an in-depth understanding of the facility systems.

The Owner typically implements FIMs after the investigation phase has been finalized. In some cases, however, the Owner may wish to implement selected FIMs before the phase is complete. Such instances will require the approval of Focus on Energy, the CxA, and the owner. A key requirement in these cases is that sufficient information be collected by the CxA to document the baseline and estimate the FIMs energy savings potential before implementation begins. Any early implementation is to be documented.

At the completion of the investigation phase, all deliverables should be submitted to Focus on Energy for review and approval. Iterations may occur as directed by Focus on Energy. The results of the investigation phase are documented in the RCx Submittal Workbook, which also includes recommended improvements, energy savings estimates and simple payback calculations. A project meeting will be held to review the investigation phase and the project recommendations. The measures to be implemented will be agreed upon by the Owner and Focus on Energy. Upon selection of the measures, the existing program agreement will be amended to include a commitment to implement the selected measures, any incentive offer and a mutually agreed-upon implementation timeline.

6.3 Key Activities

Basis of operation review

Activities during the basis of operation review are performed in order to establish precisely how the building is being operated and identify any deficiencies that may exist as result of these operations along with the corresponding FIMs.

Documentation Review^{BP} – Review building drawings and documentation to understand the building energy usage, initial basis of design, and evaluate the system integration. The review process includes the evaluation of all old and new drawings, specifications, test and balance reports, operations and maintenance manuals (typically related to mechanical, electrical, and controls).

Facility Performance Analysis^{BP} – Collect and analyze available energy, non-energy and other systems performance data to establish baseline benchmarks for facility performance. Available facility performance data may include utility billing data, sub-metering data, work orders, comfort complaint logs, indoor air quality parameters, occupant satisfaction survey results, BAS trend data and/or stand alone logger data.

- Most large energy providers offer access to 15 minute interval data upon request. This data should be included in performance analysis and as a means to identify scheduling and peak shedding opportunities as well as a means to verify implemented measures.

Detailed Site Assessment – A detailed assessment of the facility and the major energy-using equipment is necessary to expand on the general site assessment done in the planning phase. The detailed assessment focuses on problem areas identified by facility staff, identified FIMs, and potential new FIMs. At the system and equipment level, the assessment involves collecting nameplate information and conducting a minimum standard set of diagnostics and functional tests.

Systems level retrocommissioning

Utilizing the systems level RCx guide, verify that the systems meet the CFR. Identify deficiencies and related FIMs. Record information from testing on the data sheets provided in the RCx Submittal Workbook. The tests and calibrations included on these forms represent the minimal level of testing accepted by the RCx Program. Document the results of any testing performed in addition to the minimum program requirements. When using the EMS system to trend data, verify sensor calibration and validate location prior to running analysis. Spot measurements must include values for power factor when measuring watts and amps to determine power. Verify calibration of measurement devices prior to installation on site to avoid errors.

Deliverables: systems level RCx guide data sheets, sample trends, data collection form (RCx Submittal Workbook)

^{BP} Best Practices in Commissioning Existing Buildings, Building Commissioning Association

FIM testing and diagnostics

Develop testing and diagnostics plans for FIMs identified in the investigation phase. Perform testing to determine the savings potential of the FIM. Data collection forms are provided by Focus on Energy. The FIM testing and diagnostics plan must be included in the Master Data Input of the RCx Submittal Workbook.

Update master list of findings^{BP}

Update the master list of findings with the correct energy savings. Savings must be based upon actual values measured during the investigation phase. The updated master list of findings will be automatically generated based on the FIM Master Data Input.

In preparing estimates of FIM implementation cost and paybacks, estimates should be market costs based on professional experience or an accepted cost-estimating source. Should the Owner request the RTA to assist in the implementation of identified FIMs, it will be expected that costs prepared for the investigation report are honored by the RTA.

For each of the recommended FIMs, the CxA is required to develop a verification plan designed to verify that implementation was done correctly and the energy savings will occur as estimated. The verification may consist of data trending, spot measurements, visual checks, and/or interviews with the party responsible for implementation. Generally, the verification procedures follow option A or option B of the *International Performance Measurement & Verification Protocol* from the U.S. Department of Energy. To determine the appropriate level of effort for verification, the following FIM characteristics should be considered:

- Estimated peak period demand savings
- FIM complexity
- FIM cost

6.4 Overview of FIMs

The following section provides an overview of typical FIMs identified during an RCx Program project. The measures described below are not intended to be all inclusive, but to provide the CxA and Owner with guidance on the types of FIMs that can be identified through retrocommissioning.

Runtime Reduction – The most effective energy efficiency improvement is to shut equipment off when it is not needed. All of the measures in this category deal with automated controls that shut off equipment when it is not needed. The current facilities requirements (CFR) document defines the operational requirements of all systems and is the standard to which systems are evaluated. The CxA must establish a plan to validate the settings of automated controls on systems with significant energy use, verify that critical systems are being controlled properly, and identify opportunities for additional controls to reduce runtimes. FIMs associated with runtime reduction can be categorized as:

- Time of day scheduling – Time of day controls operate by minimizing equipment runtime, according to standards established in the CFR, such that equipment is used only when required and savings are achieved. Applicable systems include all systems with time based automated control. Example measures include optimizing the occupied schedule for HVAC equipment, shut off ventilation to unoccupied spaces, tighten lighting

schedules, add time control to DHW recirculation pumps, and adding optimal start and stop controls.

- Occupancy-based controls – Spaces have significantly lower energy requirements during unoccupied periods compared to occupied operation. Using sensors to determine the occupancy can reduce runtimes even further than time of day scheduling alone. Example measures include occupancy sensors for interior or exterior lighting, occupancy sensors for VAV control, vending machine misers, and smart power strips.
- Weather based controls – Weather based controls use predicted or measured weather conditions to determine whether or not equipment is operated. Example measures include heating/cooling outside air temperature cut out controls and start/stop dates for heating/cooling systems.
- Other controls – A wide variety of controllers are able to shut off equipment when it is not needed based sensor feedback. Example measures include CO/CO₂ based garage ventilation controls, photocells for exterior lighting, daylighting sensors for interior lighting, and exhaust hood controls.

Load reduction – Facility systems are often operated at excessive load. Load reduction is a very effective means of energy conservation and can often be accomplished by correcting operation practices or by implementing low-cost improvements to existing systems.

- Steam systems – Steam systems are designed to generate and transfer large quantities of steam for a variety of needs. Steam systems tend to account for a large portion of a facility's overall energy consumption and therefore have great potential for generating cost effective FIMs. Measures associated with steam system load reduction include pipe and fitting insulation, steam pressure reduction, increased rates of condensate return, and steam trap repair.
- Lighting systems – Lighting systems can provide too much light in some cases and a de-lamping, dimming control options, or redesign can be used to reduce lighting loads.
- Air/Water distribution systems – Distribution systems are often overdesigned and generate pressures and flows which are higher than necessary. Reducing pressure requirements or flow rates has a large impact on energy consumption and is a cost effective measure so long as the system is still meets the CFR. Typical measures associated with distribution systems load reduction include static pressure set point reduction, fan or pump speed reduction, and air sealing ductwork.
- Heating, cooling, and humidification systems – The CFR establishes the heating, cooling, and humidification requirements of each space type in a facility. Standardizing an acceptable range of set points reduces overheating, overcooling, and excessive humidification or dehumidification. Modern BAS systems allow occupants to adjust thermostats across an acceptable range without overly taxing the system. Care should be taken with adjustments made to comfort set points as it can lead to the increased use of auxiliary heating and cooling systems and negate savings.

Part load operations – Most systems are designed and commissioned to meet design conditions. This practice ensures that the systems are able to meet facility requirements during maximum occupancy/utilization periods, but does not address system operation during part load conditions which have a greater impact on energy costs. During testing and diagnostics activities of the system level commissioning, the CxA must address the system's ability to operate efficiently at part load conditions as well as full load. Proposed and existing part load control strategies must be validated against the CFR and verified through Systems Level Commissioning activities. Deficiencies identified during validation and/or verification lead to the

development of additional FIMs to correct those problems and improve performance. Measures associated with part load operation fall into the following sub categories.

- Reset controls – Resets operate by providing multiple set points rather than a constant set point for a system. Sensor input or equipment loading is used to determine if part load conditions exist and the automation system will reset the set points according to the predetermined reset strategy. Example measures include hot/chilled water reset, static pressure reset, discharge air temperature reset, etc.
- Setback/setup controls - Whereas reset controls react to part load conditions by resetting set points, setback/setup controls create part load conditions by lowering heating, cooling, ventilation, and/or humidity requirements in a space. Example measures include programmable thermostats, adjust BAS unoccupied settings, demand controlled ventilation, and kitchen hood controls.

Part load efficiency improvements – Many of the measures that would fall into this category are capital in nature and are not in the scope of the RCx Program. However, these maintenance, operation improvements, and low-cost equipment upgrades can impact the part load efficiencies of systems. Measures identified that increase part load efficiency include boiler combustion management controls, variable-frequency drives, and chiller-cooling tower optimization.

- Economizing – The term economizer is applied to a host of equipment and control strategies that seek to use ambient conditions or recovered waste energy to reduce heating or cooling requirements. Air handler economizers increase ventilation when spaces are in cooling mode and return air has a higher cooling load than outside air. Air handler economizers should have control strategies validated and operation verified through testing or trending. Economizers can sample temperature only (dry bulb economizers) or temperature and humidity (enthalpy economizers) when comparing air streams. Enthalpy economizers can result in additional energy savings but have more frequent recalibration requirements. Additional economizing measures include free cooling, dry cooling, boiler stack economizers, and heat recovery from compressed-air systems or data centers.

Systems calibration/maintenance – Complex systems can incur calibration or maintenance issues that do not directly impact the systems' ability to function, but negatively impact energy usage. Identifying calibration issues or hidden maintenance needs can save energy while extending equipment life and improving performance. The Retrocommissioning program recommends using sampling as a means to testing for calibration and maintenance issues without dramatically increasing the study cost.

- Sensor calibration – Sensors require regular recalibration in order to maintain effectiveness. More complex sensors such as CO₂ or humidity sensors require more frequent recalibration than temperature, pressure, or flow sensors. Precision instruments should be used on a sample set of sensors to verify calibration at the source and at the BAS level. It is recommended that the sensors with the most impact on energy consumption be given the most attention, such as a discharge air temperature sensor that controls the heating and cooling coil valves in an air-handling unit. Examples of deficiencies solved by recalibration include overheating, overcooling, excess ventilation, simultaneous heating and cooling, and excess fan power.
- Airside testing and balancing – Testing and balancing (T&B) is required on all major air handlers that transfer outside air. Excess ventilation air wastes large amounts of energy and correcting these deficiencies typically results in quick paybacks. T&B may be used to diagnose issues with units that are unable to perform as established in the CFR.

Measures associated with T&B include setting ventilation rates to minimums, adjusting damper operation, impeller trim, pump and fan flow reduction, and the addition of variable-frequency drives.

- Maintenance issues – One of the prerequisites for inclusion into the RCx Program is being free of major maintenance issues. The maintenance issues discussed in this section may not prevent the systems from operating; however they will affect energy performance. Maintenance deficiencies typically identified include chilled water, hot water or steam valve repair, damper repair, belt replacement, filter replacement, bearing repair, actuator repair, and controller replacement.

Design or installation corrections – This category applies to any number of possible corrections that allow a system to operate more effectively or efficiently. Deficiencies can occur from design limitations, improper installation, or a change of space use that makes the original design conditions invalid. Measures in this category are typically identified through systems testing and investigating comfort or IAQ issues.

Required FIMs

Certain FIMs have been found repeatedly in multiple facilities and are typically very cost effective to implement and can have a dramatic impact on energy consumption. The RCx Program will not accept an RCx systems level commissioning plan that does not evaluate the potential for these required FIMs. These FIMs are listed below:

- Validate and verify ventilation rates and scheduling of AHUs
- Test heating-coil and cooling-coil valves for leaks and proper calibration
- Evaluate steam pressure set points
- Evaluate chilled-water set points
- Evaluate static pressure set points on VAV systems
- Optimize setback/set up controls and scheduling
- Validate adjustable set points for space temp and humidity

FIM Calculations

For non-capital measures identified in the master list, the estimated annual energy savings are calculated, implementation costs are estimated, and a simple payback period is calculated. All calculations must be submitted in detail in the investigation report, as well as any data used in support of the calculations. Because implementation incentives are paid to the Owner on the basis of the estimates provided in the investigation report, it is essential that the savings calculations and estimated implementation costs are accurate.

Owner peak demand – Peak demand savings result from the reduction in power used during on peak hours as defined by the utility company's rate structure. This reduction in kW is coincident with the building's highest consumption rate during the given month. Demand measurements occur in 15-minute intervals. Demand reduction typically results from efficiency upgrades (lighting) or load reduction (static pressure set point reduction). Demand savings can also occur by implementing demand reduction strategies such as reducing non essential lighting during peak periods. Peak demand savings should be verified using interval energy data from the EMS or utility. Owner peak demand savings should be included in the savings analysis of a FIM.

Utility peak demand – Focus on Energy is charged with reducing the load on the power grid and slowing the need for additional power generation. As such demand that occurs coincident with the utility peak demand is of higher value to the RCx Program. This demand occurs summer weekdays between 1 p.m. and 4 p.m. The utility peak demand savings may be different from the Owner peak demand savings for a FIM. In this case, the Owner peak demand savings should be presented in the master list of findings while the utility peak demand is identified in the FIM narrative. Utility peak demand savings has a program value of \$150 per kW when justifying funding.

Annual electrical savings – Annual electric consumption savings can occur from efficiency upgrades, reduction in run time, or reduction in load. Annual electric consumption savings should be recorded in kWh in the master list of findings. Annual electric consumption savings have a program value of \$0.045 per kWh when justifying funding. Annual electric consumption savings should be broken down into on-peak usage and off-peak usage for the savings analysis and presented in the FIM description..

Annual natural gas savings – The annual natural gas savings should be presented in therms (100,000 Btu) and recorded in the master list of findings. Annual natural gas savings have a program value of \$0.45/therm when justifying funding.

Calculations must be done in spreadsheet format, and be clearly presented for review. The calculations must use typical meteorological year (TMY) data (typically binned in 5°F increments). This ensures that the resulting savings estimates are representative of typical weather, not the weather that occurred during the project study period. Weather data is available from Focus on Energy, or can be downloaded at http://rredc.nrel.gov/solar/old_data/nsrdb/tmy2/State.html. **Calculations done using whole-building simulation software will not be accepted without prior written approval from Focus on Energy.**

6.5 Report Presentation and Implementation Plan

Investigation Phase deliverables must be submitted to Focus on Energy for approval prior to being submitted to the Owner. Iterations may occur as directed by Focus on Energy. Following delivery of the deliverables to the owner, a meeting is held with the Owner, the CxA, and Focus on Energy to review the project recommendations. The FIMs to be implemented are agreed upon by all parties, taking into consideration factors such as comfort, safety, or liability as input by the participants in the meeting. Focus on Energy may be able to offer financial incentives to implement FIMs with an estimated simple payback greater than 1.5 years.

6.6 Investigation Phase Deliverables

The CxA must submit a copy of the RCx Submittal workbook with all relevant sections completed. The target timeline for completion of the investigation phase is approximately 12 weeks for a typical project, but is dependent upon the time of year (i.e. affected systems must be operational).

Section 7: Implementation Phase

7.1 Implementation Phase Overview

During the implementation phase of the RCx Program, the Owner is responsible for implementing the selection of FIMs identified and agreed to during the investigation phase. Upon completion, the Owner will notify Focus on Energy that the measures have been installed by submitting the Completion Notice to the RCx Energy Advisor.

7.2 Implementation Phase Requirement

Participants in the RCx Program are required to reserve funding for the implementation of facility improvement measures identified during the investigation phase. Focus will work with the Owner and the RTA to identify a group of facility improvement measures (FIMs) with a 1.5 year or shorter payback period which meet the Owner's energy use, comfort and maintenance requirements. Facilities with greater, non process related energy costs as identified in Table 2 may receive greater incentives for the investigation phase if they are willing to commit additional funding towards implementation.

7.3 Implementation Phase Execution

Responsibility for completion of the implementation phase of the RCx Program is the sole responsibility of the Owner. Unless the Owner chooses to solicit additional services from the RTA, in which case the RTA would be working under direct contract with the Owner and have no relationship with Focus on Energy (see Section 3.5), there are no specific responsibilities for the RTA during this phase of the project.

7.4 Implementation Phase Deliverables

The CxA should submit the RCx Submittal Workbook for review to Focus on Energy during the implementation phase if any changes have been made since the time of last submittal. The Owner will submit the project completion notice upon completion of all measures.

7.5 Retrocommissioning Persistence Plan

As many RCx Program energy conservation measures are O&M in nature, Focus requires participants to deliver a strategic plan for maintaining the energy savings after implementation. All plans must include training of existing and future O&M staff on improved operation of the facility according to the results of the RCx Program study including all changes made as a result of the study. The plan must also show an energy management strategy that includes routine analysis of energy benchmarks and an action plan to minimize any drift or degradation from the new performance level.

Persistence planning assistance (optional)

The CxA may include in the cost of services assistance with the development and execution of a persistence plan for the Owner. The Owner is required to submit a plan that includes training of existing and future maintenance staff on improved operation of the facility according to the results of the RCx study including all changes made as a result of the study. The plan must also show an energy management strategy that includes routine analysis of energy benchmarks and an action plan to resolve any drift or backslide from the new performance level. The plan may call for a six-month follow up with the RCx market provider to review the performance of the FIM's and address any concerns.

Some applicable training topics include:

- General purpose of a system or equipment
- Review of control drawings and schematics
- Integral controls programming, troubleshooting, alarms, and manual operation
- EMS controls programming, troubleshooting, alarms, and manual operation
- Start up, loading, normal operation, unloading, shutdown, etc.
- Energy conservation operation and strategies
- Common troubleshooting issues and methods
- Service, maintenance, and preventative maintenance

Systems manual ^{BP} (optional)

At the Owner's request the CxA may include a systems manual in the cost of the RCx study that is reimbursable according to the rates identified in the RCx Participant Manual. The systems manual is a living document that serves as a guide to facility operation for existing and future facility operators. It documents the design intent, CFR, an overview of all major systems, the current sequence of operations, and a history of changes to the facility. A systems manual is very helpful in continuous and retrocommissioning efforts, as well as being a strong corporate asset for building owner.

Systems manuals may include any of the following at the Owner's request:

- A general facility description and plot plan with the location of major-use areas and equipment identified
- A definition of current facility objectives, functional uses, special services including emergency response and desired level of control including any energy-efficiency or load-management priorities (design intent)
- Operating standards or procedures for major use and critical space/special needs areas including indoor environmental quality requirements and occupancy requirements and schedules. Include a basic understanding of what not to touch and who is recommended to touch it.
- A description of each major HVAC and lighting system, including designed capabilities, limitations, usage instructions, location, pictures as needed, and acceptable performance for each major system to help identify key performance metrics/benchmarks and accountability/follow-up requirements

^{BP} *Best Practices in Commissioning Existing Buildings*, Building Commissioning Association

- Sequence of operation (control) for each major HVAC system, including set points, schedules, energy efficiency features and seasonal changeover procedures.
- Identification of overall energy performance trends for each system if known and recommended techniques to aid in verifying performance or troubleshooting problems
- An itemized list of all equipment to be maintained including known maintenance requirements, procedures, or best practices
- A list of any necessary training requirements or issues
- A list of pertinent contact references (internal/ external)
- A log of events including dates, relevant issues, and contact information for audits or surveys (maintenance, energy, lighting), purchases, replacement of equipment or new installations, building modifications or restacking, maintenance, testing, staff or contract changes, and problems as identified and corrected
- A questionnaire that guides new supervisors in acquiring relevant information from the departing supervisor
- Basic instructions on how a building supervisor should respond to the need to restack space
- A copy of important as-built drawings
- A copy of recent HVAC load calculation and test, adjust and balance (TAB) reports
- The current annual gas and electric usage report
- Relevant information taken from any commissioning report and updates if completed including the problem log and correction plan, pertinent checks and tests, a list of improvements made, and sensor calibration data
- A list of relevant documentation identifying responsible party and storage location

Section 8: Verification Phase

8.1 Verification Phase Overview

During the verification phase, Focus on Energy visits the site to verify that measures have been properly installed; new control strategies are in place, repairs have been made, etc. Upon verification, all incentives will be paid to the Owner.

8.2 Verification Phase Execution

Responsibility for completion of the verification phase of the RCx Program is the sole responsibility of Focus on Energy; there are no specific responsibilities for the RTA during this phase of the project.

8.3 Verification Phase Deliverables

There are no specific RTA deliverables associated with the verification phase of the RCx Program.