# ***Commercial Retro-Commissioning Program Manual for 2017***

# Introduction

The Commercial Retro-Commissioning Program (RCx) is designed to achieve demand and energy savings in commercial facilities.

Savings are realized through the systematic evaluation of facility systems and implementation of low-cost measures targeted to improve HVAC system operation and, in many cases, improve occupant comfort. This Program is offered to customers in the CenterPoint Energy Service Territory to enhance their facilities' comfort, productivity, and environment, while reducing energy costs by implementing low-cost measures.

This Program Manual includes detailed information about the RCx Program and guidelines for project implementation under this program. Nexant, Inc. is the Program Administrator (PA) for this program offered by CenterPoint Energy.

CenterPoint Energy reserves the right to make modifications to this program at any time. Please check CenterPoint Energy's website for the most up-to-date information about the RCx Program: www.CenterPointEfficiency.com/RCx

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# 1 Introduction

The CenterPoint RCx Program is a program for implementing low-cost /no-cost measures to optimize and enhance existing facility systems to improve performance, reduce peak demand (kW) and save energy (kWh). The program caters to facilities with significant savings potential, with a minimum of 50,000 square feet (sq ft) of conditioned space. The program is administered by a third party Program Administrator (PA).

## 1.1 Customer Eligibility

Eligible customers must be in the CenterPoint Energy service territory. Although most facilities can benefit from retro-commissioning services, sites having the following characteristics are preferred:

- Based on our interpretation of laws passed in 2007 (HB 3693), "transmission class industrials" are excluded from this program. However, "educational, government, and not-for-profit facilities" that are transmission class customers are not excluded and can participate. Based on final rulings by the Public Utility Commission (PUC), this interpretation is subject to change.
- Existing facilities must have a minimum of 50,000 sq ft of conditioned space. Multiple smaller facilities (which have the same Owner and are similar in size and nature) may, at the discretion of the PA, be combined into one project.
- Facilities must have a motivated in-house operations and maintenance staff that are available to support the project.
- Customers are required to commit funds of $0.03/sq ft toward implementation of identified RCx measures with simple paybacks less than 1.5 years (or the total cost of such measures if less than the $0.03/sq ft value), otherwise they are required to repay the cost of engineering services incurred ($0.0475/SF of space included in study + $0.0085/kWh of savings identified in Investigation Phase Report).
- The building systems are free of major problems requiring costly repairs or replacements.
- All pertinent engineering mechanical systems design documentation is accessible.
- All measures identified in the program will not be eligible for CenterPoint Energy incentives under any other program.
- All projects must be implemented and verified within the agreed upon project schedule. The Owner and RCx agent will propose a schedule for each project at project kick-off. The schedule must be reviewed and approved by the PA. Typical project durations will be between 6 – 12 months.

Based on considerations such as those listed above, the PA will identify applicant facilities that have the highest perceived opportunity for savings to participate in the program and then will prioritize potential participants.

## 1.2 Retro-Commissioning Agents

Qualified RCx Agents are selected through a request-for-qualification process. Firms selected for the program are chosen based on a best-value ranking for performing retro-commissioning services that follow the program protocols. As part of the terms of the agreement, the RCx Agents agree to follow the guidelines set out in this program manual.

## 1.3 Key Changes for 2017

There are no new changes from the 2016 program year.

## 1.4 Peak Demand Definition and Calculation Methodology

### 1.4.1 Definition

The peak demand reduction definition for 2017 projects meets the rules established under the TRM v3.1[1].

The goal is to identify the kW change of an ECM during the hours when the grid experiences a peak demand. The calculation procedure is restricted to hours of the most extreme outdoor temperatures—the warmest hours in the summer and the coldest hours in the winter. The demand to be reported is the average demand over the 20 hours of extreme temperature which occur inside the hours defined as the peak period. It is calculated as a weighted average of 20 demand values, one for each of the 20 hours, using as the weights each hour's probability of the peak occurring during that hour. TMY3 data was used to predict the hours of extreme temperatures. ERCOT records were studied to find the probability values.

One value for demand savings is reported for each measure based on either the Summer or Winter Peak Period. Agents are expected to calculate energy savings based on both periods to determine the maximum possible savings and report only the higher of the two values.

### 1.4.2 Calculation Methodology

The following equation and example illustrates the calculation methodology that should be followed for calculating the peak period demand reduction for the program:

$$Peak\ Period\ kW\ Savings = \frac{\sum_i \left(Peak\ Probability\ Factor_i\ *\ Hourly\ kW\ Savings_i\right)}{\sum Peak\ Probability\ Factor}$$

Where:

*Peak Probability Factor*$_i$ = probability factor at the temperature bin
*Hourly kW Savings*$_i$ = hourly kW savings at the temperature bin
*ΣPeak Probability Factor* = summation of all probability factors.
Summer Peak 2017: 10.16855
Winter Peak 2017: 0.95162

The peak probability factors for summer and winter are presented in Appendix A. For convenience, the factors have been combined into 5°F and 10°F bins for use in calculations.

Measures that are not weather dependent and fall within the peak period times can use the hourly kW savings as the peak period kW savings.

<u>Example using bin temperatures:</u>
A building has two main chillers with a smaller chiller used only for backup. Inspection of the chiller plant revealed that the smaller chiller pump (on a VFD and is10 HP) was on even though the chiller was not in use. The proposed measure will be to turn off the small chiller pump and only

[1] http://www.texasefficiency.com/images/documents/RegulatoryFilings/DeemedSavings/trm3v1.pdf

start it when the chiller comes online—usually during the winter time. The motor load factor is 80% and the efficiency is 90%.

To start, calculate the hourly kW savings using bin temperatures:

$$Hourly\ kW\ Savings_{100°F-105°F} = \frac{10\ HP * 0.746\frac{HP}{kW} * 0.8}{0.9} = 6.63\ kW$$

For 95°F -100°F bin we assume the kW is 95% of the max bin:

$$Hourly\ kW\ Savings_{95°F-100°F} = \frac{10\ HP * 0.746\frac{HP}{kW} * 0.8 * 0.95}{0.9} = 6.30\ kW$$

Next, use the table in Appendix A to find the probability adjusted savings for each line item. The table below shows the results.

| Month | Day | Hour Ending | Hourly Temperature (°F) | Relative Probability | Hourly kW Savings | Probability Adjusted kW Savings |
|---|---|---|---|---|---|---|
| 8 | 1 | 17 | 102.92 | 0.92938 | 6.63 | 6.1617894 |
| 8 | 2 | 17 | 102.92 | 0.92938 | 6.63 | 6.1617894 |
| 8 | 1 | 16 | 102.92 | 0.918911 | 6.63 | 6.09237993 |
| 8 | 2 | 16 | 102.02 | 0.865717 | 6.63 | 5.73970371 |
| 8 | 3 | 16 | 100.04 | 0.650841 | 6.63 | 4.31507583 |
| 8 | 2 | 18 | 102.02 | 0.575415 | 6.63 | 3.81500145 |
| 8 | 4 | 17 | 98.96 | 0.523849 | 6.3 | 3.3002487 |
| 8 | 4 | 16 | 98.96 | 0.486478 | 6.3 | 3.0648114 |
| 8 | 29 | 16 | 98.96 | 0.486478 | 6.3 | 3.0648114 |
| 8 | 1 | 15 | 98.96 | 0.425501 | 6.3 | 2.6806563 |
| 8 | 2 | 15 | 98.96 | 0.425501 | 6.3 | 2.6806563 |
| 8 | 4 | 15 | 100.94 | 0.425501 | 6.63 | 2.82107163 |
| 8 | 1 | 18 | 100.94 | 0.40785 | 6.63 | 2.7040455 |
| 8 | 9 | 17 | 100.94 | 0.384956 | 6.63 | 2.55225828 |
| 8 | 11 | 17 | 100.94 | 0.384956 | 6.63 | 2.55225828 |
| 8 | 29 | 17 | 98.06 | 0.384956 | 6.3 | 2.4252228 |
| 8 | 10 | 16 | 98.06 | 0.350206 | 6.3 | 2.2062978 |
| 8 | 10 | 17 | 98.06 | 0.221282 | 6.3 | 1.3940766 |
| 8 | 9 | 16 | 98.06 | 0.215012 | 6.3 | 1.3545756 |
| 8 | 3 | 15 | 98.06 | 0.176375 | 6.3 | 1.1111625 |
| | | | | 10.16855 | | 66.19789 |

Finally, add the probability adjusted kW savings and divide by the sum of the probability factors:

$$Peak\ Period\ kW\ Savings = \frac{66.19789\ kW}{10.16855}$$

$$Peak\ Period\ kW\ Savings = 6.51006kW\ (summer)$$

Example without using temperature bins:
An office building is unoccupied from 5:30pm until 6:00am the next morning. The AHUs are scheduled to turn off at 8:00pm. The measure would be to turn off the AHUs at 5:30pm and save two and a half extra hours per day of runtime. The AHUs have 15 HP motors each with an efficiency of 90%. Only one AHU is affected.

$$Hourly\ kW\ Savings = \frac{15\ HP * 0.746\frac{HP}{kW} * 0.8}{0.9} = 9.95\ kW$$

This measure only has savings from 6:00pm therefore the probability adjusted savings for hours before 6:00pm will be zero. The table below breaks down the calculation.

| Month | Day | Hour Ending | Hourly Temperature (°F) | Relative Probability | Hourly kW Savings | Probability Adjusted kW Savings |
|---|---|---|---|---|---|---|
| 8 | 1 | 17 | 102.92 | 0.92938 | 0 | 0 |
| 8 | 2 | 17 | 102.92 | 0.92938 | 0 | 0 |
| 8 | 1 | 16 | 102.92 | 0.918911 | 0 | 0 |
| 8 | 2 | 16 | 102.02 | 0.865717 | 0 | 0 |
| 8 | 3 | 16 | 100.04 | 0.650841 | 0 | 0 |
| 8 | 2 | 18 | 102.02 | 0.575415 | 9.95 | 5.72537925 |
| 8 | 4 | 17 | 98.96 | 0.523849 | 0 | 0 |
| 8 | 4 | 16 | 98.96 | 0.486478 | 0 | 0 |
| 8 | 29 | 16 | 98.96 | 0.486478 | 0 | 0 |
| 8 | 1 | 15 | 98.96 | 0.425501 | 0 | 0 |
| 8 | 2 | 15 | 98.96 | 0.425501 | 0 | 0 |
| 8 | 4 | 15 | 100.94 | 0.425501 | 0 | 0 |
| 8 | 1 | 18 | 100.94 | 0.40785 | 9.95 | 4.0581075 |
| 8 | 9 | 17 | 100.94 | 0.384956 | 0 | 0 |
| 8 | 11 | 17 | 100.94 | 0.384956 | 0 | 0 |
| 8 | 29 | 17 | 98.06 | 0.384956 | 0 | 0 |
| 8 | 10 | 16 | 98.06 | 0.350206 | 0 | 0 |
| 8 | 10 | 17 | 98.06 | 0.221282 | 0 | 0 |
| 8 | 9 | 16 | 98.06 | 0.215012 | 0 | 0 |
| 8 | 3 | 15 | 98.06 | 0.176375 | 0 | 0 |
| | | | | 10.16855 | | 9.78349 |

$$Peak\ Period\ kW\ Savings = \frac{9.78349\ kW}{10.91641}$$

$$Peak\ Period\ kW\ Savings = 0.89622\ kW\ (summer)$$

## 1.5 Project Deliverables

Each RCx project includes two reports to be delivered to the PA by the RCx Agent– the Investigation Phase Report and final Verification Phase Report. An additional report that is created before the Investigation Phase Report will be created by the PA. These reports define and document the retro-commissioning activities for the project. The PA must review and accept each RCx Agent deliverable before the project may proceed to the next program phase.

Microsoft Word is the preferred format for the reports. Microsoft Excel is the preferred format for spreadsheets.

## 1.6 Contact Information

All applications, supporting documentation, general program inquiries, and specific project inquiries should be directed to the Program Administrator at CenterPointEnergyRCx@nexant.com.

Additional concerns may be directed to the CenterPoint Energy program manager:

Calvin Burnham, P.E., CEM
CenterPoint Energy
1111 Louisiana Street, 9th Floor
Houston, TX 77002
Phone: (713) 207-3423
Email: calvin.burnham@centerpointenergy.com

# 2 Program Process

The administrative process for each RCx project follows these basic program phases:

- Application Screening Phase
- Investigation Phase
- Implementation Phase
- Verification Phase

A breakdown of each phase is presented in the following sections.

## 2.1 Application Screening Phase

### 2.1.1 Overview

The program begins with the Application Screening Phase. The steps comprising this phase are outlined in Figure 1. Applications are completed by the facility representative and submitted to the PA, who screens projects to ensure sufficient RCx savings opportunities exist.

Part of the evaluation involves the creation of a Preliminary Assessment Report that benchmarks the facility against comparable peers and identifies end uses (HVAC, lighting, etc.) with significant potential for savings. This report will be shared with the facility owner whether or not an application is approved for acceptance into the program.

If an application is accepted, the facility owner is required to sign a Building Owner Agreement with the PA. If the facility representative does not request a specific RCx Agent, the PA will assign one based on an equitable rotation and on appropriateness of Agent qualifications and experience.

The assigned Agent will enter into a contract (Task Order) with the PA to complete services. Soon after the contracts are signed, a project kick-off meeting may be scheduled. Attendees may include representatives from CenterPoint Energy, the PA, the assigned RCx Agent, and the owner or facility representative.

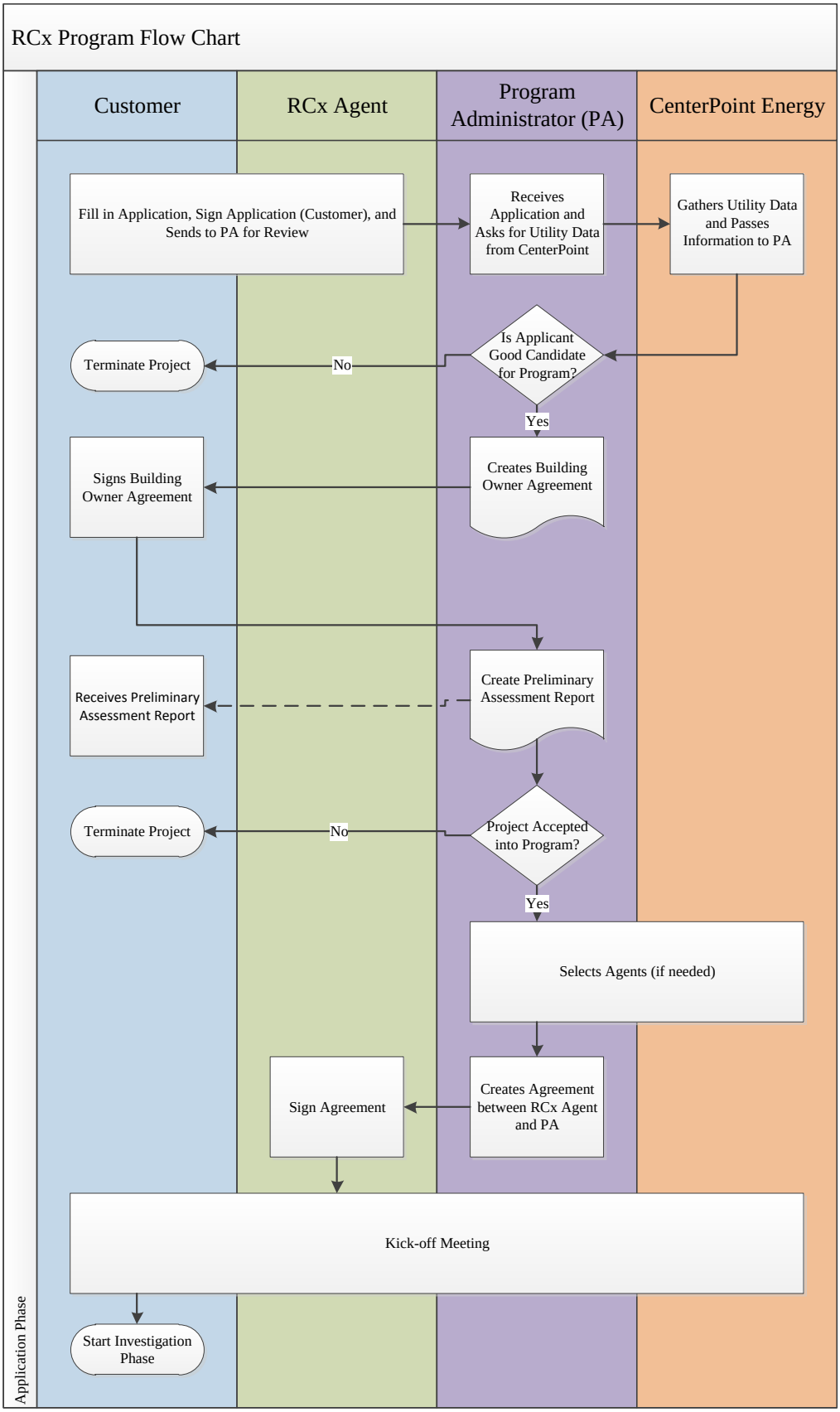


**Figure 1. Application Phase Administration**

### 2.1.2 Preliminary Assessment Report

The screening involves a review of the information gathered in the application along with utility data provided by CenterPoint Energy. A Preliminary Assessment Report is created and used to determine whether a given project is appropriate for the RCx program. The report benchmarks the facility and provides an overview of potential areas of savings that the Customer or RCx Agent can explore further during the site visit. Applicants receive the report whether or not the facility is accepted into the program.

### 2.1.3 Deliverables for Application Screening Phase

- Application submitted to the PA or CenterPoint Energy by the owner or representative
- Preliminary Assessment report created by PA
- Building Owner Agreement signed by the owner or owner representative
- Project Contract (Task Order) signed by RCx Agent to commence work
- Fourteen months of utility (Electricity and Natural Gas) bills in Microsoft Excel format (Owner to provide ESI ID # in the project application, for use in obtaining the utility information.)

## 2.2 Investigation Phase

### 2.2.1 Overview

During this phase (see Figure 2), the RCx Agent conducts detailed site-audits to validate the potential measures identified in the Preliminary Assessment Report. In addition, the RCx Agents are expected to identify ECMs which were not noted in the Preliminary Assessment Report. However, it is critical to understand the program's focus on RCx measures versus capital intensive equipment upgrades and replacements. The latter are outside the scope of an RCx project, and the fee structure for agents assumes both fieldwork and analysis are focused solely on RCx measures.

The Investigation Phase Report includes a detailed description of recommended improvements, energy saving projections, equipment data, assumptions and calculations, implementation cost estimates, and a simple payback calculation. It may include one-line diagrams and written and graphical sequences of operations for affected equipment, and verification procedures for each recommended measure. The Investigation Report must be submitted to the PA for review and acceptance. The PA will review the Investigation Phase Report submittal and accept it or make recommendations for refinement.

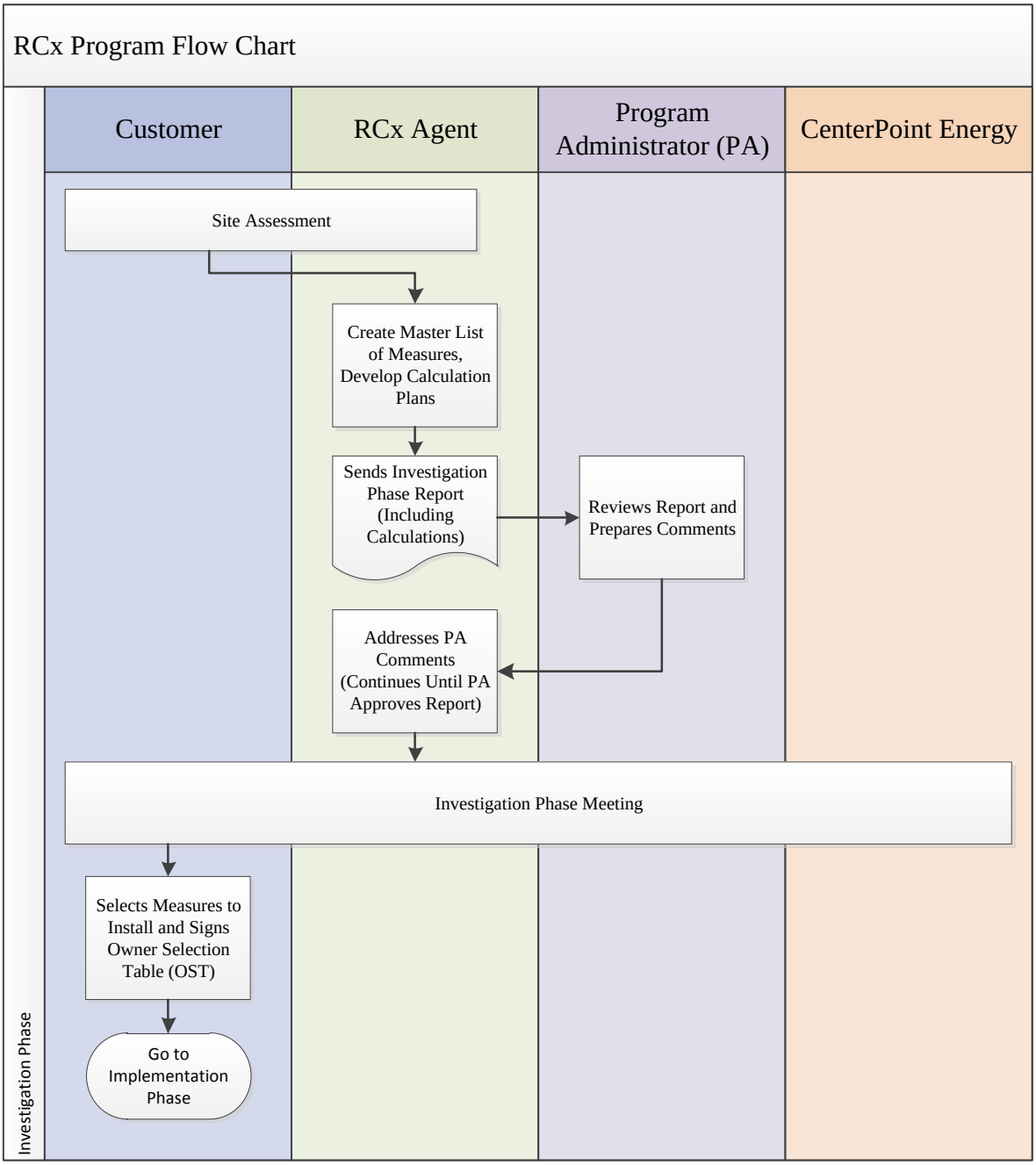


**Figure 2. Investigation Phase Administration**

### 2.2.2 Investigation Phase Execution

During the investigation phase, the RCx Agent, with assistance from the building facility staff, will conduct a site assessment to develop an in-depth understanding of the building systems. The key investigation phase activities to be documented and included in the Investigation Report are (as applicable):

- Gathering data to assess equipment operation, including operational hours, building equipment data, current control sequences, etc.
- Estimating the potential peak period demand reduction (kW) and energy savings (kWh) from identified RCx ECMs, assessing the cost to implement the identified RCx ECMs, and calculating the corresponding savings to generate a simple payback period.
- Compiling the Master Findings List of low-cost RCx ECMs.
- Preparing a written sequence of operation or detailed description for any control changes and/or ECMs recommended.
- Preparing a one-line schematic of any major equipment (e.g., AHU, Central Plant) for which ECMs are recommended as applicable.

The owner may implement low-cost, no-cost measures only after sufficient information is collected to document the baseline and estimate the measures' energy savings potential. Information and test results gathered during this phase are to be included in the Investigation Report.

## Facility and System Equipment Assessment

At the facility level, the following information is collected:

- Systems with highest energy use and demand
- Significant control, operational, and maintenance problems
- Comfort problems
- Operations and maintenance (O&M) practices
- Facility operation and occupancy schedules

System assessment occurs at the equipment level and involves collecting nameplate information and conducting a minimum standard set of diagnostic tests for each system and piece of equipment included in the ECM Master Findings List. The system and equipment assessments generally include collecting the following information:

- Nameplate data (with efficiency)
- Design and operational intent
- Actual operation
- Operating parameters
- General conditions

### Master Findings List

The observations made during the site assessment and detailed facility assessment form the basis for the Master Findings List. The Master Findings List identifies savings opportunities (or performance deficiencies) and recommended improvements. It summarizes all of the findings of the investigation phase, including the adjustments and repairs made during the course of investigation. The list includes all recommended low-cost and no-cost measures.

The Master Findings List includes the name of the system or equipment, a description of the problem or deficiency, recommended solutions, and savings category. Savings categories classify measures by the time period during which savings are anticipated. Categories include program peak-period demand savings and annual energy savings. The program peak period savings indicate the project's impact on the utility peak demand. The facility annual energy savings are to be calculated to determine the cost savings associated with each RCx measure.

For the measures identified by the RCx Agent, the estimated annual electricity 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. The PA has compiled Typical Meteorological Year (TMY3) weather

data for Houston, Texas and it is available for the RCx Agents to develop their calculation templates. The RCx Agent may develop their own bin weather database using bin weather software or Houston TMY data. Note that the bin data must be formatted to allow isolation of the applicable energy savings for each measure and each time period (i.e., peak period, annual, etc.).

### Typical ECMs

- Turn-off unnecessary systems
- Revise equipment operating schedules
- Optimize outdoor air ventilation
- Reset supply air temperature
- Automatic reset of static pressure set-point
- Minimize simultaneous heating and cooling
- Reset chilled water supply temperature
- Air balancing
- Water balancing
- Implement chiller plant optimization
- Use variable speed drives in fans and pumps
- Eliminate leakage in air and water distribution systems
- Improve air-side economizer operation

### Unacceptable ECM Characteristics

- Compromise occupant comfort
- Compromise safety
- Violates building code
- Unacceptable to owner/staff

### ECMs outside RCx Program Scope

- Major equipment replacements or additions
- Lighting retrofits

While capital-intensive measures are outside the scope of this program, Agents who identify obvious opportunities during the course of RCx investigations are encouraged to relay this information to facility staff and to suggest other CenterPoint programs which may be applicable for such opportunities, such as the Commercial & Industrial Standard Offer Program.

### RCx Survey Elements

The survey tasks noted in this manual are intended to provide quality assurance, streamline the RCx process, and standardize the services provided by the RCx Agents. As part of the process, the RCx Agent is requested to adhere to the RCx Survey Elements Summaries outlined below as a minimum.

The survey list is organized by system and equipment type and covers the major mechanical components typically found in commercial facilities. Table 1 provides a summary of the minimum requirements of the survey tasks.

The RCx Agent should include a simple system schematic, record a minimum set of operating parameters, and include templates for conducting functional tests to verify proper component, equipment, or system operation, as necessary. The required fields in the forms are marked by an asterisk (*). The functional tests outlined in the forms are recommendations only, and may be revised or rewritten based on the RCx Agent's judgment. The functional tests may be carried out

manually by forcing system variables, or automatically by trending variables in the Energy Management and Control System (EMCS) or stand-alone logging device. It is up to the RCx Agent to determine the best method that will meet the needs for testing and be acceptable to the owner.

**Table 1. RCx Survey Elements Summaries**

| System or Equipment | Typical Survey Requirements |
|---|---|
| Chilled Water System (Chiller and pumps) | Document sequence of operations (SeqOp)*<br>Verify / Justify SeqOp<br>Document actual schematic*<br>Spot measure actual performance (kW/ton)<br>Document setpoints*<br>Verify temperature and pressure sensor calibration<br>Verify thermostat calibration<br>Document operations and maintenance (O&M) procedures |
| Air Handling Unit | Document SeqOp*<br>Verify / Justify SeqOp<br>Document system type*<br>Document nameplate ratings*<br>Document actual schematic<br>Document temperature, pressure at control points*<br>Verify economizer operation (if present)<br>Verify damper operation and sealing<br>Verify temperature and pressure sensor calibration<br>Verify proper chilled water, hot water, and/or steam valve operation<br>Measure motor/fan load, flow, pressure<br>Identify operating point on fan curve<br>Verify inlet guide vane / discharge damper / VFD operation (if present)<br>Document O&M procedures |
| Cooling Tower | Document SeqOp*<br>Verify / Justify SeqOp<br>Document system type*<br>Document nameplate ratings*<br>Document temperature, flow at control points*<br>Document O&M procedures |
| Control System | Document SeqOp for the HVAC system, integrating the equipment SeqOp s*<br>Verify / Justify SeqOp<br>Verify and sketch system schematic |

**Diagnostic Monitoring**

During the RCx process, the Agent may identify problems that require short-term monitoring to understand how equipment is operating under a range of conditions or to prove the existence of suspected problems. A summary of the diagnostic monitoring activities should be submitted as part of the Investigation Report. Diagnostic monitoring should be performed using the existing building control system, existing sensors, etc. Additional monitoring may be performed, but it will not be considered part of this program, and additional fees for this will not be included in this program.

The diagnostic monitoring plan typically lists the systems to be investigated, any simulation activity to create a desired condition, variables to be monitored, location of existing or proposed sensors (identified on associated schematic), data collection equipment, monitoring time period, sampling frequency, storage frequency, and parameter engineering units. The monitoring period must be appropriately chosen (at most, hourly intervals) to capture the desired operational characteristics.

**Investigation Phase Meeting (ECM Selection)**

Following delivery of the Investigation Phase Report to the owner, a meeting is to be held with the owner, the RCx Agent, and the PA to review the project recommendations. The list of measures to be implemented is agreed upon by all parties, taking into consideration factors such as comfort, safety, or liability as input by the participants in the meeting.

**Owner Selection Table (OST)**

After the Investigation Phase Meeting, the owner is expected to review and complete the OST. The owner will designate in the Investigation Phase OST the measures they have implemented or intend to implement during this project. The owner will sign the completed OST and return it to the PA and/or the RCx Agent.

**Verification Plan Development**

For each of the owner-selected measures, the RCx Agent is to develop a Verification Plan. The verification may consist of data trending, spot measurements, visual checks, and/or interviews with the party responsible for implementation. A statistically significant amount of the affected equipment for each measure implemented is required to be checked to ensure implementation took place. This plan is followed after implementation of the completed project with the goal of verifying that implementation was done correctly and the potential to reduce demand and energy usage exists.

In deciding the appropriate level of effort for verifying savings, the following measure characteristics should be considered:

- Estimated peak period demand and annual energy savings
- Measure complexity

The PA, as part of the verification plan review, will assess the suitability of the verification tasks for each ECM.

### 2.2.3 Deliverables for Investigation Phase

The Investigation Phase Report provides a summary of the investigation phase activities. Key elements to be included in the Investigation Report as appendices if applicable are as follows:

- Diagnostic tests and calculation plans
- Verification plans
- Survey forms
- Schematics of affected systems
- Written sequence of operation for affected systems or equipment

### 2.2.4 Investigation Phase Timeline

The Investigation Phase Report must be submitted by the RCx Agent to the PA within two months of the site visit, in accordance with the approved project timeline.

## 2.3 Implementation Phase

Completing the implementation phase of the project is the responsibility of the building owner/facility representative. The steps comprising the Implementation Phase are shown in Figure 3. The facility owner may choose to implement the measures using in-house staff or contractors.

The facility owner keeps the RCx agent and PA up-to-date on the status of implementation of measures selected for implementation.

At the completion of implementation, the owner must submit an accounting of the actual cost of the RCx project to the RCx Agent for inclusion in the Verification Report or delivery to the PA separately.

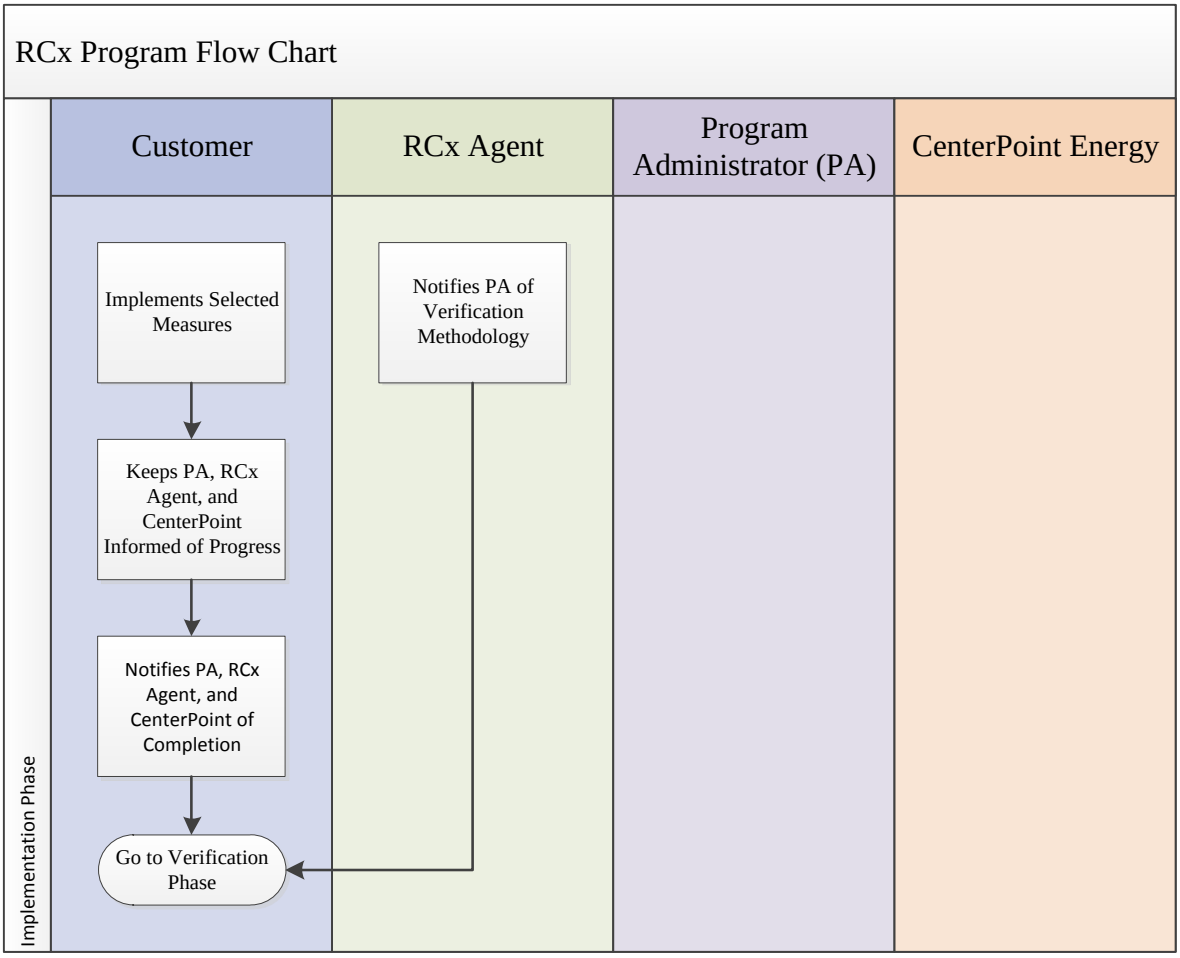


**Figure 3. Implementation Phase Administration**

After implementation is complete, it is the facility owner's responsibility to confirm that the recommended energy conservation measures have been implemented as per the signed Investigation Phase Owner Selection Table. The RCx Agent is not responsible for making the system work if it

fails the construction-commissioning phase. The Owner shall promptly notify the RCx Agent upon completion of implementation, so that the RCx Agent may begin the Verification process.

## 2.4 Verification Phase

### 2.4.1 Overview

During the Verification Phase, the RCx Agent visits the site to verify that measures have been properly installed and are functioning, new control strategies are in place, repairs have been made, etc. The program steps comprising this phase are shown in Figure 4. The RCx Agent submits the Verification (Final) Report that summarizes its findings, and includes revised savings estimates. The PA will review the verification report.

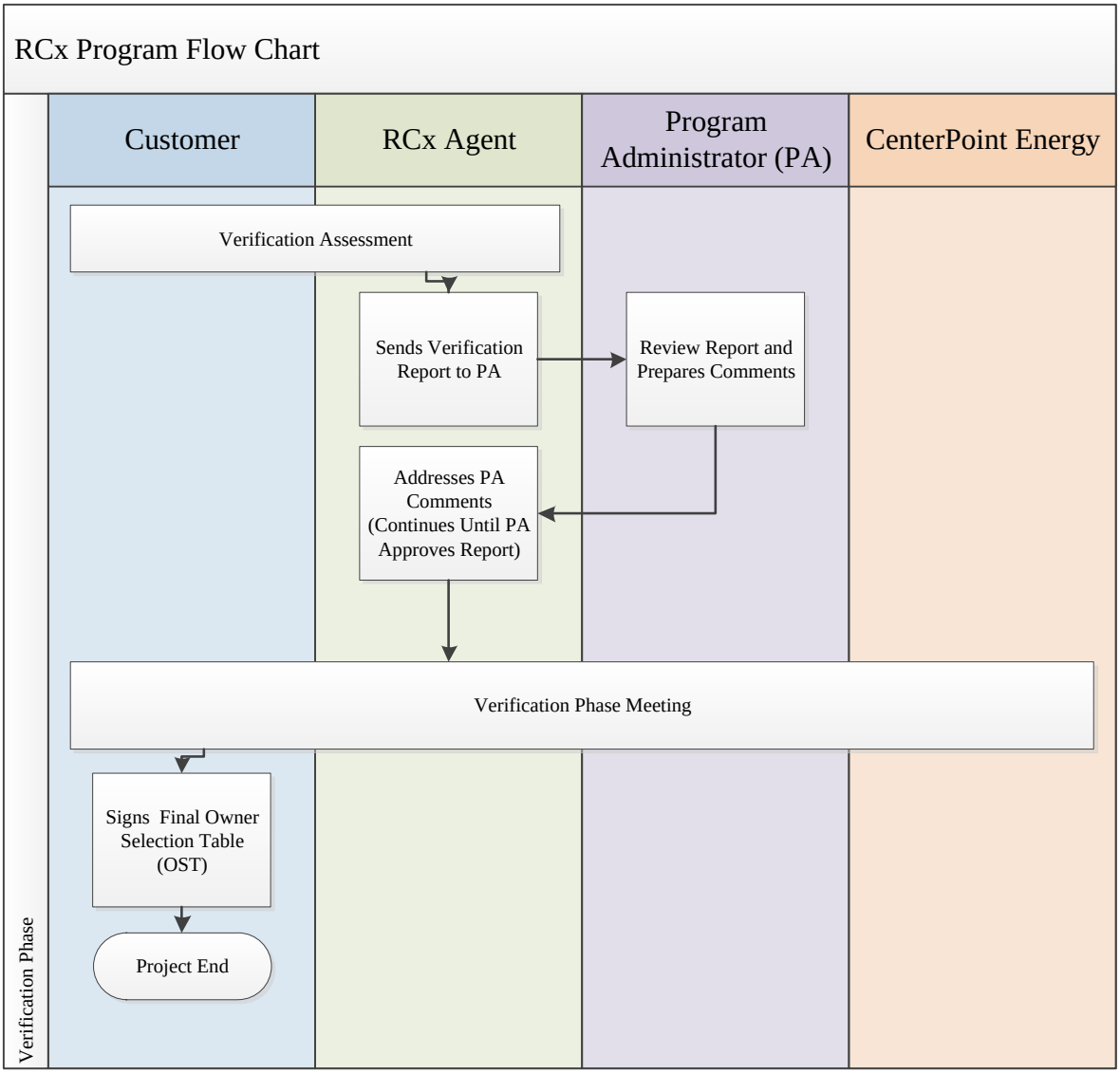


**Figure 4. Verification Phase Administration**

### 2.4.2 Verification Phase Execution

To confirm that the recommended energy conservation measures were properly implemented, the RCx Agent is required to prepare and submit a Verification Plan to the PA for approval (see section

2.2.3). After implementation, the RCx Agent shall perform the verification activities as outlined in the approved Verification Plan. After the owner has completed their selected implementation, the RCx Agent shall document the verified savings in the Verification Report, which will be reviewed and approved by the PA.

### Deliverables for Verification Phase

The Verification Report is prepared by the RCx Agent, and submitted to the PA after implementation verification is completed. The purpose of this report is to verify that the measures were properly implemented, provide justification for measures that were recommended but not implemented, and document verified project demand and energy savings. It shall also include a concise document clearly stating the RCx changes made to the systems and the reasons those changes were made, which may be posted on-site for the facility staff's reference. The RCx agent is expected to brief the facility operators on the changes made to the systems and emphasize the importance of persistence with these changes. It is essential that documented data be included in the report to support the final savings calculations because measures may not always be implemented exactly as recommended by the RCx Agent. A template for this report can be provided upon request.

Key elements to be included in the Verification Report if applicable are as follows:

- Final Owner Selection Table
- Description of each implemented ECM
- Savings calculations
- Written sequence of operation for affected systems or equipment
- Owner's receipts/invoices for project costs

# Appendix A: Probability Tables for Calculating Peak kW

| Month | Day | Hour Ending | Hourly Temperature (°F) | Relative Probability |
|---|---|---|---|---|
| 8 | 1 | 17 | 102.92 | 0.92938 |
| 8 | 2 | 17 | 102.92 | 0.92938 |
| 8 | 1 | 16 | 102.92 | 0.918911 |
| 8 | 2 | 16 | 102.02 | 0.865717 |
| 8 | 3 | 16 | 100.04 | 0.650841 |
| 8 | 2 | 18 | 102.02 | 0.575415 |
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| 8 | 29 | 16 | 98.96 | 0.486478 |
| 8 | 1 | 15 | 98.96 | 0.425501 |
| 8 | 2 | 15 | 98.96 | 0.425501 |
| 8 | 4 | 15 | 100.94 | 0.425501 |
| 8 | 1 | 18 | 100.94 | 0.40785 |
| 8 | 9 | 17 | 100.94 | 0.384956 |
| 8 | 11 | 17 | 100.94 | 0.384956 |
| 8 | 29 | 17 | 98.06 | 0.384956 |
| 8 | 10 | 16 | 98.06 | 0.350206 |
| 8 | 10 | 17 | 98.06 | 0.221282 |
| 8 | 9 | 16 | 98.06 | 0.215012 |
| 8 | 3 | 15 | 98.06 | 0.176375 |

**Figure 5: Summer Peak Probability Table**

| Summer | |
|---|---|
| Bin Temperature (°F) | Probability Factor Sum |
| 100-105 | 6.472907 |
| 95-100 | 3.695638 |
| | 10.16855 |

**Figure 6: Summer Peak Table in Temperature Bins (5°F bins)**

| Summer | |
|---|---|
| Bin Temperature (°F) | Probability Factor Sum |
| 100-110 | 6.472907 |
| 90-100 | 3.695638 |
| Total | 10.16855 |

**Figure 7: Summer Peak Table in Temperature Bins (10°F bins)**

| Month | Day | Hour Ending | Hourly Temperature (°F) | Relative Probability |
|---|---|---|---|---|
| 2 | 3 | 7 | 30.92 | 0.09128 |
| 1 | 23 | 8 | 21.02 | 0.087855 |
| 1 | 23 | 7 | 21.02 | 0.079459 |
| 1 | 11 | 20 | 21.02 | 0.067479 |
| 1 | 18 | 20 | 30.02 | 0.067479 |
| 1 | 18 | 19 | 24.08 | 0.062001 |
| 1 | 11 | 21 | 35.06 | 0.060733 |
| 12 | 20 | 19 | 24.08 | 0.054753 |
| 1 | 18 | 21 | 24.08 | 0.042934 |
| 1 | 11 | 8 | 28.94 | 0.041312 |
| 1 | 19 | 8 | 26.06 | 0.041312 |
| 1 | 19 | 7 | 35.96 | 0.037183 |
| 1 | 11 | 9 | 39.02 | 0.032685 |
| 1 | 4 | 20 | 39.02 | 0.03136 |
| 12 | 20 | 20 | 41 | 0.027589 |
| 1 | 5 | 7 | 37.04 | 0.026094 |
| 1 | 11 | 7 | 26.96 | 0.026094 |
| 2 | 2 | 20 | 39.92 | 0.025473 |
| 2 | 2 | 22 | 37.94 | 0.024772 |
| 12 | 25 | 8 | 30.02 | 0.023773 |

**Figure 8: Winter Peak Probability Table**

| Winter | |
|---|---|
| Bin Temperature (°F) | Probability Factor Sum |
| 40-45 | 0.027589 |
| 35-40 | 0.2383 |
| 30-35 | 0.182532 |
| 25-30 | 0.108718 |
| 20-25 | 0.394481 |
| Total | 0.95162 |

**Figure 9: Winter Peak Table in 5°F Temperature Bins**

| Winter | |
|---|---|
| Bin Temperature (°F) | Probability Factor Sum |
| 40-50 | 0.027589 |
| 30-40 | 0.420832 |
| 20-30 | 0.503199 |
| Total | 0.95162 |

**Figure 10: Winter Peak Table in 10°F Temperature Bin**