

PBEEEP

State Government

Public Buildings Enhanced Energy Efficiency Program

2.3.1 Investigation Guidelines for Trend Data Collection

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1.0 Executive Summary

This is a supplement to the *Investigation Guidelines*. Data about the operation of mechanical equipment is essential for rigor and accuracy in the identification and calculation of energy savings for the Program. Best practices call for continuous trending for at least six to seven months of the majority of available “points” on a building automation system across the heating, cooling and shoulder seasons.

The *Investigation Guidelines for Trend Data Collection* contained in this document define data collection procedures and practices that are required for measuring and verifying the pre- and post-conditions of typical operational improvements and retrofits. The document is intended as a supplement to the *Investigation Guidelines* which guide Providers through the primary tasks and associated deliverables of the investigation phase. The use of trend data is dealt with in Section 6.3.1 of the *Investigation Guidelines*, this document defines the best practices for collection of this data with either a building automation system (BAS) or portable data loggers.

Please note the *Investigation Guidelines for Trend Data Collection* cannot predict every question or issue uncovered during the investigation. When questions arise, the Provider should immediately consult with Program staff to develop a mutually agreeable approach and solution.

2.0 Trend Data Overview

Best practices call for continuous trending for at least six to seven months of a majority of all available “points” on a building automation system across the heating, cooling and shoulder seasons. All data must be collected concurrently so that the interrelationship of systems and controls can be well understood, and energy saving opportunities discovered.

During the investigation, the RCx Provider conducts a rigorous analysis of the building operations. Through observation, targeted functional testing, and analysis of extensive trend and portable logger data, the RCx Provider identifies deficiencies in the operation of the mechanical equipment, lighting, envelope and related controls. The goal is to identify opportunities for operational and maintenance improvements and/or retrofits to reduce energy consumption.

Definition of Trend Data

Trend data is digital time series data in a readable format. (Screen captures are not an acceptable format; for details on acceptable digital file formats, see the PBEEEP Investigation Guidelines, (Section 2.3 of the Manual), 6.3.1 Trending.) It may be collected using portable data loggers or by using sensors that are monitored and/or controlled by the BAS. A point refers to the value recorded by an electronic sensor that measures data such as temperature, pressure, on/off status, position of a valve, etc. A current list of points that have been observed in facilities participating in PBEEEP is provided in Section 3.0 below.

Definition of Baseline Data

Trend data is required to establish baseline energy use associated with an energy savings opportunity. Data will be collected from the same point(s) to verify that savings from implemented measures have actually been realized.

Trend data is preferred in support of all energy savings opportunities. For temperature dependent data, it is to be collected, at a minimum, for two weeks in the heating, cooling and shoulder seasons. An example of temperature dependent data is the supply fan speed, and associated VFD reading, for an air handler (space temperatures alone cannot support a savings calculation based on reduced energy use due to reduction of fan speed). An example of non-temperature dependent data is lighting in spaces where savings may be realized by improved scheduling and/or occupancy sensors.

The data required to quantify proposed energy savings measures should be selected from the complete (6 month) data set as it is not possible to predict the dates when weather will be warmest or coldest.. (For example, one would ideally select the period with the lowest temperatures for the heating season, not guess in advance that December 1 to 14 will be this period.) For full details, see the “Findings Reference” tab in the *PBEEEP Findings Work Book*.

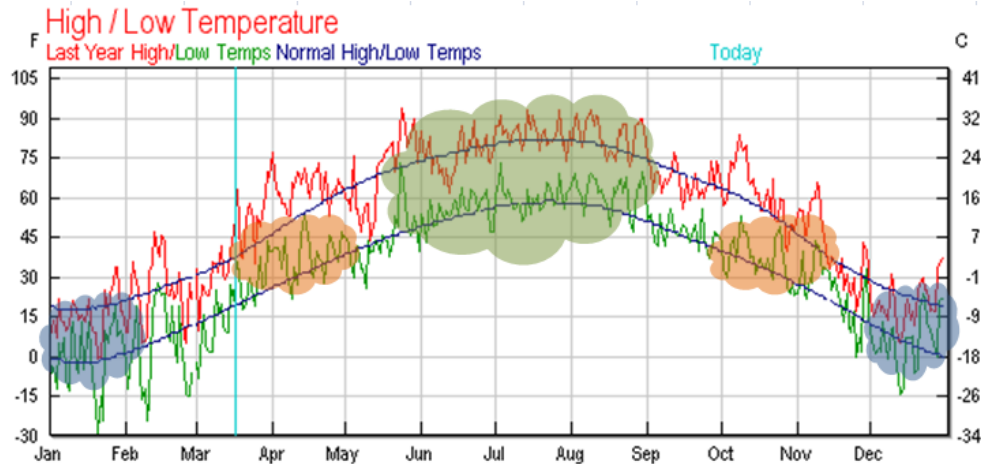
Definition of Heating, Cooling and Shoulder Seasons

The seasons are best defined by the operational conditions of the facility: the Heating season is when the mechanical system is decidedly in heating mode, the Cooling season is when the mechanical system is decidedly in cooling mode and the Shoulder season (spring or fall) occurs when heating is needed in the morning, but transitions to cooling mode as the outside temperature increases throughout the day.

Engineering judgment will often be required when defining these seasons due to the widely varying attributes of buildings. For the majority of buildings in Minnesota, the following general guidelines may be useful. Cooling season weather should include days with high temperatures above 80F, above 90F is preferred; shoulder season weather refers to days where heating is needed in the morning (40’s or below) and cooling is needed in the afternoon (upper 50’s and higher); heating season refers to days where the overnight temperatures are below 10F (below 0F is better) and the high temperatures are in the teens or 20’s. These conditions occur nearly every year in Minnesota, and thus are representative of what building mechanical systems are designed to manage.

As can be seen from the graph below, the dates that are predicted for the best periods of data collection do not always coincide with actual weather conditions. This is one of the reasons that best practices call for collecting trend data continuously for at least 6 months, starting early in either the heating or cooling season. In this way you can be sure to collect the data necessary without having to make last minute scheduling decisions.

Actual and Average Temperature Data for St Cloud, MN. Shaded areas indicate the heating season (green), cooling season (blue) and shoulder seasons (orange)



(from http://www.wunderground.com/NORMS/DisplayNORMS.asp?AirportCode=KSTC&StateCode=MN&SafeCityName=Saint_Cloud&Units=none&IATA=STC&lastyear=on&normals=on&MR=1)

When to Set Up Trending

At the onset of the investigation, ideally in conjunction with the kick-off meeting, the RCx provider shall fully assess the trending capabilities of the site. If any discrepancies are found when compared to the RFP they shall immediately be brought to the attention of the Program Manager for resolution. Any identified issues or discrepancies must be presented within a timeframe that does not impact data collection for the current season, for this reason we have updated the initial review requirements to include the submission of sample trend data and a trending plan, both of which must be reviewed and approved by the Project Engineer. The purpose of this review is to ensure that all of the necessary points for each item of equipment are being trended and that the data is complete. When setting up trends, it is common for some points to not collect correctly, resulting in loss of data. This is not an issue if caught early and resolved before a season comes to an end. If adequate data is not captured for each season, it may cause the project to be extended.

2.1.1 Basic Trending Requirements (Excerpts from *Investigation Guidelines*)

For trending and data logging, collect a minimum of one week of fifteen minute interval data for non-temperature dependent data, and two weeks of data for temperature-dependent data. Data should be collected during operating conditions that are applicable to the measure (season, outside air temperatures, operating / occupancy schedules). As stated in section 2.0, six to seven months of continuous trending is typically needed to achieve these requirements.

It can take substantial time to set up trends and to download the data, this is why it is important to prepare a trend plan in advance of the data collection period. Sample trends should be set up at the time of the first visit to a building.

Trended or logged data used for implementation verification should be the same type as the baseline data.

To gather time-series data, RCx Providers may use the building automation system to trend data or may install portable data loggers. In all instances, the data collection method used must provide accurate values. This means that the accuracy of BAS and data logger sensors must be verified. The following table shows the preferred format for trend data collection:

Data Format and Availability	ASCII; Importable to Microsoft Excel and available as .txt, .csv or .xls files for submission to the Project Engineer
Duration	Minimum of one week of data for non-temperature dependent data, , two weeks for temperature dependent data
Sampling Rate	One to 15 minutes (Use a shorter interval when a data logger can sample and average separately. Some building automation systems may only be able to trend relatively few parameters simultaneously, and the shorter the sampling interval, the fewer points that can be trended.)
Averaging/Archiving Rate	Five to 30 minutes or less. For fast acting controls, or evaluation of control loop stability, short interval data may be required.
Typical Points	All available points on each piece of equipment that is being trended should be included, subject to the capacity of the building automation system. See the Table below for specific points.

2.1.2 Sampling

When there are large numbers (over 10 identical units) of equipment, sampling may be used. By identical equipment this means that the configuration and major characteristics of the equipment are all the same. For example, with an air handler this means whether or not it recirculates return air or brings in 100% outside air; whether it is a face bypass unit or not; whether it is heating only; whether it is a single zone or multizone unit, and so on. The fact that two air handlers have the same motor size does not make them identical. All points for each piece of equipment that is in the sample are to be collected. One of the most common equipment sets that may be sampled are VAV boxes. The sampling must occur among similar equipment. Individual buildings may not be combined with one another to reduce sample numbers. The sample should be designed to include representative spaces. In addition, if measurements of the equipment within the sample show that they are significantly non-uniform, the sample size must be increased (please contact the program if you have a question).

Sampling cannot be done for equipment that has a motor horsepower rating greater than 15hp; therefore, all equipment greater than 15hp must be trended.

3.0 Common Points by Equipment Types

It is expected that all of these points, if they are available on the building automation system, would be trended for each major piece of equipment in the sample.

System Description	Point Description	Sampling Interval
VAV Air Handler	Fan Status (SF and RF)	Status Change or 15 min
	VFD Frequency (SF and RF)	15 min
	Return Air Temperature	15 min
	Economizer Damper Position	15 min
	Outside Air Temperature	15 min
	Mixed Air Temperature	15 min
	Mixed Air Temperature Setpoint	15 min
	Hot Water or Steam Valve Position	15 min
	Chilled Water Valve Position or DX Cooling Stage	15 min
	Discharge Air Temperature	15 min
	Discharge Air Temperature Setpoint	15 min
	Discharge Air Duct Static Pressure	15 min
	Space Temperature	15 min
	Space Temperature Setpoint	15 min

System Description	Point Description	Sampling Interval
Multizone Air Handler	Fan Status (SF and RF)	Status Change or 15 min
	VFD Frequency (SF and RF, if applicable)	15 min
	Return Air Temperature	15 min
	Economizer Damper Position	15 min
	Outside Air Temperature	15 min
	Mixed Air Temperature	15 min
	Mixed Air Temperature Setpoint	15 min
	Hot Water or Steam Valve Position	15 min
	Chilled Water Valve Position or DX Cooling Stage	15 min
	Hot Deck Temperature	15 min
	Hot Deck Temperature Setpoint	15 min
	Cold Deck Temperature	15 min
	Cold Deck Temperature Setpoint	15 min
	Discharge Air Duct Static Pressure (if applicable)	15 min
	Zone Damper Positions	15 min
	Zone Temperatures	15 min
Zone Temperature Setpoints	15 min	

System Description	Point Description	Sampling Interval
VAV Boxes	Hot Water or Steam Valve Position	15 min
	Discharge Air Temperature	15 min
	Discharge Air Temperature Setpoint	15 min
	Flow (cfm)	15 min
	Flow Setpoint (cfm)	15 min
	AHU Discharge Air Temperature	15 min
	Space Temperature	15 min
	Space Temperature Setpoint	15 min

System Description	Point Description	Sampling Interval
Boiler	Boiler Status	Status Change or 15 min
	Supply Hot Water Temp or Steam Pressure	15 min
	Return Hot Water Temp (if applicable)	15 min
	Outside Air Temperature	15 min
	Hot Water Pump Status (if applicable)	Status Change or 15 min
	How Water Pump VFD Speed (if applicable)	15 min
	Hot Water Differential Pressure (if applicable)	15 min
	Hot Water Flow (gpm)	15 min
	Secondary HW Loop Temperature (if applicable)	15 min

System Description	Point Description	Sampling Interval
Chiller and Cooling Tower	Chiller Status	Status Change or 15 min
	Chiller VFD Speed (if applicable)	15 min
	Supply Chilled Water Temperature	15 min
	Return Chilled Water Temperature	15 min
	Tower Fan Status	Status Change or 15 min
	Tower Fan VFD Speed (if applicable)	15 min
	Chilled Water Pump Status	Status Change or 15 min
	Chilled Water Pump VFD Speed (if applicable)	15 min
	Chilled Water Pump Flow (gpm)	15 min
	Tower Pump Status	Status Change or 15 min
	Condenser Water Pump VFD Speed (if applicable)	15 min
	Condenser Water Pump Flow (gpm)	15 min
	Secondary CHW Loop Temperature (if applicable)	15 min