Energy Efficiency Auction Pilot Measurement ~~&~~and Verification (M&V) Procedures

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Contents

1. Purpose of the M&V Procedures

EE capacity providers must provide consistent and reliable evidence of peak summer and/or winter demand reduction to demonstrate they have met their *EE capacity* obligation(s) and receive payment. The Independent Electricity System Operators (IESO) has established Procedures for the measurement of peak demand reduction during the *demand reduction windows* for the summer and winter *obligation periods* (as defined below in Figure 1). The purpose of this document is to ensure the Energy Efficiency resources are accurately measured and verified in accordance with the M&V Protocols and Procedures specified in this document.

This document is relevant to multiple stages of the EE Auction Pilot:

1. Pre-Auction Period: prior to the auction, prospective *pilot auction participants* must submit an *EE resource plan* describing planned *measures*, measure Effective Useful Life (EUL), and estimated *EE capacity*, and (at a high-level) M&V approach. IESO will review the *EE resource plan* to confirm resource eligibility for the EE Auction Pilot, the maximum quantity of *EE capacity* that can be offered with respect to the resource, and maximum EUL. Prospective auction participants should review the M&V Procedures to ensure proposed M&V approach is in alignment with the requirements for the pilot auction. Where applicable, this may include referencing the deemed savings values found in the EE Auction Pilot Measures Reference Manual. Please refer to the template attached as Appendix D to the Detailed Design for further details on *EE resource plan* requirements.
2. Forward Period: Where a *pilot auction participant* has secured an *EE capacity* obligation with respect to a resource (becoming an *EE capacity provider*), it must provide an *M&V plan* in alignment with these M&V Procedures no less than 60 days before the beginning of the resource's first obligation period for IESO review and acceptance.
3. Commitment Period: after each obligation period for which an *EE capacity provider* has an *EE capacity* obligation (after summer, after winter, or both), it must provide an *M&V report* calculating peak demand savings using the methodology stated in the accepted *M&V plan* and aligned with the requirements of these M&V Procedures. Where applicable, this may include referencing the deemed savings values found in the Measure Reference Manual and verifying the quantity and type of *measures*. IESO will use M&V reports to confirm *EE capacity delivery* and calculate payment due.

Please note that italicized terms in this document are defined terms defined in the primary Detailed Design document.

2. Energy Efficiency Demand Reduction Window

The auction will procure reductions in electricity demand from *EE resources* during specific hours of the day (*the EE demand reduction window*) during two seasonal *obligation periods*, summer and winter. Pilot auction participants can offer to deliver EE capacity just during the winter *obligation period*, just during the summer *obligation period*, or both.

For the purposes of the EE Auction Pilot, this verified demand reduction will be referred to as *EE capacity* and expressed in units of kW$_{\text{-WINTER}}$ and kW$_{\text{-SUMMER}}$. *EE capacity* will be calculated as average demand reduction during over the *demand reduction windows* hours for each *obligation period* and measured in alignment an IESO-accepted *M&V plan* that conforms to these M&V Procedures.

For the summer *obligation period*, the *demand reduction window* is from Hour Ending (HE) 12 to HE 21 Eastern Standard Time (i.e., 12:00 pm – 9:00 pm EST, 1:00 pm – 10:00 pm Daylight Savings Time) during all days from June 1 through August 31, inclusive, that is not a weekend or Federal/Provincial holiday.

For the winter *obligation period*, the demand reduction window is from HE17 to HE 21 Eastern Standard Time (4:00 pm - 9:00 PM Eastern Standard Time EST) during all days from November 1 through February 28, inclusive, that is not a weekend or Federal/Provincial holiday.

Figure 1: Timing of obligation periods and demand reduction windows

Obligation period	Demand reduction window
Winter – November 1, 2022 to February 28, 2023	Non-holiday weekdays, Hour Ending (HE) 17-21 (4:00 pm – 9:00 pm Eastern Standard Time [EST])
Summer – June 1, 2023 to August 31, 2023	Non-holiday weekdays, Hour Ending (HE) 13-21 (12:00 pm – 9:00 pm Eastern Standard Time [EST], 1:00 pm – 10:00 pm Eastern Daylight Time [EDT])

3. Measure M&V Procedures by EE Capacity Level

The required Measure M&V Procedures is categorized by the level of *EE capacity* expressed in kilowatt (kW). Table 2 summarizes the EE Capacity Thresholds and M&V Procedures:

Table 2: M&V Procedures by *measure EE Capacity* expressed in kW

M&V Category	Measure EE Capacity Thresholds	Prescribed M&V Procedures
Basic	Less than or equal to 50 kW	Deemed EE Capacity with EE Auction Pilot Measure Reference Manual or Measure Substantiation Sheet or IPMVP Protocol Option A, B, or C
Enhanced	Greater than 50 kW	IPMVP Protocol Option A, B, or C

The threshold for triggering Enhanced M&V is applied at the individual measure level except where the *EE capacity provider* is using the IPMVP Option C (Whole Facility analysis) approach to capture the impact of multiple measures within a single measurement boundary. Where Option C is used, the threshold is applied based on the cumulative estimated *EE capacity* of all measures within the measurement boundary.

3.1. BASIC M&V PROCEDURES FOR EE CAPACITY LESS THAN OR EQUAL TO 50 KW

Basic M&V Procedures should be followed for those measures with *EE capacity* of less than or equal to 50 kW. *EE capacity providers* can use the Deemed EE Capacity stated in the Measure Reference Manual to substantiate *EE capacity* or IPMVP Protocol Option A, B, or C. Auction Participant should complete a Basic M&V Plan for every measure at each facility except where using Option C to measure peak demand reduction from multiple measures at the whole building (or other measurement boundary)-level. A copy of the Basic M&V Plan can be found in Appendix A.

An *EE resource* must be qualified for at least 100 kW of *EE capacity* to participate in the EE Auction Pilot. For clarity, an *EE resource* may be an aggregation of multiple *measures* at *multiple* facilities. For example, 10 *measures* with *EE capacity* of 10 kW each can be aggregated into a single *EE resource* and each measure would be subject to the Basic M&V Procedures since it is less than the threshold of 50 kW.

For the purpose of the Energy Efficiency Auction Pilot, deemed *EE capacity* is provided for various *measures* listed in the Measure Reference Manual. The *measure* selected to substantiate *EE capacity* should conform with the Measure Reference Manual's prescribed Base Measure & Conservation Measure Description, and the End Use Load Profile. The deemed *EE capacity* for summer and winter *obligation periods* for various measures are provided to auction participants. The Measure Reference Manual is attached to the Detailed Design as Appendix C EE Auction Pilot Measure Reference Manual.

For *measures* that cannot be located in the Pilot Measure Reference Manual, the Auction Participant may request to have IESO recognize deemed *EE capacity* by submitting a completed IESO Measure Substantiation Sheet. The Measure Substantiation Sheet requires load shape analyses which requires *pilot auction participants* to use verifiable measure load shape to calculate a measure's EE capacity within the *demand reduction windows*. Measure load shapes must be based on actual metered data, load research (current or historic), and/or simulation modelling. Values for monthly or annual energy savings (whether from engineering calculations, analysis of billing data, simulation modelling) can be combined with information on verifiable measure load shapes to produce values for EE capacity (kW) during the *demand reduction window*.

3.2. ENHANCED M&V PROCEDURES FOR EE CAPACITY GREATER THAN 50 KW

Enhanced M&V Procedures should be followed for projects with *EE capacity* of greater than 50 kW. *EE capacity providers* should complete an Enhanced M&V Plan for a single measure or group of measures. The Enhanced M&V Plan template can be found in Appendix B of these M&V Procedures.

An *EE resource* must be enrolled for at least 100 kW of *EE capacity* to participate in the pilot auction. For clarity, an *EE resource* may be an aggregation of multiple *measures* at multiple contributor facilities. For example, 2 measures at the same or different *facilities* with *EE capacity* of 51 kW each can be aggregated into a single *EE resource* and each measure is subjected to the Enhanced M&V Procedures since it is greater than the *EE capacity* threshold of 50 kW.

4. Measurement & Verification Methodologies

Measure Measurement and Verification (M&V) Procedures should be consistent with International Performance Measurement & Verification Protocol (IPMVP). IPMVP Protocols means: Core Concepts October 2016 EVO 10000 – 1:2016, ~~and~~ Uncertainty Assessment for IPMVP July 2019 EVO 10100 – 1:2019~~.~~[12] and IPMVP Application Guide on Non-Routine Events & Adjustments October 2020 EVO 10400 – 1:2020.

4.1. OPTION A: RETROFIT-ISOLATION KEY PARAMETER MEASUREMENT

Definition: For IPMVP Option A, savings are determined by field measurement of the key parameter(s), which define the energy consumption and demand of the Energy Conservation Measure's (ECM's) affected system(s) or the success of the project. Measurement frequency ranges from short-term to continuous, depending on the expected variations in the measured parameter and the length of the reporting period. Parameters not selected for field measurements are estimated values. Estimates can be

[2] Definition & How savings are calculated are referenced from IPMVP Core Concepts October 2016 Table 2. Overview of IPMVP Options

based on historical data, manufacturer specifications or engineering judgement. Documentation of the source of justification of the estimated value is required. The plausible saving error arising from estimation rather than measurement is evaluated.

How savings are calculated: Engineering Calculation of baseline period energy and reporting period energy from: short-term or continuous measurements of key parameter(s) and estimated values. Routine and non-routine adjustments as required. Key parameter(s) measured during both baseline and reporting period.

4.2. OPTION B: RETROFIT-ISOLATION ALL PARAMETER MEASUREMENT

Definition: Savings are determined by field measurement of the energy consumption and demand and/or related independent or proxy variables of the ECM affected system. Measurement frequency ranges from short-term to continuous, depending on the expected variations in savings and length of the reporting period.

How savings are calculated: Short terms or continuous measurements of baseline and reporting period energy, or engineering computations using measurements of proxies of energy consumption of proxies of energy and demand. Routines and non-routine adjustments as required.

4.3. OPTION C: WHOLE FACILITY

Definition: Savings are determined by measuring energy consumption and demand at the whole facility utility meter level. Continuous measurements of the entire facility's energy consumption and demand are taken throughout the reporting period.

How Savings are calculated: Analysis of the whole facility baseline and reporting period (i.e. Utility) meter data. Routine adjustments as required, using techniques such simple comparison or regression analysis. Non-routine adjustments as required EE capacity provider should alert IESO to any non-routine baseline adjustments during the reporting period at the earliest opportunity.

Option C uses utility meters, whole-facility meters, or sub-meters to assess the energy performance of a total facility. The option determines the collective savings of Energy Conservation Measures (ECMs) applied to the part of the facility monitored by the energy meter. Whole-Building Option C is intended for projects where expected savings are significant compared to the random or unexpected energy variations which occur at the whole-facility level. Option C should not be used if the demand savings is expected to be small relative to the total facility demand. Hourly interval energy consumption data is required for the regression modelling over the entire *obligation period*.
Alternatively, savings are deemed to be statistically valid if they are large relative to the statistical variations. Specifically, the savings need to be larger than twice the standard error of the baseline value.

The most recent hourly interval data should be used to reflect the most current operation of the facility. Alternate baseline periods may be accepted at the discretion of the IESO where the most recent data is not representative of typical building conditions.

5. Establishing Baseline Conditions

The *EE capacity provider* should describe in its *M&V plan* the methodology used to determine Baseline Conditions for the equipment or process comprising the *measure*. Baseline Conditions are defined as the kW demand of the equipment or process during the *obligation period*, or the demand that would have existed, in the absence of the energy efficiency project.

The *EE capacity provider* should identify in its *M&V plan* any and all equipment, systems, practices or strategies or type of the aforementioned, whose alteration from its Baseline Condition operation will lead to reduced demand during the *obligation period's demand reduction window*.

The *EE capacity provider* must describe in its *M&V plan* how it will satisfy each of the applicable requirements listed below.

1) For projects where the demand reduction results from measures involving variable load equipment or equipment whose operation is time-dependent or weather-dependent, the Baseline Conditions must be calculated for each hour across the *demand reduction window*.
2) Current Load Baseline: For projects in which replacement, modification or removal of equipment and controls in systems, the Baseline Condition is the kW load of the existing equipment across the *demand reduction window* under pre-retrofit conditions.

5.1. APPLICABLE STATISTICAL SIGNIFICANCE REQUIREMENTS

5.1.1 Statistical Performance Indices

M&V methods to determine *EE capacity* delivery may include measurement methodologies requiring statistical estimation techniques. In the event that statistical methods are required, the following requirements for statistical significance should be met.

The following statistical indices should be provided in the submission for review by the IESO for each regression used in the overall model:

Coefficient of Determination (R^2) illustrates how well the independent variables explain the variation in the dependent variables and ranges from 0.0 to 1.0.

Coefficient of Variation of Root Mean Squared Error (CVRMSE) is the standard deviation of errors of prediction about the regression line normalized by the average y value. It is not affected by the degree of dependence between the independent and dependent variables (e.g. (R^2). CVRMSE should be less than 15%

Net Determination Bias Error (NDBE) is the sum of the errors divided by the actual. The NDBE should be less than 0.005% (absolute).

T-Statistic (T_{stat}) is the coefficient a_n divided by its standard error. T_{stat} should be calculated for each coefficient $a_1,\ldots,a_n$. Tstat should be greater than 2 for all coefficients.

The EE Auction Pilot will not dictate the form of the baseline models as long as they are transparent, can be reproduced. In general, it is expected that the model will be of the form:

$y = a_0 + a_1 n_1 + \ldots a_n x_n$

where y is the dependent variable, x is the independent variable and a_0, a_1 an are coefficients describing the relationship between the dependent and independent variable(s). Higher-order regression models are acceptable provided they meet the statistical requirements.

Weather data is often used as an independent variable. Hourly or average daily temperature data from either a local Environment Canada weather station or NASA's Near Real-time Global Radiation and Meteorology (as used by Natural Resources Canada's RETScreen tool) should be used. *EE capacity providers* can use either Environment Canada or NASA's weather data, but not both interchangeably across the participating facilities.

5.1.2 Sample Size Determination

A sample is a subset of a population selected for direct assessment of one or more variables of interest. The sample size should be determined by the desired confidence level of 90% and precision level of ±10%. The sample size requires the use of a population coefficient of variation (CV). A CV of 0.5 is often assumed when determining sample sizes when the actual value is not known. The 90/10

confidence/precision is a common target, samples of size 68[3] is very common. The necessary sample size can be reduced if the entire population being sample is no more than 20 times the size of the sample.

Population sampling error and precision should be recalibrated using a measured CV. Because the initial sample size is determined using an assumed CV, it is critical to remember that the actual CV of the population being sampled may be different. Therefore, a different actual sample size is needed to meet the precision criterion. If the actual CV turns out to be less than the initial assumption, the required sample size will be unnecessarily large to meet the precision goals. If the actual CV turns out to be larger than assumed, then the precision goal will not be met unless the sample size increases beyond the initial sample size computed.

[3] $n_0 = (Z \times CV / e)^2 = (1.645 \times 0.5 / 0.10)^2 = 68$.
Z is t_{stat} for the desired confidence level
CV is the coefficient of variation
e is the desired level of relative precision

5.1.3 Treatment of Outliers & Missing Data in the Baseline Period

Adjustments to the data in the Baseline Period used for preparation of the model will be accepted under certain conditions to create a more accurate/robust model. Allowable adjustments are outlined as follows:

Missing data should be omitted for purposes of calculating the baseline model.

In the case where an hourly interval meter is non-functional for an extended period of time, it is the responsibility of the *EE capacity provider* or its authorized representative to obtain utility interval metered data from the Local Distribution Company (LDC) to fill in the missing data.

Hours where the site has been required to reduce load due to contractual obligations (e.g. participation in the IESO-Administered Markets as a Demand Response resource) should be removed from the baseline model calculation.

Other outliers may be removed from the raw data for the Baseline Period, subject to approval. Examples of allowable outliers are temporary use of load banks for generator testing or periods of power failure or generator operation. All data removed from the dataset should be documented and submitted with the baseline model including the nature/reason for the removal and the period of time affected.

The technique(s) employed for gap filling are up to the *EE capacity provider*. The IESO will assess validity of each gap filled.

Refer to Appendix F for Illustrative Examples of acceptable Gap Gilling Techniques for gaps/missing data.

6. M&V Plan Components

A key component towards IPMVP adherence involves the development of a clear and transparent measure-specific *M&V plan* that describe various measurements and data to be gathered, analysis methods employed and verification activities that are conducted to evaluate the performance of a measure or group of measures. An IPMVP adherent *M&V plan* should be consisted of the following components:

- Facility and Measure Overview
- ECM Intent
- Selected IPMVP Option and Measurement Boundary
- Baseline: Period, Usage and Conditions
- Reporting Period
- Basis for Adjustment
- Calculation Methodology and Analysis
- Meter Specification
- Monitoring Responsibility
- Expected Accuracy
- Reporting Format
- Quality Assurance

Please refer to Appendix A for a Basic M&V Plan Template and Appendix B for an Enhanced M&V Plan Template and their components explained.

7. M&V Report Components

EE capacity providers will be required to submit an *M&V report* for each *EE resource* following the completion of each *obligation period* for which the *EE capacity provider* has a EE *capacity obligation* (i.e. after winter 2022/2023 and/or summer 2023). The *M&V report* will document the overall performance of the measures using the M&V procedures stated in the accepted *M&V plan*. Please refer to Appendix D for *M&V report* format and its components explained.

8. Measurement Equipment Specifications

The *EE capacity provider* should describe, to the most practical extent possible, in its *M&V plan* how each measurement, monitoring and/or data recording device will be installed (including its specific location) and operated to measure, monitor and/or record data from each of the parameters and variables described in the *M&V plan*. The *EE capacity provider* must describe in its *M&V plan* how it will satisfy each of the requirements listed below:

- All solid-state measurement, monitoring and data recording equipment must meet or exceed the relevant standards set by the American National Standard Institute ("ANSI") or equivalent standard.
- Measurement, monitoring and data recording equipment that is directly measuring watt-hour, volt-hour, volt-ampere-hours, reactive volt-ampere-hour, and the associated demand components should conform to ANSI or equivalent standards.
- Instruments or transducers for the analog or digital measurement of volt, volts-squared, amperes, amperes-squared, phase angle, volt-amperes, watts, and reactive volt-amperes should conform to ANSI or equivalent standards.
- Data recorders that are recording pulses from measurement and monitoring devices must utilize a pulse rate within the resolution capabilities of the recorder.
- All measurement, monitoring and data recording equipment installed on electric circuits with significant harmonics must meet the relevant standards provided by the Institute of Electrical and Electronics Engineers ("IEEE").
- Any measurement or monitoring equipment that directly measures electrical demand (kW) must be a true RMS measurement device with an accuracy of no less than ±2%.
- Any measurement or monitoring equipment that directly measures electrical demand from three-phase devices must be installed such that measurements are taken on all three-phases to account for any phase imbalance or an equivalent method that can measure electrical demand using two phases.
- Any measurement or monitoring equipment that directly measures electrical demand on circuits with significant harmonics must have a digital sampling rate of at least 2.6 kHz as defined in the relevant IEEE Standards.
- Data recorders must be synchronized in time, within an accuracy of +/- 2 minutes per month, with the National Institute of Standards and Technology ("NIST").
- All measurement, monitoring and data recording equipment must be calibrated by the *EE capacity provider* or its independent calibration contractor in such a way to meet or exceed the International Measurement and Verification Protocol (IPMVP) or NIST. If a recalibration interval is not specified by its manufacturer, electrical measurement equipment should be recalibrated at least once every two calendar years.
- The *EE capacity provider* must ensure that all measurement, monitoring and data logging equipment should be maintained in such a way as to meet or exceed industry and manufacturer standards.
- The *EE capacity provider* must maintain documentation on all measurement, monitoring and data recording equipment maintenance and calibration activities. Documentation and records must be maintained.

- The *EE capacity provider* should provide to IESO, upon request, measurement equipment maintenance, calibration and testing records to demonstrate that the *EE capacity provider*'s measurement equipment is calibrated and maintained in accordance the requirements described in this document.
- Any measurement, monitoring and data recording equipment that sample continuously and integrate values should collect data at a frequency of one hour or less. For devices that only sample "snapshots" or applications susceptible to data aliasing, one should collect data at a frequency of 15 minutes or less.

Appendix A – Basic M&V Plan

1.0 Measure General Information
Application Identifier
Facility Name: Facility Address: Facility Type: Distribution Connected (Dx) or Transmission Connected (Tx) Local Distribution Company Name (if applicable)
Facility Overview
Provide a brief description of the facility/facilities where the retrofit measure will take place including approximately square footage, number of floors, type of facility (e.g. office, warehouse, etc.) and occupancy schedule as applicable.
Timelines and Dates
Details of measure time lines and milestones and document dates such as: • Estimated Start Date: • Estimated Completion Date: • Actual Start Date: • Actual Completion Date: • In Service Date:
2.0 Energy Conservation Measures (ECM) Intent
Describe the ECM, its intended result, and the operational verification procedures that will be used to verify the successful implementation of each ECM. Identify any planned changes to conditions of the baseline, such as unoccupied building temperature settings.
3.0 Baseline: Period, energy and conditions
Document the facility's baseline conditions and energy data, within the boundary. This baseline documentation should include: a) baseline energy consumption and demand data;

1.0 Measure General Information

b) independent variable data coinciding with the energy data (e.g., production data, ambient temperature);
c) static factors coinciding with the energy data;
   1) occupancy type, density and periods;
   2) operating conditions for each baseline operating period and season, other than the independent variables;
   3) description of any baseline conditions that fall short of required conditions;
d) details of adjustments that are necessary to the baseline energy data to reflect the energy management program's expected improvement from baseline conditions.

5.0 Basis for Adjustment

Declare the set of conditions to which energy measurements will be adjusted. The conditions may be those of the reporting period or some other set of fixed conditions. The conditions for the basis for adjustment determine whether savings are reported as avoided energy or as normalized savings.

6.0 Analysis Procedure

Specify the exact data analysis procedures, algorithms and assumptions to be used in each M&V report. For each mathematical model used, report the terms, and range of independent variables over which it is valid.

Alternatively, where using deemed savings values drawn from the Measure Reference Manual, please state the listed sector, end use, conservation measure, base measure, and EEAP summer and/or winter peak demand savings (as applicable). Where using deemed savings drawn from an IESO-accepted Measure Substantiation Sheet, please attach the Measure Substantiation Sheet.

7.0 Report format

Specify how EE capacity will be reported and documented.

Appendix B – Enhanced M&V Plan

1.0 General
Application Identifier
Facility Name: Facility Address: Facility Type: Distribution Connected (Dx) or Transmission Connected (Tx) Local Distribution Company Name (if applicable)
Facility Overview
Provide a brief description of the facility/facilities where the retrofit measure will take place including approximately square footage, number of floors, type of facility (e.g. office, warehouse, etc.) and occupancy schedule.
Timelines and Dates
Details of measure timelines and milestones and document dates such as: • Estimated Start Date: • Estimated Completion Date: • Actual Start Date: • Actual Completion Date: • In Service Date:
2.0 Energy Conservation Measures (ECM) Intent
Describe the ECM, its intended result, and the operational verification procedures that will be used to verify the successful implementation of each ECM. Identify any planned changes to conditions of the baseline, such as unoccupied building temperature settings.
3.0 Selected IPMVP Option and Measurement Boundary

1.0 General

Specify which IPMVP option will be used to determine savings. Identify the measurement boundary of the savings determination. The boundary may be as narrow as the flow of energy through a pipe or wire, or as broad as the total energy use of one or many facilities. Describe the nature of any interactive effects beyond the measurement boundary together with their possible effects.

Identify IPMVP Core Concepts October 2016 EVO 10000 – 1:2016 M&V Option that will be used for determining the energy and demand savings including brief justification for the selection of this M&V Option. (Check one box only)

☐ Option A Retrofit Isolation: Key Parameter Measurement

☐ Option B Retrofit Isolation: All Parameter Measurement

☐ Option C Whole Facility: Utility Bill Analysis

*For example, M&V Option A is chosen for this lighting retrofit measure because it involves only one energy conservation measures – Lighting Retrofit, which retrofit isolation allows the narrowing of the measurement boundary in order to reduce the effort required to monitor independent variables and static factors, when retrofits affect only a portion of the facility.

4.0 Baseline: Period, energy and conditions

Document the facility's baseline conditions and energy data, within the measurement boundary. This baseline documentation should include:

a) identification of the baseline period;
b) baseline energy consumption and demand data;
c) independent variable data coinciding with the energy data (e.g., production data, ambient temperature);
d) static factors coinciding with the energy data;
    1) occupancy type, density and periods;
    2) operating conditions for each baseline operating period and season, other than the independent variables;
    3) description of any baseline conditions that fall short of required conditions;
e) details of adjustments that are necessary to the baseline energy data to reflect the energy management program's expected improvement from baseline conditions;
f) size, type and insulation of any relevant building envelope elements such as walls, roofs, doors, windows;
g) equipment inventory;

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h) equipment operating practices;
i) any design, install, calibrate, and commission and any special measurement equipment that is needed under the plan;
j) Significant equipment problems or outages during the baseline period.

The baseline documentation typically requires well-documented short term metering activities. The extent of this information is determined by the measurement boundary chosen or the scope of the savings determination. If the whole-facility M&V methods are employed, all facility equipment and conditions should be documented.

5.0 Reporting Period

Identify the reporting period, which may be as short as an instantaneous measurement during commission of an ECM, or as long as the time required to recover the investment cost of the ECM.

6.0 Basis for Adjustment

Declare the set of conditions to which energy measurements will be adjusted. The conditions may be those of the reporting period or some other set of fixed conditions. The conditions for the basis for adjustment determine whether savings are reported as avoided energy or as normalized savings.

7.0 Analysis Procedure

Specify the exact data analysis procedures, algorithms and assumptions to be used in each M&V report. For each mathematical model used, report the terms, and range of independent variables over which it is valid.

8.0 Energy Prices

Not applicable to the EE Auction Pilot

9.0 Meter Specifications

Specify the metering points and period if metering is not continuous. For non-utility meters, specify:

- meter characteristics;
- meter reading and witnessing protocol;

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- meter commissioning or calibration procedure;
- routine calibration process;
- Method of dealing with lost data and data transfer.

10.0 Monitoring Responsibilities

Assign responsibilities for reporting and recording during the reporting period:

a) energy data;
b) independent variables;
c) Static factors within the measurement boundary.

Identify those individuals that are responsible for conducting M&V activities and prepared the M&V report (analyses and documentation).

Name: _____
Title: _____
Company: _____
Email Address: _____
Phone: _____
Address: _____

11.0 Expected Accuracy

Evaluate the expected accuracy associated with the measurement, data capture, sampling and data analysis. This assessment should include qualitative and any feasible quantitative measures of the level of uncertainty in the measurements and adjustments to be used in the planned M&V report.

12.0 Budget

Not Applicable to the EE Auction Pilot

13.0 Report format

Specify how EE capacity will be reported and documented.

14.0 Quality Assurance

1.0 General

Specify quality-assurance procedures that will be used for M&V reports and any interim steps in preparing reports.

Appendix C – Measure Substantiation Sheet

Measure Name

Efficient Equipment and Technologies Description
Base Equipment and Technologies Description

Codes, Standards and Regulations

Resource Savings Table

	Base Measure	Conservation Measure	Annual Savings	Lifetime Savings
Electricity (kWh)				
Demand (kW)				
Connected (kW)				
Obligation Period Demand Reduction Window Peak (kW)				
Effective Useful Life (years)				

Resource Savings Assumptions & Calculations

Annual Energy Savings
Base Measure Assumptions: **Conservation Measure Assumptions:** **Energy Savings:**
Demand Savings – EE Capacity
Summer/Winter Peak Demand Savings

Obligation period	Demand reduction window
Summer – June 1 to August 31	Non-holiday weekdays, Hour Ending (HE) 13-21 (12:00 pm – 9:00 pm EST, 1:00 pm -10:00 pm EDT)
Winter – November 1 to February 28	Non-holiday weekdays, Hour Ending (HE) 17-21 (4:00 pm – 9:00 pm EST)

The winter/peak demand savings is calculated with the following formula:

$$EEAP\ Summer\ Peak\ Demand\ Savings\ (kW) = Annualized\ energy\ savings\ (kWh) * Summer\ Peak\ Demand\ factor$$
$$= Annualized\ energy\ savings\ (kWh) * \frac{\sum kW(\text{June 1 to August 31,non−holiday weekdays,hour ending (HE) 13−21})}{594\ hours}$$

$$EEAP\ Winter\ Peak\ Demand\ Savings\ (kW) = Annualized\ energy\ savings\ (kWh) * Winter\ Peak\ Demand\ factor$$
$$= Annualized\ energy\ savings\ (kWh) * \frac{\sum kW(November\ 1\ to\ February\ 28/29, non-holiday\ weekdays,\ hour\ ending\ (HE)\ 17-21)}{425\ hours}$$

The summer/winter peak demand factor is defined as the average demand of an 8760 load shape (normalized to 100%) during the Energy Efficiency demand reduction period and window. The number of hours under this period and window is 594 hours for the summer peak demand and 425 hours for the winter peak demand.

The EEAP Summer/Winter Peak Demand Savings (kW) is calculated by multiplying the annual energy savings (kWh) by the peak demand factor

Other Resource Savings

Other Input Assumptions

Effective Useful Life (EUL)

Seasonal Energy Savings Pattern

	Winter On – Peak	Winter Mid -Peak	Winter Off - Peak	Summer On - Peak	Summer Mid - Peak	Summer Off Peak	Shoulder Mid - Peak	Shoulder Off Peak	Summer Peak Demand	Winter Peak Demand
Baseload Profile	%	%	%	%	%	%	%	%	%	%

Measure Assumptions Used by Other Jurisdictions

Source	Annual Electricity Savings (kWh)	On-Peak Demand Reduction		Effective Useful Life (yrs)	Incremental Cost ($)
		Winter (kW)	Summer (kW)		
Comments:					
Comments:					

References

Appendix D - M&V Report Components

1.0 Measure Background
Provide a brief description of the facility where the retrofit measure will take place including approximately square footage, number of floors, type of facility (e.g. office, warehouse, etc.) and occupancy schedule.
2.0 Energy Conservation Measures (ECM) Description
Describe the ECM, its intended result, and the operational verification procedures that will be used to verify the successful implementation of each ECM. Identify any planned changes to conditions of the baseline, such as unoccupied building temperature settings.
3.0 M&V Option chosen for the ECM part of the M&V Plan
Deemed EE Capacity with EE Auction Pilot Measure Reference Manual or Measure Substantiation Sheet or IPMVP Protocol Option A, B, or C including brief justification for the selection of this M&V Option
4.0 M&V Activities Conducted during the Reporting Period
• Start and end time for the measurement period • Energy use data • Data for independent and static variables • Description of inspection activities conducted • Verified saving calculations and methodology • Provide detailed description of data analysis and methodology • Provide an updated list of assumptions and source of data used in the calculations • Provide details of any baseline or saving adjustments including both routine and non-routine adjustment to account for changes • Clear presentation of verified *EE capacity* and comparison to the proposed savings
5.0 Verified EE Capacity
Clear presentation of verified *EE capacity* and comparison to the proposed savings

Appendix E - EE Auction Pilot Measure Reference Manual

Appendix F - Examples of Acceptable Gap Filling Techniques for Missing Meter Data

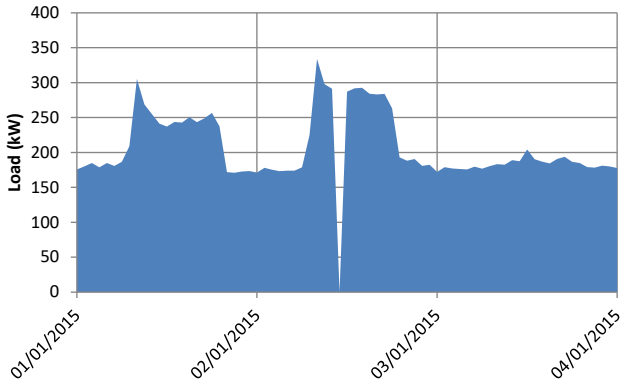
This appendix illustrates acceptable methods to address meter data gaps.

EXAMPLE 1: SINGLE POINT GAP FILL USING INTERPOLATION

This technique is applicable to most situations where the gap corresponds to a single hour (data point).

In this example a gap in the interval data occurs January 2, 2015 at 11:00AM lasting 1 hour.

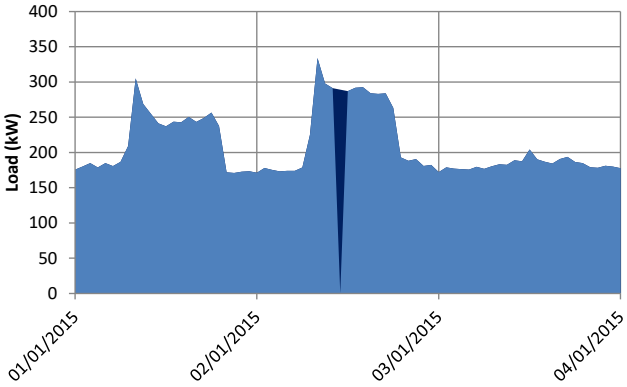
Illustration 1: Single point gap



The load just prior to the gap (10:00 AM) was 291 kW and the load just after the gap (12:00 PM) was 287 kW.

The gap was filled with a value of 289 kW, determined by taking the average between the two known data points.

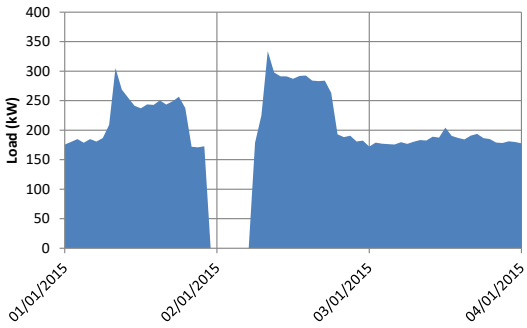
Illustration 2: Single point gap fill using interpolation



EXAMPLE 2: MULTIPLE POINT GAP FILL OVER A PERIOD OF RELATIVELY CONSTANT LOAD USING LINEAR INTERPOLATION

In this example a gap in the data occurs between January 2, 2015 11:00PM and January 2, 2015 5:00AM.

Illustration 2: Multiple point gap

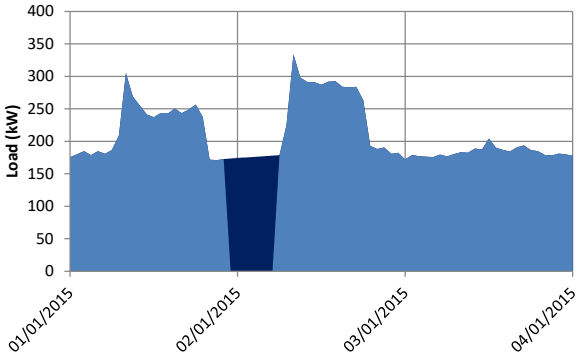


An analysis over similar hours on other days was made, and it indicated that the load over which the gap appears is generally constant[4]. The load just prior to the gap (January 1 10:00PM) was 172.7 kW and just after the gap (January 2, 6:00AM) was 178.5 kW.

The gap was filled by linear interpolation with the values summarized in the chart.

Illustration 3: Multiple point gap fill using linear interpolation

Timestamp	Load (kW)
Jan-01, 2015 - 10:00 PM	172.7
Jan-01, 2015 - 11:00 PM	172.8
Jan-02, 2015 - 12:00 AM	172.9
Jan-02, 2015 - 1:00 AM	173
Jan-02, 2015 - 2:00 AM	173.1
Jan-02, 2015 - 3:00 AM	173.2
Jan-02, 2015 - 4:00 AM	173.3
Jan-02, 2015 - 5:00 AM	173.4
Jan-02, 2015 - 6:00 AM	173.5

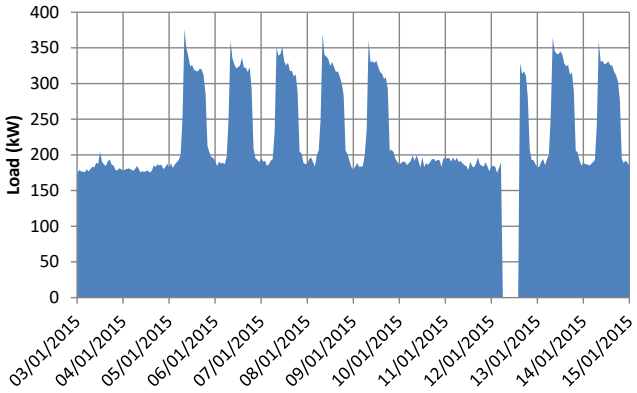


[4] Subject to independent verification

EXAMPLE 3: MULTIPLE POINT GAP FILL USING AVERAGING

There is a gap in the data January 12, 2015 occurring between 6:00AM and 2:00PM.

Illustration 4: Multiple point gap

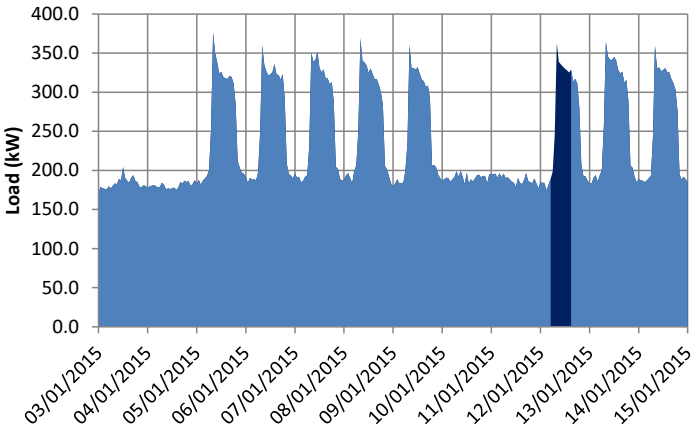


An analysis on other days over similar hours that the load over which the gap appears is not constant, but is repeatable.

The gap was filled by averaging interval data over similar time periods representative of the gap.

Illustration 5: Multiple point gap fill using averaging

hour	Date							
beginning	Jan-05	Jan-06	Jan-07	Jan-08	Jan-09	Jan-13	Jan-14	average
6:00AM	199.8	197.4	193.6	206.3	199.5	200.1	192.9	198.5
7:00AM	252.6	249.6	230.6	251.1	234.8	256.4	242.4	245.3
8:00AM	376.0	360.0	350.4	368.8	360.5	364.1	359.4	362.7
9:00AM	349.9	335.4	338.8	340.2	330.2	345.8	330.6	338.7
10:00AM	338.1	326.7	341.3	337.9	331.1	341.6	331.65	335.5
11:00AM	323.8	321.3	351.8	334.2	328.8	341.1	326.85	332.6
12:00PM	326.0	322.8	331.1	324.6	331.9	345.0	328.2	329.9
1:00PM	319.2	325.5	325.3	330.3	323.6	340.6	330.75	327.9
2:00PM	317.7	336.2	329.1	322.9	316.1	328.5	325.65	325.2



Appendix G - M&V Procedures by Common Energy Efficiency Measures

The table below identifies common Energy Efficiency Measures. Refer to the specific M&V Procedures for the measure selected:

Table 3: Selection of Energy Efficiency Measure

#	**Energy Efficiency Measure Name**
1	Lighting Retrofit
2a)	Equipment Replacement – Chillers
2b)	Equipment Replacement – Refrigeration
2c)	Equipment Replacement – Motors
2d)	Equipment Replacement – Air Compressors
2e)	Equipment Replacement – Aeration Blowers
3	HVAC Redesign
4	Variable Speed Drives (VSDs)
5	Building Envelope
6	Building Automation Systems (BAS)
7	Lighting Controls
8	Monitoring and Targeting (M+T)
9	Thermal Storage
10	Other Custom Measure

MEASURE #1 LIGHTING RETROFIT

Required Parameters	M&V Requirements
Existing System Description	Provide Inventory of existing lamps, fixtures, and ballasts affected including fixture, lamp and ballast types, operating log (e.g. common space 24/7; tenant space lease hours), usage area designation, counts of operating and non-operating fixtures and lamps* **Reporting of non-operating fixtures is required and should be limited to 10% of total number of fixtures. If there is more than 10% of non-operating fixture, these should be excluded from the project.*
Proposed System Description	Inventory of Retrofit lamps, fixtures, and ballasts affected including fixture, lamp and ballast types, operating log (e.g. common space 24/7; tenant space lease hours), usage area designation, counts of operating and non-operating fixtures and lamps
Measurement Boundaries	For power measurements, include only those equipment (i.e. fixtures, lamps) types selected as per Sampling protocol within measurement boundaries. Measurement boundary should include all the fixtures being replaced as per Measure Scope
Measurement Conditions	Post Retrofit measurements should allow for a minimum 100 hours of burn–in A statistically significant sample of fixtures as per Sampling protocol should be measured
Sampling	Representative sampling to be followed for the selection of samples. Sampling is to be distributed across the facility. The measurement data should be collected for each fixture usage group. Measurement data should be obtained for a sample of loads (Sampling size determination is typically 90% Confidence and ±10% Precision for each homogeneous population) for both Baseline and Retrofit for each type of fixtures. Selecting the appropriate sampling criteria requires balancing accuracy requirement with M&V costs within the budget it may be appropriate to establish a maximum sample size in the M&V Plan. If this maximum is actually reached after the re-computations, the saving report should note the actual precision achieved by the sampling.
Baseline Period and Reporting Period Duration	Installation report is required to substantiate burn-in hours (100 hours). Operating hours logging is required for Large Custom Projects to validate operating hours. Retrofit measurements for Lighting Measure wattages should allow for a minimum 100 hours of burn-in hours.
Metering Requirements	In cases where measurements are not commercially reasonable, fixture wattages should be stipulated using Standard Lighting Tables or manufacturer's data sheets available Spot metering should be conducted for Retrofit fixtures using the same methods and procedures used for the Baseline fixtures. Metering to be conducted for both RMS wattage and/or operating hours (manual or metered) IPMVP M&V Option A or B should be used.

Required Parameters	M&V Requirements
	Metering Instructions for both Baseline and Retrofit: *(1) Metering of Fixture Wattages:* Requires the use of RMS meter, continuous monitoring on a sample population within each usage group, the readings should be averaged and calibrated Meters should be used. *(2) Logging Operating Hours:* Continuous monitoring (manual or metering) on a sample population within each usage group should be conducted for a minimum of one week or span across full operating cycle. When seasonal variations or scheduled activity affect equipment operation, metering should be conducted during each variation period. (e.g. summer operating schedules in classrooms). Metering period should not include vacations or holidays.
EE Capacity Calculation	Summer – June 1 to August 31 • Non-holiday weekdays, Hour Ending (HE) 13-21 (12:00 pm – 9:00 pm EST, 1:00 pm -10:00 pm EDT) Winter – November 1 to February 28 • Non-holiday weekdays, Hour Ending (HE) 17-21 (4:00 pm – 9:00 pm EST) $kW_{Savings} = kW_{Baseline} - kW_{Retrofit}$ $\sum Total\ kW_{savings} / Total\ EE\ demand\ reduction\ window\ Hours$
Energy Savings Calculation	Not Applicable for the EE Auction Pilot
Baseline Adjustments	Baseline Adjustments are required in the case that quantity, lighting level and operating hours are reduced significantly (typically more than 30%)

MEASURE #2A EQUIPMENT REPLACEMENT - CHILLERS

Required Parameters	M&V Requirements
Existing System Description	Baseline information of existing equipment including chiller nameplate data, load served, efficiency ratings, operating schedule and equipment location
Proposed System Description	Baseline information of existing equipment including chiller nameplate data, load served, efficiency ratings, operating schedule and equipment location
Measurement Boundaries	Measurements to be taken at *Measure* level and should include equipment that will be retrofitted
Measurement Conditions	Baseline metering is normally performed during a period where a range of cooling loads exists (e.g. summer). Baseline and Retrofit performance is to be measured at representative distributed load levels spanning total design loads, multiplied by stipulated operating hours at each point.
Sampling	Samples should span across different load levels with minimum of 20% sample across the different load levels.
Baseline Period and Reporting Period Duration	Continuous interval measurements are to be made to reflect full cycle of operation of Baseline and Retrofit chiller
Metering Requirements	Multiple measurements are made while the cooling systems are operating at different loads so that the complete range of chiller performance can be evaluated Metering to be conducted for both continuous interval metering of chiller kW using true RMS meter and cooling load using a BTU meter or monitoring of supply and return chilled water temperature and chilled water flow rate.
EE Capacity Calculation	Summer – June 1 to August 31 • Non-holiday weekdays, Hour Ending (HE) 13-21 (12:00 pm – 9:00 pm EST, 1:00 pm -10:00 pm EDT) Winter – November 1 to February 28 • Non-holiday weekdays, Hour Ending (HE) 17-21 (4:00 pm – 9:00 pm EST) $kW_{Savings} = kW_{Baseline} - kW_{Retrofit}$ $\sum Total\ kW_{savings} / Total\ EE\ demand\ reduction\ window\ Hours$
Energy Savings Calculation	Not Applicable for the EE Auction Pilot
Baseline Adjustments	Baseline Adjustment is required when Retrofit cooling load is significantly different from the measured Baseline cooling load. Baseline should be adjusted to the Reporting Period conditions using CDD, HDD or rate of production.

MEASURE #2B EQUIPMENT REPLACEMENT – REFRIGERATION

Required Parameters	M&V Requirements
Existing System Description	Baseline information of existing equipment required refrigeration unit nameplate data, load served, efficiency ratings, operating schedule and equipment locations
Proposed System Description	Baseline information of existing equipment required refrigeration unit nameplate data, load served, efficiency ratings, operating schedule and equipment locations
Measurement Boundaries	Measurements to be taken at *Measure* level and boundaries should include equipment that will be retrofitted
Measurement Conditions	Baseline and Retrofit performance is to be measured at representative distributed load levels spanning total design loads, multiplied by stipulated operating hours at each point.
Sampling	Sampling should be carried out as per IPMVP protocol
Baseline Period and Reporting Period Duration	Continuous interval measurements are to be made to reflect full cycle of operation of existing and retrofit units
Metering Requirements	Metering to be conducted for both continuous interval metering of Refrigeration kW and metering of Cooling Load
EE Capacity Calculation	Summer – June 1 to August 31 • Non-holiday weekdays, Hour Ending (HE) 13-21 (12:00 pm – 9:00 pm EST, 1:00 pm -10:00 pm EDT) Winter – November 1 to February 28 • Non-holiday weekdays, Hour Ending (HE) 17-21 (4:00 pm – 9:00 pm EST) $kW_{Savings} = kW_{Baseline} - kW_{Retrofit}$ $\sum Total\ kW_{savings} / Total\ EE\ demand\ reduction\ window\ Hours$
Energy Savings Calculation	Not Applicable for the EE Auction Pilot
Methodology Applied for Variable Load	Continuous interval kW measurement required at various load levels

MEASURE #2C EQUIPMENT REPLACEMENT MOTORS ERM-E

Required Parameters	M&V Requirements
Existing System Description	Provide Inventory of existing motors affected including nameplate data, motor horsepower, quantity, load profile, operating schedule and motor application
Proposed System Description	Provide Inventory of existing motors affected including nameplate data, motor horsepower, quantity, load profile, operating schedule and motor application
Measurement Boundaries	Measurement boundaries should include all motors that will be replaced and including all dependent and independent variables
Measurement Conditions	A statistically significant sample of motors should be measured
Sampling	In case of multiple motor replacements, sampling is to be done on the type of load they serve by usage groups. For projects in which a large number of equal-sized motors and same operating hours, metering can be conducted on a sample of motors and the results can be extrapolated to the population Measurements should be made on the lesser of 30 motors or 10% of the population. This should be applied to each usage group of comparable load application
Baseline Period and Reporting Period Duration	Metering observation should be made for both Baseline and Retrofit in 15 minute intervals for variable or constant load respectively and should span a full operating cycle from maximum to minimum energy.
Metering Requirements	In cases where measurements are not practically possible, kW should be stipulated using manufacturer's datasheets or nameplates. Where metering is required, spot metering should be conducted for Retrofit motors using the same methods and procedures used for the Baseline motors. Metering is required for both spot/short term power measurements and operating hours <u>Metering Instructions:</u> *(1) Power Consumption Measurements (kW)* - For constant load motors, spot or short-term measurements on a sample population within each usage group should be conducted to obtain three-phase amps, volts, Power Factor, kW, and RPM. Multiple spot measurements at each load level are required for variable load application. *(2) Logging Operating Hours* - Continuous monitoring on a sample population within each usage group should be conducted for a minimum of one week or span across full operating cycle. When seasonal variations or scheduled activity affect equipment operation, metering should be conducted during each variation period. Metering period should not include vacations or holidays.
EE Capacity Calculation	Summer – June 1 to August 31

Required Parameters	M&V Requirements
	• Non-holiday weekdays, Hour Ending (HE) 13-21 (12:00 pm – 9:00 pm EST, 1:00 pm -10:00 pm EDT) Winter – November 1 to February 28 • Non-holiday weekdays, Hour Ending (HE) 17-21 (4:00 pm – 9:00 pm EST) $kW_{Savings} = kW_{Baseline} - kW_{Retrofit}$ $\sum Total\ kW_{savings} / Total\ EE\ demand\ reduction\ window\ Hours$
Energy Savings Calculation	Not Applicable for the EE Auction Pilot

MEASURE #2D EQUIPMENT REPLACEMENT – AIR COMPRESSORS

Required Parameters	M&V Requirements
Existing System Description	Baseline information of existing equipment including compressor nameplate data, CFM at full load, Voltage, Amps (FLA), Amps (LRA), pressure, age, operating schedule and conditions, equipment location, type (reciprocating, rotary screw, etc.), operation type (modulating, load/unload,etc.), annual operating hours.
Proposed System Description	Baseline information of existing equipment including compressor nameplate data, CFM at full load, Voltage, Amps (FLA), Amps (LRA), pressure, age, operating schedule and conditions, equipment location, type (reciprocating, rotary screw, etc.), operation type (modulating, load/unload,etc.), annual operating hours.
Measurement Boundaries	Measurements to be taken at *Measure* level. Measurement boundaries should include equipment and other accessories that will be Retrofitted.
Measurement Conditions	Baseline and Retrofit performance is to be measured in 15 minute continuous interval measurements to represent the full operating cycle.
Sampling	Samples should span across different load levels. Minimum of 20% sample across the different load levels
Baseline Period and Reporting Period Duration	• Continuous interval Measurement should be conducted to reflect typical operating cycle – e.g. Monday to Friday, a full working week.
Metering Requirements	Measured parameters include power (kW) or voltage, amps, power factor and airflow load (CFM), and/or pressure. For Retrofit, Power (kW) and design load (CFM) are to be measured and compared with Baseline measurement. If the process flow is significantly different, Baseline adjustment should be made to reflect the Retrofit conditions. .
EE Capacity Calculation	Summer – June 1 to August 31 • Non-holiday weekdays, Hour Ending (HE) 13-21 (12:00 pm – 9:00 pm EST, 1:00 pm -10:00 pm EDT) Winter – November 1 to February 28 • Non-holiday weekdays, Hour Ending (HE) 17-21 (4:00 pm – 9:00 pm EST) $kW_{Savings} = kW_{Baseline} - kW_{Retrofit}$ $\sum Total\ kW_{savings} / Total\ EE\ demand\ reduction\ window\ Hours$ Baseline performance is to be measured and/or simulated by using stipulated values (nameplate data, manufacturer specifications, etc.). Measured parameters include power (kW) or voltage, amps, power factor and airflow load (CFM),

Required Parameters	M&V Requirements
	and/or pressure. Measurement should be conducted to reflect typical operating cycle – e.g. Monday to Friday, a full working week. Retrofit case performance is to be measured by the same method as the Baseline measurement. Power (kW) and design load (CFM) are to be measured and compared with Baseline measurement.
Energy Savings Calculation	Not Applicable for the EE Auction Pilot
Baseline Adjustments	In case where the design load (CFM) is significantly different between Base and Energy Efficient Case, the measurement may be normalized. The normalization may be taken in the Retrofit stage as the Savings may be subject to change based on the Energy Efficient case measurement. Regression analysis (kW vs. CFM) is required for normalization. <u>Baseline Adjustment Calculation</u> *Baseline Efficiency [kW/CFM] = Baseline Peak Demand [kW] ÷ Baseline Average Airflow Load [CFM]* *Adjusted Baseline Demand [kW] = Baseline Efficiency [kW/CFM] x Retrofit Case Average Airflow [CFM]* <u>Savings Calculation after Adjustment</u> *Demand Savings [kW] = Adjusted Baseline Demand [kW] – Retrofit case Demand [kW]* *Annual Savings [kWh] = Adjusted Baseline Consumption [kWh] – Retrofit case Consumption [kWh]*

MEASURE #2E EQUIPMENT REPLACEMENT – AERATION BLOWERS

Required Parameters	M&V Requirements
Existing System Description	Baseline information of existing equipment including manufacturer/Model Number, HP, load, voltage, amps, constant speed/variable speed, and annual operating hours
Proposed System Description	Baseline information of existing equipment including manufacturer/Model Number, HP, load, voltage, amps, constant speed/variable speed, and annual operating hours
Measurement Boundaries	Measurements should be taken at Measure e.g. blowers, level and boundaries should include equipment that will be replaced.
Measurement Conditions	A minimum of 1-week monitoring period representative of the typical blowers' operating schedule or a typical full cycle of operation.
Sampling	Samples should span across different load levels. Minimum of 20% sample across the different load levels.
Baseline Period and Reporting Period Duration	Utility bill comparison analysis is recommended for when blowers represent 50% or more of the total facility electrical Energy Consumption. Establish a regression model compiling utility meter data and historical wastewater flow volume as independent variable for the Baseline Period.
Metering Requirement	Measured parameters include power (kW) or voltage, amps, power factor and airflow (CFM), and/or pressure at 15-minutes interval for a minimum of one week. If the process flow is significantly different, Baseline adjustment should be taken to adjust the Savings.
EE Capacity Calculation	Summer – June 1 to August 31 • Non-holiday weekdays, Hour Ending (HE) 13-21 (12:00 pm – 9:00 pm EST, 1:00 pm -10:00 pm EDT) Winter – November 1 to February 28 • Non-holiday weekdays, Hour Ending (HE) 17-21 (4:00 pm – 9:00 pm EST) kWSavings = kWBaseline − kWRetrofit ∑Total kWsavings / Total EE demand reduction window Hours
Energy Savings Calculation	Not Applicable for the EE Auction Pilot
Baseline Adjustments	Perform non-routine Baseline Adjustment when Retrofit wastewater effluent is significantly different from those recorded in the Baseline Period. A regression model should be established to calculate the adjusted Baseline with the Retrofit wastewater effluent in the Reporting Period. A minimum of R-squared (R2) statistic of greater than 75% should be used. R-squared is a statistical measure of

Required Parameters	M&V Requirements
	how close the data are to the fitted regression line. Refer to the Statistical Significance section.

MEASURE #3 HVAC REDESIGN

Required Parameters	M&V Requirements
Existing System Description	Inventory of Baseline equipment affected. Baseline information of all components in HVAC system to be studied including but not limited to HVAC equipment (refrigeration units, AC units, fans, etc.), Location – weather bin data, HDD, CDD, Cooling/heating load and Operating schedule
Proposed System Description	Inventory of Baseline equipment affected. Baseline information of all components in HVAC system to be studied including but not limited to HVAC equipment (refrigeration units, AC units, fans, etc.), Location – weather bin data, HDD, CDD, Cooling/heating load and Operating schedule
Measurement Boundaries	Measurement boundaries should include all components within the HVAC system and any other auxiliary components that are affected by the proposed re-design. Measurements to be taken at system level Component Measure within the HVAC Re-design is to be considered separately and in isolation, to the extent practical
Measurement Conditions	Measurement conditions should be comparable between Baseline and Retrofit case (e.g. operating profile, time and duration of measurement, measured parameters, equipment, etc.)
Sampling	For measure that involves other Measure combined with replacement of HVAC units sampling can be excluded for HVAC units
Baseline Period and Reporting Period Duration	Reporting duration should cover full operating profile of the system and the result is to be compared with engineering references (manufacturer specifications of equipment, reasonable and practical operating hours
Metering Requirements	Metering to be conducted will require short and/or long-term continuous interval measurements Continuous interval measurements are to be made to reflect full cycle of operation of all components of the existing and re-designed HVAC system performance The measurement method/approach for both Baseline and Retrofit should be comparable (e.g. time, method, etc.).
EE Capacity Calculation	Summer – June 1 to August 31 ○ Non-holiday weekdays, Hour Ending (HE) 13-21 (12:00 pm – 9:00 pm EST, 1:00 pm -10:00 pm EDT) Winter – November 1 to February 28 ○ Non-holiday weekdays, Hour Ending (HE) 17-21 (4:00 pm – 9:00 pm EST) $kW_{Savings} = kW_{Baseline} - kW_{Retrofit}$ $\sum Total\ kW_{savings} / Total\ EE\ demand\ reduction\ window\ Hours$

Required Parameters	M&V Requirements
Energy Savings Calculation	Not Applicable for the EE Auction Pilot
Baseline Adjustments	Baseline Adjustments should be made based on Operating Profile, cooling and heating load, weather data (location, HDD, CDD)
Methodology Applied for Variable Load	For various load, continuous interval measurement should be performed for kW at various load and/or use engineering reference. Output such as airflow rate, cooling and heating load are also to be measured and studied to establish kW at each representative load.

MEASURE #4 VARIABLE SPEED DRIVES (VSDs)

Required Parameters	M&V Requirements
Existing System Description	Inventory of Baseline equipment affected. Baseline information of existing equipment including Nameplate data, Motor horsepower, Quantity, Load served, Operating schedule, Motor application, Location, Spot-metering data for a Baseline sample that is representative of each usage group
Proposed System Description	Inventory of Baseline equipment affected. Baseline information of existing equipment including Nameplate data, Motor horsepower, Quantity, Load served, Operating schedule, Motor application, Location, Spot-metering data for a Baseline sample that is representative of each usage group
Measurement Boundaries	Measurement boundary should include all existing equipment that will be Retrofitted with VSD(s). The measurement boundary should capture all existing equipment and not only those that are selected to be representative samples during measurements.
Measurement Conditions	Measurements should be conducted to include all operating parameters and to reflect the various operating points
Sampling	Baseline equipment should be grouped into usage groups according to those with identical operating characteristics and/or expected operating hours. The lesser of 30 or 10% of the existing equipment from each usage group should be subject to metering where measurements are required For projects in which a large number of equal-sized motors with the same application and operating schedule will be replace, metering may be conducted on a sample of motors and the results extrapolated to the applicable population.
Baseline Period and Reporting Period Duration	Reporting duration should span through a full operating cycle in both Baseline and Reporting periods. A typical operating cycle should reflect the highest and lowest consumption and various operating points.
Metering Requirements	Metering to be conducted for both motor power draw to be defined using continuous-metering at each motor load level. Operating hours to be logged for each load levels. <u>Metering Instructions:</u> For both Baseline and Retrofit: *(1) Power Consumption Measurements (kW)* • For constant load motors, spot or short-term measurements on a sample population within each usage group should be conducted to obtain three-phase amps, volts, Power Factor, kVA, kW, and RPM. • Multiple spot measurements at each load level are required for variable load application. *(2) Logging Operating Hours*

Required Parameters	M&V Requirements
	• Continuous monitoring on a sample population within each usage group should be conducted for a minimum of two weeks or span of full operating cycle. • When seasonal variations or scheduled activity affect equipment operation, metering should be conducted during each variation period. (e.g. HVAC system motors should be measured during summer peak months). • Metering period should not include vacations or holidays.
EE Capacity Calculation	Summer – June 1 to August 31 o Non-holiday weekdays, Hour Ending (HE) 13-21 (12:00 pm – 9:00 pm EST, 1:00 pm -10:00 pm EDT) Winter – November 1 to February 28 o Non-holiday weekdays, Hour Ending (HE) 17-21 (4:00 pm – 9:00 pm EST) • Baseline Demand is assumed to stay constant into Retrofit stage, as Baseline and Retrofit equipment are not changed • In the case where there are multiple usage groups, Demand is the sum of $kW_{usage\ group}$: $kW_{usage\ group} = (kW/Motor)\ x\ (Motor\ Quantity\ in\ Usage\ Group)$ This equation applied to both Baseline and Retrofit calculations. Motor quantities and number of usage groups should remain constant. If these values change, refer to Baseline Adjustment. $kW_{Baseline} = kW_{Baseline\ usage\ group}\ x\ (\#\ of\ usage\ groups)_{Baseline}$ $kW_{Retrofit} = kW_{Retrofit\ usage\ group}\ x\ (\#\ of\ usage\ groups)_{Retrofit}$ $kW_{Savings} = kW_{Baseline} - kW_{Retrofit}$ Measurements of $kW_{Baseline}$ and $kW_{Retrofit}$ to be collected in 15-min interval RMS metering wattage measurements. $\sum Total\ kW_{savings} / Total\ EE\ demand\ reduction\ window\ Hours$
Energy Savings Calculation	Not Applicable for the EE Auction Pilot
Baseline adjustments	Baseline Adjustments are required in the case that there are non-operating motors in the Post-stage that were normally operating or are intended for operation (e.g. typically operating motors that are intended for repair)

Required Parameters	M&V Requirements
Methodology Applied for Variable Load	For variable load motors, continuous metering is required for each motor grouping while the motors' applicable systems are modulated over their normal operating range. An average kW Demand is used for calculating Energy use. Baseline operating hours can be logged for an interval then extrapolated over a year. In post-VSD installation stage, operating hours should be measured.

MEASURE #5 BUILDING ENVELOPE BE-E

Required Parameters	M&V Requirements
Existing System Description	Use of energy modeling software such as RETScreen and EE4 are required. Simulation modeling should account for actual glazing types, actual building envelop features, shading, building orientation, local weather data Ontario Building code (OBC) should be used as reference in absence of Baseline parameters. Specify manufacturers' data, industry references, for thermal or leakage properties.
Proposed System Description	Use of energy modeling software such as RETScreen and EE4 are required. Simulation modeling should account for actual glazing types, actual building envelops features, shading, building orientation, local weather data Ontario Building code (OBC) should be used as reference in absence of Baseline parameters. Specify manufacturers' data, industry references, for thermal or leakage properties. Blower door test is required to demonstrate infiltration reduction Simulations should demonstrate solar effects and coincident loading for all orientations
Measurement Boundaries	Measurement boundary should cover all the area impacted by proposed measure
Measurement Conditions	Measurements should be under normal operating conditions.
Sampling	Not Applicable
Baseline Period and Reporting Period	Baseline period should be not less than the most recent 12 months prior to the Retrofit installation period. A minimum of 6 months is required for the monitoring period covering the peak demand period over a block of hours as defined in EE Auction Pilot Peak Demand Definition
EE Capacity Calculation	Summer – June 1 to August 31 o Non-holiday weekdays, Hour Ending (HE) 13-21 (12:00 pm – 9:00 pm EST, 1:00 pm -10:00 pm EDT) Winter – November 1 to February 28 o Non-holiday weekdays, Hour Ending (HE) 17-21 (4:00 pm – 9:00 pm EST) $kW_{Savings} = kW_{Baseline} - kW_{Retrofit}$ $\sum Total\ kW_{savings} / Total\ EE\ demand\ reduction\ window\ Hours$ To be based on hour-by-hour annual whole building model.
Energy Savings Calculation	Not Applicable for the EE Auction Pilot

Required Parameters	M&V Requirements
Baseline Adjustments	Baseline Adjustment should be made based on cooling and heating load and operating hours
Methodology Applied for Variable Load	Variable load exist in BAS projects if they are implemented to enhance cooling/heating fans

MEASURE #6 BUILDING AUTOMATION SYSTEM (BAS)

Required Parameters	M&V Requirements
Existing System Description	Inventory of Baseline equipment affected by the BAS, such as: motors, fans, pumps and controls. Baseline information required for each component including manufacturer, model number, quantity, rated capacity, energy-use factors (such as rated voltage, amps, Btu/hr), nominal efficiency, load served, location, any key parameters such as weather data (HDD, CDD) and operating hours, metering data or whole facility utility bills for a minimum of 12-months
Proposed System Description	Retrofit information required for the BAS and its components. Metering data or whole facility utility bills post-BAS installation for a minimum of 12-months. Any key parameters such as weather data (HDD, CDD) and operating hours
Measurement Boundaries	Measurement boundary should include all the components that are impacted by the new BAS – such as lighting system, cooling and heating equipment, fans, etc.
Measurement Conditions	For all BAS projects, measurement conditions should be comparable between Baseline and Retrofit cases. Operating profile, time and duration of measurement and other measured parameters should be obtained and approached in similar methods.
Sampling	As BAS projects are considered as inherently uncertain, all components should be measured and analyzed
Baseline Period and Reporting Period Duration	Reporting duration should reflect full operating profile of all components that are covered under the new BAS. A typical operating profile should reflect the maximum and minimum consumption for the ECM.
Metering Requirements	All **e**nergy-use factors for each components of the existing system should be metered. More complex systems where predicted Savings are greater than 10% of the site's Energy, Utility bill analysis is to be used and metering data is to be obtained from Utility bills using single point meter or a combination of multiple point meters. Measurements can be obtained from Tracking system in Post-stage as well <u>Metering Instructions:</u> For both Baseline and Retrofit: *(1) Energy-use Factors' Measurements* Continuous monitoring of input Energy (e.g. kWh, Btu) or Demand (e.g. kW, Btu/hr) for each component affected by the BAS Upgrade. When seasonal variations or scheduled activity affect equipment operation, metering should be conducted during each variation period Metering period should not include vacations or holidays *(2) Other Key Variables, if applicable:* Cooling loads (Tons), Heating loads (MMBtu)
EE Capacity Calculation	Summer – June 1 to August 31 o Non-holiday weekdays, Hour Ending (HE) 13-21 (12:00 pm – 9:00 pm EST, 1:00 pm -10:00 pm EDT) Winter – November 1 to February 28

Required Parameters	M&V Requirements
	○ Non-holiday weekdays, Hour Ending (HE) 17-21 (4:00 pm – 9:00 pm EST) $kW_{Savings} = kW_{Baseline} - kW_{Retrofit}$ $\sum Total\ kW_{savings} / Total\ EE\ demand\ reduction\ window\ Hours$ Demand Savings may be available if, for example, the new BAS implements variable speed controls for ventilation fans however, there is high risk of uncertainty. If there is any replacement or modification of existing equipment, it can be applied separately as a different measure.
Energy Savings Calculation	Not Applicable for the EE Auction Pilot
Baseline Adjustments	Baseline Adjustment should be made based on cooling and heating load and operating hours
Methodology Applied for Variable Load	Variable load exists in BAS projects if they are implemented to enhance cooling/heating fans (variable speed/air flow). For various load, continuous interval measurement or kW at various load from engineering reference and/or manufacturer data should be used. Recorded/measured operating profile to be used as basis to find kW at each representative load.

MEASURE #7: LIGHTING CONTROLS LC-E

Required Parameters	M&V Requirements
Existing System Description	Inventory of lamp/ballast fixture type affected. Baseline information required for each type including fixture, lamp and ballast types, room conditions, usage area designation, operating periods (e.g. common space 24/7; tenant space lease hours), room location and counts of operating and non-operating fixtures and lamps. Spot-metering data for a Baseline sample that is representative of each usage group
Proposed System Description	Retrofit information required for each lighting type relevant to Project. Operating periods as per post-retrofit lighting controls' settings. Metering data for duration that reflects full operating profile.
Measurement Boundaries	Measurement boundary should include all the lamps that are retrofitted and controlled by the new lighting controls system
Measurement Conditions	Readings for retrofitted fixtures should be taken at least 100 hours of burn-in time following their installation.
Sampling	Baseline fixtures should be grouped into usage groups according to those with similar occupancy areas and/or expected operating hour schedules. At least 6 sample fixtures from each usage group should be subject to metering where measurements are required.
Baseline Period and Reporting Period Duration	Baseline and Reporting Period duration should span through a full operating cycle.
Metering Requirements	Refer to EM&V's protocol for demand saving definition. Metering to be conducted for both Fixture wattages to be measured using spot or short-term representative sample of Baseline and post-installation fixtures (if lamps or ballasts are changed) and Operating hours <u>Metering Instructions:</u> For both Baseline and Retrofit: *(1) Metering of Fixture Wattages:* • Requires the use of RMS meter • Continuous monitoring on a sample population within each usage group should be conducted. The readings will be averaged. • Meters used for this task will need to be calibrated *(2) Logging Operating Hours* • Continuous monitoring on a sample population within each usage group should be conducted for a minimum of one weeks or span of full operating cycle. • When seasonal variations or scheduled activity affect equipment operation, metering should be conducted during each variation period. (E.g. summer operating schedules in classrooms).

Required Parameters	M&V Requirements
	• Metering period should not include vacations or holidays.
EE Capacity Calculation	Summer – June 1 to August 31 ○ Non-holiday weekdays, Hour Ending (HE) 13-21 (12:00 pm – 9:00 pm EST, 1:00 pm -10:00 pm EDT) Winter – November 1 to February 28 ○ Non-holiday weekdays, Hour Ending (HE) 17-21 (4:00 pm – 9:00 pm EST) $kW_{Savings} = kW_{Baseline} - kW_{Retrofit}$ $\sum Total\ kW_{savings} / Total\ EE\ demand\ reduction\ window\ Hours$
Energy Savings Calculation	Not Applicable for the EE Auction Pilot
Baseline Adjustments	Baseline Adjustments are required in the case that there are non-operating fixtures in the Retrofit stage that were normally operating or are intended for operation (e.g. typically operating fixtures that are intended for repair). A de-lamped fixture is not considered a non-operating fixture Lighting levels are to be assessed before applying Baseline adjustments

MEASURE #8: MONITORING AND TARGETING (M+T)

Required Parameters	M&V Requirements
Existing System Description	Provide detailed description of loads or facility areas that are proposed to be monitored. Breakdown of loads connected or facility areas that are proposed to be monitored. Description of the methodology including assumptions used in estimating the target energy and demand savings for the monitoring period. Statistical qualifiers should be used to establish Baseline i.e. R^2 >0.75, etc. Provide the Estimated Savings Target.
Proposed System Description	Operating logs or other monitoring data to support claimed operating conditions throughout the M&T Monitoring Period is required. Description of the methodology including assumptions used in developing the Estimated Savings Target for the Monitoring Period. List of action items for the education and awareness program. A schematic of the system and the location of the installed meters and confirmation of installation and proper operations. Details on proposed actions items & projects such as costs, timeline, payback, and potential savings. Provide measure plan and estimated savings for implementation of identified projects with a payback of less than one year.
Measurement Boundaries	Measurement boundaries should include the entire facility in which the M+T Measure is implemented.
Measurement Conditions	Baseline and Retrofit performance is to be measured at the facility level comparing utility metered data e.g. utility bills comparison.
Sampling	Statistical qualifiers should be used to establish Baseline i.e. R^2 >0.75, etc.

Required Parameters	M&V Requirements
Baseline Period and Reporting Period Duration	M+T Monitoring Period with savings continued for a minimum period of 24vmonths from the M&T Installation Date. Before calculating the actual Demand Savings and Energy Savings from the M&T Project, the Participant should monitor and record data from the M&T Measure for a period of no less than the M&T Monitoring Period. Energy Savings and Demand Savings in respect of the M&T Measure should only be calculated during the M&T Monitoring Period. Energy Savings achieved from programs under the Initiative Schedule during the M&T Monitoring Period should be subtracted from the total Energy Savings achieved from the M&T Project. An application should have a minimum monitoring period of 6 months with annual reporting Report any partial or major equipment or operational changes to Systems within the Monitoring Period. Provide operating logs or other monitoring data to support claimed operating conditions. A calculation of savings, based on the M+T Monitoring Period, properly reconciling for operational changes implemented as well as the education and awareness activities conducted. Demonstrate, following the IPMVP that required savings are achieved and maintained. A minimum of 12 months of utility data should be collected for pre and post retrofit conditions.
Metering Requirements	Using utility metered data and sub metered data for monitoring end user's energy consumption.
EE Capacity Calculation	Summer – June 1 to August 31 ○ Non-holiday weekdays, Hour Ending (HE) 13-21 (12:00 pm – 9:00 pm EST, 1:00 pm -10:00 pm EDT) Winter – November 1 to February 28 ○ Non-holiday weekdays, Hour Ending (HE) 17-21 (4:00 pm – 9:00 pm EST) $kW_{Savings} = kW_{Baseline} - kW_{Retrofit}$ $\sum Total\ kW_{savings} / Total\ EE\ demand\ reduction\ window\ Hours$
Energy Savings Calculation	Not Applicable for the EE Auction Pilot
Baseline Adjustments	Routine adjustments as required, using techniques such as simple comparison or regression analysis. Non-routine adjustments as required.

Required Parameters	M&V Requirements
Additional Information	Estimated Savings Target - In respect of an M+T Project, the savings target estimated to be achieved at the end of the M+T Monitoring Period in kW and kWh. M&T Installation Date - The date that the LDC confirms that (i) the M&T Measure is fully functional; (ii) the M&T System has been installed; and (iii) the LDC has received an invoice from the Participant showing proof of payment of the installed equipment in respect of the M&T Project. M&T Monitoring Period - A period of no less than 6 months prior to calculating the actual Demand Savings and Energy Savings from an M&T Project. M&T System - Equipment to monitor the energy and/or demand performance (including electricity performance) of a System relative to the production of such System, for purposes that include setting targets for future energy performance, and assisting with the implementation of savings targets through continuous feedback obtained or received from the M&T System.

MEASURE#9 OTHER CUSTOM MEASURES

M&V Procedures for Other Custom Measures should be consistent with International Performance Measurement & Verification Protocol (IPMVP). IPMVP Protocols means: Core Concepts October 2016 EVO 10000 – 1:2016, and Uncertainty Assessment for IPMVP July 2019 EVO 10100 – 1:2019.