Measurement and Verification Guidelines

Prepare the M&V Plan as presented below.

List of Processes and Tables:

Risk, Responsibility and Performance Matrix.

M&V Plan and Savings Calculation Methods

- *Proposed Annual Savings Overview*
- *Site Use and Savings Overview (Optional)*
- *M&V Plan Summary*
- *Schedule of Verification Reporting Activities*
- *Proposed Annual Savings for Cost-Saving Measures*
- *Expected Year 1 Savings for Cost-Saving Measures*

1. Risk and Responsibility in M&V

One of the primary purposes of M&V is to reduce the risk of nonperformance to an acceptable level, which is based on the Entity's priorities and preferences. Risk refers to the uncertainty that the expected savings will be realized. Fundamental principles that can be applied to the allocation of responsibilities in EPC contracts include:

- *Logic and cost-effectiveness drive the allocation of responsibilities*
- *The responsible party predicts its likely tasks and associated costs to fulfill its responsibilities and makes sure these are covered in the EPC or Entity's budget.*
- *Any unforeseen costs are paid by the party that caused the costs or by the party responsible for that risk area.*
- *Stipulating certain parameters in the M&V plan can align responsibilities, especially for the items no one controls.*

Risks in achieving energy savings can be allocated to use and performance factors. Risk related to use stems from uncertainty in operational factors such as weather, hours of operation, user intervention, and equipment loads. Because ESPs often have no control over such factors, they are usually reluctant to assume usage risk. The Entity generally assumes responsibility for usage risk by either allowing baseline adjustments based on measurements or by agreeing to stipulated equipment operating hours or other usage-related factors. By using stipulations the ESP and Entity agree to a set value for a parameter for the term of the contract, regardless of the actual behavior of that parameter.

The use of stipulations is a cost-effective way to reduce M&V costs and allocate risks. Stipulations used appropriately do not jeopardize the savings guarantee, the Entity's ability to pay for the project, or the overall value of the project to the customer. However, stipulations have the potential to shift risk to the Entity, and the Entity should understand the potential consequences before accepting them. Risk is minimized and optimally allocated through carefully crafted M&V requirements, including diligent estimation of any stipulated values.

The ESP shall complete and include the matrix below to summarize the allocation of responsibility for key items related to M&V.

RISK, RESPONSIBILITY AND PERFORMANCE MATRIX

RESPONSIBILITY/DESCRIPTION	ESP PROPOSED APPROACH
1. Financial	
a. Interest rates: Neither the ESP nor the Entity has significant control over prevailing interest rates. Higher interest rates will increase project cost, financing term, or both. The timing of the EPC signing may impact the available interest rate and project cost.	
b. Construction costs: The ESP is responsible for determining construction costs and defining a budget. In a fixed-price design/build contract, the Entity assumes little responsibility for cost overruns. However, if construction estimates are significantly greater than originally assumed, the ESP may find that the project or measure is no longer viable and drop it before EPC award. In any design/build contract, the Entity loses some design control. **Clarify design standards and the design approval process (including changes) and how costs will be reviewed.**	
c. M&V confidence: The Entity assumes the responsibility to determine the confidence that it desires to have in the M&V program and energy savings determinations. The desired confidence will be reflected in the resources required for the M&V program, and the ESP must consider the requirement prior to submittal of the final proposal. **Clarify how project savings are being verified (e.g., equipment performance, operational factors, energy use) and the impact on M&V costs.**	
d. Energy Related Cost Savings: The Entity and the ESP may agree that the project will include savings from recurring and/or one-time costs. This may include one-time savings from avoided expenditures for projects that were appropriated but will no longer be necessary. Including one-time cost savings before the money has been appropriated may involve some risk to the Entity. Recurring savings generally result from reduced O&M expenses or reduced water consumption. These O&M and water savings must be based on actual spending reductions. **Clarify sources of non-energy cost savings and how they will be verified.**	
e. Delays: Both the ESP and the Entity can cause delays. Failure to implement a viable project in a timely manner costs the Entity in the form of lost savings, and can add cost to the project (e.g., construction interest, re-mobilization). **Clarify schedule and how delays will be handled.**	
f. Major changes in facility: The Entity controls major changes in facility use, including closure. **Clarify responsibilities in the event of a premature facility closure, loss of funding, or other major change.**	
2. Operational	
a. Operating hours: The Entity generally has control over operating hours. Increases and decreases in operating hours can show up as increases or decreases in savings depending on the M&V method (e.g., operating hours multiplied by improved efficiency of equipment vs. whole-building/utility bill analysis). **Clarify whether operating hours are to be measured or stipulated and what the impact will be if they change.** If the operating hours are stipulated, the baseline should be carefully documented and agreed to by both parties.	
b. Load: Equipment loads can change over time. The Entity generally has control over hours of operation, conditioned floor area, intensity of use (e.g., changes in occupancy or level of automation). Changes in load can show up as increases or decreases in "savings" depending on the M&V method. **Clarify whether equipment loads are to be measured or stipulated and what the impact will be if they change**. If the equipment loads are stipulated, the baseline should be carefully documented and agreed to by both parties.	
c. Weather: A number of energy efficiency measures are affected by weather. Neither the ESP nor the Entity has control over the weather. Should the Entity agree to accept risk for weather fluctuations, it shall be contingent upon aggregate payments not exceeding aggregate savings. **Clearly specify how weather corrections will be performed.**	

d. User participation: Many energy conservation measures require user participation to generate savings (e.g., control settings). The savings can be variable and the ESP may be unwilling to invest in these measures. **Clarify what degree of user participation is needed and utilize monitoring and training to mitigate risk.** If performance is stipulated, document and review assumptions carefully and consider M&V to confirm the capacity to save (e.g., confirm that the controls are functioning properly).	
3. Performance	
a. Equipment performance: The ESP has control over the selection of equipment and is responsible for its proper installation, commissioning, and performance. The ESP has the responsibility to demonstrate that the new improvements meet expected performance levels including specified equipment capacity, standards of service, and efficiency. **Clarify who is responsible for initial and long-term performance, how it will be verified, and what will be done if performance does not meet expectations.**	
b. Operations: Performance of the day-to-day operations activities is negotiable and can impact performance. However, the ESP bears the ultimate risk regardless of which party performs the activity. **Clarify which party will perform equipment operations, the implications of equipment control, how changes in operating procedures will be handled, and how proper operations will be assured.**	
c. Preventive Maintenance: Performance of day-to-day maintenance activities is negotiable and can impact performance. However, the ESP bears the ultimate risk regardless of which party performs the activity. **Clarify how long-term preventive maintenance will be assured, especially if the party responsible for long-term performance is not responsible for maintenance (e.g., ESP provides maintenance checklist and reporting frequency). Clarify who is responsible for performing long-term preventive maintenance to maintain operational performance throughout the contract term. Clarify what will be done if inadequate preventive maintenance impacts performance.**	
d. Equipment Repair and Replacement: Performance of day-to-day repair and replacement of ESP-installed equipment is negotiable; however it is often tied to project performance. The ESP bears the ultimate risk regardless of which party performs the activity. **Clarify who is responsible for performing replacement of failed components or equipment replacement throughout the term of the contract.** Specifically address potential impacts on performance due to equipment failure. Specify expected equipment life and warranties for all installed equipment. Discuss replacement responsibility when equipment life is shorter than the term of the contract.	

2. Measurement and Verification Plan

Measurement and verification (M&V) is the basis for guaranteed savings that pay for the project financing. A preliminary monitoring and verification plan is typically developed in the Investment Grade Audit process. This plan is finalized in the Energy Performance Contract. Also see Schedule A Section 2 (Baseline Energy Consumption) and Schedule A Section 3 (Methodology to Adjust Baseline).

By Montana statute an EPC requires M&V for a minimum of three years following completion of the project. The cost for M&V is paid for by the Entity during the initial monitoring period. If there is a shortfall in savings for any year of the monitoring period, the ESP pays for M&V for years following the initial monitoring period until 1) the guaranteed savings are met for consecutive years equal to the initial monitoring period or 2) the Entity and the ESP negotiate a settlement regarding the shortfall for all future years of the contract term.

The M&V plan shall:

- *Include a description of the energy savings measurement, monitoring and calculation procedures used to verify and compute the savings performance of the installed equipment;*
- *Include methods to compare the baseline use with the actual use during a specific time period (monthly, quarterly, etc.);*

- *Explicitly describe all methods of measuring savings including engineered calculations, metering, equipment run times, pre- and post-installation measurements, etc. for all equipment installed.*
- *Provide a clear methodology for converting energy savings into energy cost savings;*
- *Define the utility rates to be used for the baseline and actual energy costs;*
- *Explicitly define how savings will be adjusted. Adjustments made during the performance period Adjustments are allowed only for changes as noted in the IGA contract. These include:*
  - *Billing days*
  - *Floor area*
  - *Operational schedules*
  - *Facility temperature*
  - *Weather*
  - *Amount of equipment or lighting, if change is significant*
  - *Space type(s), if change is significant*
  - *Material change(s), if change is significant*
- *Use agreement clauses that allow predictable or expected changes and/or a "re-open" clause that allows either party to renegotiate the baseline.*

The use of stipulated calculations (permissible only in Option A) should be kept to a minimum. Stipulated values must be based on reliable, traceable and documented sources of information, such as:

- *Standard lighting tables from major manufacturers*
- *Equipment Manufacturer's specifications*
- *Building occupancy schedules*
- *Maintenance logs*
- *Performance curves published by national organizations*
- *Weather data from government agencies*
- *Standard performance degradation curves*

The EPC will define the methods used for M&V. These are based on the latest version of the International Performance Measurement and Verification Protocol (IPMVP). FEMP has also published guidelines for M&V (M&V Guidelines: Measurement and Verification for Federal Energy Projects) that includes procedures for applying the IPMVP.

The IPMVP offers four options for measuring and verifying performance and energy and water savings. These options, (A, B, C, and D), are the cornerstones of the standardized set of procedures contained in the IPMVP. In brief, Options A and B focus on the performance of specific ECMs. Option C assesses the energy savings at the whole-facility level by metering and analyzing utility costs before and after the implementation of ECMs. Option D is based on computer models of the energy performance of equipment or the whole facility, calibrated against historical utility consumption data to verify the accuracy of the simulation model.

Factors that affect the appropriate choice of M&V option include:

- *Value of projected savings*
- *Cost of M&V options*
- *Level of savings uncertainty*
- *Number and complexity of savings measures*
- *Quality of baseline data available*

Each M&V Option and its relative accuracy and cost is explained in further detail in Table 1.

Table 1 Description of IPMVP Options

OPTION	DESCRIPTION & RELATIVE ACCURACY	EXAMPLES
A. Retrofit Isolation with Key Parameter Measurement	Savings are based on a combination of measured and estimated factors. Measurements are taken at the component or system level for both baseline and retrofit conditions. Measurements taken for key performance parameters that define energy use for cost-saving measure. Estimated factors are supported by historical or manufacturer's data. Some parameters may be stipulated. Used when highly accurate measurements are not necessary or economically viable. Lowest cost	Lighting retrofits, motor replacement where load is constant when operating (no VFD)
B. Retrofit Isolation with All Parameter Measurement	Savings are determined by short-term or continuous field measurement of baseline and post-retrofit energy use. Used to track long-term performance when accurate savings measurements are needed. Medium to high cost	VFD on electric motor
C. Whole Facility Measurement	Savings are determined by measuring energy use at the whole facility or sub-facility level during the baseline and post-retrofit periods. Short-term or continuous measurements are taken throughout the post-retrofit period. Medium to high cost	Boiler replacement, windows, insulation
D. Calibrated Computer Simulation	Savings are determined through simulation of the energy use of components or the whole facility. Simulation routines must be demonstrated to adequately model actual energy performance measured in the facility. Typically used for new construction or where baseline data are unavailable or unreliable. Medium to high cost	Comprehensive retrofit involving multiple interactive measures

Further information regarding measurement and verification can be found in the M&V Guidelines document published by the Federal Energy Management Agency (FEMP) and accessed at http://www1.eere.energy.gov/femp/pdfs/mv_guidelines.pdf and the M&V Resource List, a frequently updated document that provides an extensive collection of resources and tools available to help users apply the IPMVP.

M&V PLAN AND SAVINGS CALCULATION METHODS OUTLINE

Fill in the following tables or provide equivalent information.

Proposed Annual Savings Overview

[Include all fuels/commodities for project, e.g., electric energy, electric demand, natural gas, fuel oil, coal, water, etc.]

Cost-saving Measure	Total energy savings (MBtu/yr)	Electric energy savings (kWh/yr)	Electric demand savings (kW/yr)*	Natural gas savings (MBtu/yr)**	Water savings (gallons/yr)	Other energy savings (MBtu/yr)**	Total energy and water cost savings, Year 1 ($/yr)	Energy-related O&M cost savings, Year 1 ($/yr)	Total cost savings, Year 1 ($/yr)
Total Savings									

First Year Guaranteed Cost Savings: $

Notes
MBtu=10^6 Btu.
*Annual electric demand savings (kW/yr) is the sum of the monthly demand savings.
**If energy is reported in units other than MBtu, provide a conversion factor to MBtu (e.g., 0.003413 MBtu/kWh).

Site Use and Savings Overview

	Total energy savings (MBtu/yr)	Electric energy savings (kWh/yr)	Electric demand savings (kW/yr)*	Natural gas savings (MBtu/yr)**	Water savings (gallons/yr)	Other energy savings (MBtu/yr)**
Total proposed project savings						
Usage for entire site**						
% Total site usage saved						

Project square footage (SF)	
Total site square footage (SF)	
% Total site area affected	

Notes
MBtu=10^6 Btu
*Annual electric demand savings (kW/yr) is the sum of the monthly demand savings.
**If energy is reported in units other than MBtu, provide a conversion factor to MBtu (e.g., 0.003413 MBtu/kWh).

M&V Plan Summary

Cost-Saving Measure	Cost-Saving Measure Description	M&V Option Used*	Summary of M&V Plan

*M&V options include A, B, C, and D of the International Performance Measurement and Verification Protocol (IPMVP) or similar from M&V Guidelines: Measurement and Verification for Federal Energy Projects

Schedule of Verification Reporting Activities

Item	[a] Recommended time of submission	[a] Entity's review and acceptance period
Post-Installation Report	30 to 60 days after acceptance	30 days
Annual Report	30 to 60 days after annual performance period	30 days

[a] Times are recommended based on industry practice; modify as needed.

Proposed Annual Savings for Each Cost-Saving Measure

[Include all fuels/commodities for project, such as: electric energy, electric demand, natural gas, fuel oil, coal, water, etc.]

	Total energy use (MBtu/yr)	Electric energy use (kWh/yr)	Electric energy cost, Year 1 ($/yr)	Electric demand* (kW/yr)	Electric demand cost, Year 1 ($/yr)	Natural gas use (MBtu/yr)**	Natural gas cost, Year 1 ($/yr)	Water use (gallons/yr)	Water cost, Year 1 ($/yr)	Other energy use (MBtu/yr)**	Other energy cost, Year 1 ($/yr)	Energy-related O&M costs, Year 1 ($/yr)	Total costs, Year 1 ($/yr)
Baseline													
Post-install													
Savings													

Notes
MBtu = 10^6 Btu.
*Annual electric demand savings (kW/yr) is the sum of the monthly demand savings.
**If energy is reported in units other than MBtu, provide a conversion factor to MBtu (e.g., 0.003413 MBtu/kWh).

COST-SAVING MEASURE M&V PLAN AND SAVINGS CALCULATION METHODS

Develop section for each Cost-Saving Measure

- *Summarize the scope of work, location, and how cost savings are generated. Describe source of all savings including energy, water, O&M, and other (if applicable).*
- *Specify the M&V guideline and option used from the IPMVP or the FEMP M&V Guidelines.*
- *Provide an overview of M&V Activities for Cost-Saving Measures. Explain intent of M&V plan, including what is being verified.*
- *Provide an overview of savings calculations methods for Cost-Saving Measures. Provide a general description of analysis methods used for savings calculations.*

Proposed Energy and Water Savings Calculations and Methodology

- *Provide detail description of analysis methodology used. Describe any data manipulation or analysis that was conducted prior to applying savings calculations.*
- *Detail all assumptions and sources of data, including all stipulated values used in calculations.*
- *Include equations and technical details of all calculations made. (Use appendix and electronic format as necessary.) Include description of data format (headings, units, etc.).*
- *Details of any savings or baseline adjustments that may be required.*
- *Detail energy and water rates used to calculate cost savings. Provide post-acceptance performance period energy and water rate adjustment factors.*
- *Detail proposed savings for this energy conservation measure for post-acceptance performance period. Include table - Proposed Annual Savings for Each Cost-Saving Measure.*

Operations and Maintenance Cost Savings

- *Provide justification for O&M cost savings. Describe how savings are generated. Detail cost savings calculations.*
- *Provide post-acceptance performance period other cost savings adjustment factors.*

Details of other savings (if applicable)

- *Provide justification for cost savings. Describe how savings are generated. Detail cost savings calculations.*
- *Provide post-acceptance performance period other cost savings adjustment factors.*

Post-Installation M&V Activities

- *Describe the intent of post-installation verification activities, including what will be verified.*
- *Describe variables affecting post-installation energy or water use. Include variables such as weather, operating hours, set point changes, etc. Describe how each variable will be quantified, i.e., measurements, monitoring, assumptions, manufacturer data, maintenance logs, engineering resources, etc.*
- *Define key system performance factors characterizing the post-installation conditions such as lighting intensities, temperature set points, etc.*
- *Define requirements for Entity witnessing of measurements if different than whole project data requirements.*
- *Provide details of post-installation data to be collected, including:*
    - *Parameters to be monitored,*
    - *Details of equipment to be monitored (location, type, model, quantity, etc.),*
    - *Sampling plan, including details of usage groups and sample sizes,*
    - *Duration, frequency, interval, and seasonal or other requirements of measurements,*
    - *Monitoring equipment to be used,*
    - *Installation requirements for monitoring equipment,*
    - *Calibration requirements/procedures,*
    - *Expected accuracy of measurements/monitoring equipment,*
    - *Quality control procedures to be used,*
    - *Form of data to be collected (.xls, .csv, etc.),*
    - *Sample data collection forms (optional)*
- *Detail data analysis to be performed.*

Post-Acceptance Performance Period Verification Activities

- *Describe variables affecting post-acceptance performance period energy or water use. Include variables such as weather, operating hours, set point changes, etc. Describe how each variable will be quantified, i.e., measurements, monitoring, assumptions, manufacturer data, maintenance logs, engineering resources, etc.*
- *Define key system performance factors characterizing the post-acceptance performance period conditions. Include factors such as comfort conditions, lighting intensities, temperature set points, etc.*
- *Describe the intent of post-acceptance performance period verification activities – what will be verified.*
- *Provide detailed schedule of post-acceptance performance period verification activities and inspections.*
- *Define requirements for Entity witnessing of measurements if different than whole project data requirements.*
- *Provide details of post-acceptance performance period data to be collected, including: Parameters to be monitored, Details of equipment to be monitored (location, type, model, quantity, etc.), Sampling plan, including details of usage groups and sample sizes, Duration, frequency, interval, and seasonal or other requirements of measurements, Monitoring equipment to be used, Installation requirements for monitoring equipment, Calibration requirements/procedures, Expected accuracy of measurements/monitoring equipment, Quality control procedures to be used, Form of data to be collected (.xls, .csv, etc.), Sample data collection forms (optional)*
- *Detail data analysis to be performed.*
- *Define O&M and repair reporting requirements. Detail verification activities and reporting responsibilities of Entity and ESP on operations and maintenance items. Define reporting schedule.*