THE UNIVERSITY OF TEXAS AT AUSTIN

Measurement & Verification Program

for

Demand-Side Energy Management & Conservation Projects

Main Campus (CAM) &

Pickle Research Campus (PRC)

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Measurement and Verification (M&V) is a standardized process used to predict and verify energy and water savings gained through energy management and water conservation projects. The M&V concepts uniformly adopted for use on such projects are described in the International Performance Measurement and Verification Protocol (IPMVP), last revised in 2007[(1)]. IPMVP defines key terms and outlines issues that must be considered in developing an M&V plan, but does not provide details for specific measures or technologies. It leaves the specifics to be developed and negotiated by the parties involved in each contract, often involving energy savings performance guarantees.

The Federal Energy Management Program (FEMP) Guidelines[(2)], last revised April 2008, are an application of the IPMVP that give specific procedures for applying concepts originating in the IPMVP to federal projects with savings guarantees, including those that include lighting retrofits and water conservation measures. Thus, the FEMP Guidelines are the most useful to us in providing the methodologies for predicting and verifying the savings from our lighting and water conservation projects. M&V "Option A" is utilized, which requires measuring or estimating performance factors (e.g. watts/fixture, gallons/flush) and operating factors (e.g. operating hours, flushes/day).

A trend in the industry over the past 10 years is the use of standard contractual arrangements (without savings guarantees) for audits and implementation of conservation measures which have widely accepted methodologies for quantifying savings, such as lighting and domestic water fixture retrofits. Still, for these projects, the Owner requires a sound basis for predicting savings, and this will involve M&V methodologies where such are available and reasonable to apply.

It is important to note that M&V is not applied to the steam trap replacements because the steam savings from replacing failed-open traps is purely calculated from the manufacturer's (Spirax Sarco) proprietary software that yields steam blowdown flow for each given pipe and orifice size and utilizes the steam production cost provided by the University. Energy Savings from insulation improvements are calculated by Spirax as well.

The following steps are being taken to measure, calculate and verify savings from the Demand-Side Energy Management and Conservation Program (DSEMC).

Lighting Upgrade Savings Calculation Steps and Parameters:

1. Pre-retrofit - Measure illumination levels (average foot-candles) per room BEFORE retrofits. Retrofits are designed to provide recommended illumination levels per the Illuminating Engineering Society of North America (IESNA); there is generally either a reduction or (more often) an increase in light levels and a decrease in energy consumption after the retrofits.

2. Pre-retrofit - Measure electrical power before retrofits
    a. Measure power draw (kilowatts, kW) per light switch
    b. Divide measured kW by the number of identical fixtures powered from that light switch to yield watts per existing fixture; this project involved measurement of dozens of fixture configurations.
    c. Observe burnout factor (% of existing lamps removed or burned out)
3. Pre-retrofit - Measure operating hours for the lights in each room
    a. Assign a usage category to each room in all buildings (e.g. classroom, office, lecture hall, corridor, etc)
    b. Install lighting loggers in a sampling of each category of room to determine typical operating hours for each category
4. Calculate existing annual electrical usage in a room by room spreadsheet using watts/fixture, burnout factor (0.9), operating hours and production cost of electricity (main Campus) or City electric rates (PRC) as applicable.
5. Post-retrofit – measure illumination levels in each room; adjust the levels (e.g. use different power ballast) if needed to meet IESNA targets or best achievable.
6. Post-retrofit – Measurements and Savings Calculations
    a. Measure watts/fixture (power draw at light switch)
    b. (Operating hours are unchanged)
    c. Calculate electrical usage and savings in room by room spreadsheet
    d. Subtotal savings by building/campus/project and as otherwise directed
7. Deliverables
    a. All Measurement & Verification (M&V) deliverables as follows to be included in a separate tab(s) of the final as-built lighting room-by-room inventory spreadsheet:
        i. Operating hours per room usage category
        ii. Pre-retrofit energy measurements for sampled fixtures
        iii. Post-retrofit energy measurements for sampled fixtures
        iv. Summary savings report
    b. For each of the items above, the M&V deliverables requested here meet the Federal Energy Management Program (FEMP) intent for a “Post-Installation Report.”

Water Conservation Upgrades Savings Calculation Steps and Parameters:

1. Pre-retrofit (domestic fixtures) - Measure toilet and urinal flush volumes
    a. Units: gallon per flush (gpf)
    b. Measured by flushing fixture directly into a calibrated bucket via the fixture’s discharge tube
2. Pre-retrofit (domestic fixtures) - Measure faucet and showerhead flow rates
    a. Units: gallons per minute (gpm)
    b. Measured using a micro weir device

3. Pre-retrofit (domestic fixtures) - Utilize standardized usage data from the American Water Works Association Research Foundation (AwwaRF) and building demographics for savings calculations
4. Post-retrofit (domestic fixtures) - Measure fixture performance in same manner as pre-retrofit; calculate savings in room by room spreadsheet
5. Pre-retrofit (Process water audit) – Walk buildings, interview occupants, observe/measure usage to determine inputs for calculating estimated savings.
6. Deliverables
    a. All Measurement & Verification (M&V) deliverables as follows to be included in a separate tab(s) of the final as-built domestic water fixture room-by-room inventory spreadsheet:
        i. Pre-retrofit flow measurements for sampled toilet and urinal valves, faucets and showerheads
        ii. Post-retrofit flow measurements for sampled toilet and urinal valves, faucets and showerheads
        iii. Summary savings report
    b. Process equipment upgrades – Provide savings report as standalone worksheet.
    c. For each of the items above, the M&V deliverables requested here meet FEMP's intent for a "Post-Installation Report."

Steam Trap Upgrade Savings Calculation Steps and Parameters:

Direct measurement of savings is not performed for the steam trap replacements because it is not feasible to measure steam leakage from individual failed open traps. The traps that fail internally in an "open" condition, continuously blowing down steam to drain or to the downstream condensate tank for recycling back to the boiler, and they can blow down steam at rates ranging from a slight leak to a very large leak. The leakage rate and the resulting steam savings from replacing the failed-open traps is calculated from the hardware manufacturer's proprietary software (Spirax Sarco) that uses empirical data and conservative assumptions to yield steam blowdown flow for each given pipe and orifice size. Steam production costs are provided by the University.

1. Pre-retrofit - Measure parameters of all steam traps on Main Campus and Pickle Research Campus
    a. Size/Diameter
    b. Connection type
    c. Orientation
    d. Application
    e. Pressure (psig)
    f. Temperature (°F)
    g. Failed open or closed
2. Test trap stations using ultrasonic and infrared equipment to determine if trap is failed open, failed closed, out of service or strainer clogged

3. Identify steam and condensate leaks and insulation issues to be repaired
4. Using proprietary software, calculate energy losses due to failed traps (steam lbs/yr) in dollars according to current production cost of steam provided by the University
5. Calculate money/energy saved by replacing failed steam traps
6. Calculate (estimate) savings from repairs to leaks and insulation
7. Deliverables
    a. Final Steam Trap Report
    b. Summary savings report included within the Final Steam Trap Report describing savings calculation methodology
    c. Report requested here meets the Federal Energy Management Program (FEMP) intent for a "Post-Installation Report."

Notes:
(1) Link to sign in and download IPMPV 2007 - http://www.evo-world.org/index.php?option=com_philaform&form_id=37&Itemid=1
(2) Direct link to FEMP April 2008 – http://ateam.lbl.gov/mv/docs/mv_guidelines-3_0_wAppend.pdf