3 Simplified M&V Guidelines for Replacement of Cooling Equipment

3.1 Overview

Cooling equipment retrofits involve the replacement of the existing (baseline) equipment with high-efficiency equipment. In general, the measurement and verification (M&V) method described in this chapter can be used for projects involving the one-for-one change-out of cooling equipment. Potential qualifying equipment includes:

- Unitary air conditioners (DX, air-cooled, evaporative, or water-cooled);
- Heat pumps (air-cooled, evaporative, or water-cooled);
- Chillers (air-cooled centrifugal, water-cooled centrifugal, air-cooled screw, etc.);
- Compressors (centrifugal, screw, reciprocating); and
- Fuel-switching from electric to gas-driven cooling equipment[1].

The retrofits must have the following characteristics:

- The newly installed electric cooling equipment capacity must be within **80%** to **120%** of the replaced electric cooling equipment capacity; and
- No additional measures are being installed that directly affect the operation of the cooling equipment (i.e., control sequences, cooling towers, condensers).

If the proposed retrofit does not meet these requirements, refer to the Full M&V guidelines for appropriate M&V techniques.

To qualify for incentives, the new cooling equipment must exceed the minimum efficiency for electric chillers specified by ASHRAE Standard 90.1-1999. However, the baseline efficiency used in the savings calculation is based on ASHRAE Standard 90.1-1989. Efficiency values for both standards can be found in the Standard Cooling Equipment Tables.

The simplified M&V procedure for electric-to-electric cooling equipment replacement involves collecting one year of post-consumption kWh data. To determine demand savings, the maximum equipment demand that occurs during the utility peak summer hours must be measured. This can be accomplished with continuous demand metering or spot metering during peak conditions.

[1] Qualifying fuel-switching measures qualify only for peak-demand-based savings and incentives.

3.2 Pre-Installation M&V Activities

3.2.1 Pre-installation Site Survey

The goals of the pre-installation site survey are to identify the existing equipment, evaluate its schedule of use, and establish the baseline efficiency or coefficient of performance (COP). The Project Sponsor will conduct a survey of all the existing cooling equipment for buildings with a central plant, regardless of whether they will be retrofitted. The information collected should include: equipment type, year, make/model, rated capacity, rated efficiency, operating schedule, and operating sequence. The information will be needed to complete the program application process.

The baseline efficiency is determined by comparing the rated efficiency of the existing unit to the minimum efficiency listed in the Standard Efficiency Tables, which is based on ASHRAE 90.1-1989. The baseline efficiency is equal to the more efficient of the two values.

3.2.2 Pre-installation Inspection

Entergy or its contractor will conduct a pre-installation inspection to verify that the Sponsor has properly documented the baseline in the FA. The M&V administrator will make any necessary corrections to the pre-installation survey based on the results of the inspection. **Demolition or removal of existing equipment and/or installation of new equipment cannot commence until the pre-installation inspection is completed and Entergy has issued the Project Authorization**

3.2.3 Pre-installation Performance Monitoring

The simplified M&V procedure for electric-to-electric cooling equipment replacements does not require pre-installation monitoring of existing equipment. The existing equipment efficiency is determined from the Standard Cooling Equipment Tables. The existing equipment load and operating schedule are assumed to be the same as those of the post-retrofit equipment.

The simplified M&V procedure for electric-to-gas cooling equipment replacement does require pre-installation monitoring of the existing equipment. The maximum demand (measured for a one-hour period) that coincides with the utility peak demand period must be determined, through spot measurements or continuous metering.

3.3 Post-Installation M&V Activities

3.3.1 Post-installation Equipment Survey

Once the new equipment retrofit is complete, the Sponsor conducts and submits a post-installation equipment survey as part of the Installation Report (IR). The survey should include: installed equipment type, year, make/model, rated capacity, rated efficiency, operating schedule, and operating sequence. The cooling equipment description, its location, as well as mechanical design drawings should be included with the IR submittal.

The Sponsor must submit manufacturer's documentation of the rated efficiency of all newly installed cooling equipment, based upon ARI test conditions. This documentation will be in the form of manufacturer cut sheets or factory performance test results that document the part load performance of the equipment.

3.3.2 Post-installation Inspection

Entergy or its contractor will conduct a post-installation inspection to verify that the retrofit was installed as reported and is documented accurately.

3.3.3 Post-installation Performance Monitoring

Two basic steps comprise the necessary post-retrofit M&V monitoring activities for electric-to-electric cooling equipment replacements:

1. Measure the maximum demand (measured for a one hour period) that occurs between the hours of 1 PM and 7 PM on weekdays during the months of May through September. This can be accomplished with continuous demand metering (at 15-minute intervals) or a spot measurement during peak conditions.
2. Collect twelve months of post-installation consumption (kWh) data.

For electric-to-gas fuel switching cooling equipment replacements, there are no post-installation metering requirements in the simple M&V procedure.

3.4 Calculation of Demand and Energy Savings

3.4.1 Electric to Electric Equipment Replacements

Incentive payments based on demand and energy savings are made for electric-to-electric cooling equipment replacement measures. However, demand savings are allowed only for new equipment that will be in operation on weekdays between the hours of 1 PM and 7 PM Monday through Friday for the months of May through September. Peak demand and energy savings are calculated according to Equation 3.1 and Equation 3.2, respectively.

Equation 3.1: Peak Demand Savings

$$\Delta kW = kW_{meter} \cdot \left\{ \left[\frac{COP_{new}}{COP_{base}} \right] - 1 \right\}$$

Where:

kW_{meter} = Maximum 15-minute cooling equipment demand measured during the utility peak-demand period.

COP_{new} = Newly-installed cooling equipment coefficient-of-performance (COP) at ARI design conditions.

COP_{base} = Baseline efficiency for retrofitted cooling equipment from Standard Cooling Equipment Tables.

Equation 3.2: Energy Savings

$$\Delta kWh = kWh_{meter} \cdot \left\{ \left[\frac{COP_{new}}{COP_{base}} \right] - 1 \right\} * \left(\frac{CDD(65)_{TMY}}{CDD(65)_{meter}} \right)$$

Where:

kWh_{meter}	=	Summed metered kWh cooling equipment energy use determined for one year.
COP_{new}	=	Newly-installed cooling equipment coefficient-of-performance (COP) at ARI design conditions.
COP_{base}	=	Baseline efficiency for retrofitted cooling equipment from Standard Cooling Equipment Tables.
$CDD(65)_{TMY}$	=	Cooling degree days (base 65 F) for a typical meteorological year (TMY) for the National Climatic Data Center (NCDC) station nearest the site. Standard Cooling Equipment Tables, Table A.9.
$CDD(65)_{meter}$	=	Cooling degree days (base 65 F) determined for the metering period for the National Climatic Data Center (NCDC) station nearest the site. The value is determined by Entergy based on the metering period start and stop dates.

Example

In a Beaumont office building, a 600-ton, water-cooled, electric centrifugal chiller is replaced with a new chiller of the same type and capacity. The new chiller has an ARI rated COP of **6.6 (0.530 kW/ton)**. After one year of metering the new chiller energy use totals **858,000 kWh**. The maximum demand recorded for the chiller during the metering period that coincided with the utility peak demand period was **300 kW**.

This measure is a one-for-one electric chiller replacement. One year of continuous, energy-consumption data has been collected. Thus, this measure qualifies for the simple M&V analysis procedure. To complete the savings calculation for the simple M&V, the following additional information is required:

- ASHRAE 90.1-1989 minimum chiller efficiency;
- The NCDC station nearest the site;
- The NCDC station TMY CDD(65); and
- The NCDC station CDD(65) determined for the metering period.

From Standard Equipment Tables, the minimum COP for a water-cooled centrifugal chiller of 300 tons or more is **5.2** (or 0.676 kW/ton; see the Standard Cooling Equipment Tables). The NCDC weather station closest to the site is determined by Entergy to be the **Port Arthur** station. The cooling degree day data for the station are **2,695 (°F day) for TMY** and **2,500 (°F day) for the metering year**.

Based on the collected data and system characteristics, the demand savings are determined to be:

$$\Delta kW = kW_{meter} * \left\{ \left[\frac{COP_{new}}{COP_{base}} \right] - 1 \right\}$$

$$\Delta kW = 300 * \left\{ \left[\frac{6.6}{5.2} \right] - 1 \right\}$$

Thus, the estimated demand savings are **80.8 kW**.

Based on the collected data and system characteristics, the energy savings are determined to be:

$$\Delta kWh_{chiller} = kWh_{meter} * \left\{ \left[\frac{COP_{new}}{COP_{base}} \right]_{rated} - 1 \right\} * \left(\frac{CDD(65)_{TMY}}{CDD(65)_{meter}} \right)$$

$$\Delta kWh = 858{,}000 * \left\{ \left[\frac{6.6}{5.2} \right] - 1 \right\} * \left(\frac{2{,}695}{2{,}500} \right)$$

Thus, the energy savings are **249,018 kWh**.

3.4.2 Electric to Gas Equipment Replacements

Incentive payments based on demand savings only are made for electric-to-gas fuel-switching projects involving the replacement of cooling equipment. Demand savings are allowed only for equipment that operates on weekdays between the hours of 1 PM and 7 PM Monday through Friday for the months of May through September. Peak demand savings are calculated according to Equation 3.3.

Equation 3.3: Peak Demand Savings

$$\Delta kW = kW_{meter}$$

Where:

kW_{meter} = Maximum existing, electric, cooling equipment demand-use measured during the utility peak-demand period