2010

Measurement & Verification

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The intent of the LEED Measurement & Verification (M&V) Credit 5 is to provide for the ongoing accountability of building energy consumption over time. The requirements for the LEED M&V credit are as follows:

1. Develop an M&V Plan to evaluate building and/or energy system performance.

2. Characterize the building and/or energy systems through energy simulation or engineering analysis. Install the necessary metering equipment to measure energy use.

3. Track performance by comparing predicted performance to actual performance, broken down by component or system as appropriate. Evaluate energy efficiency by comparing actual performance to baseline performance.

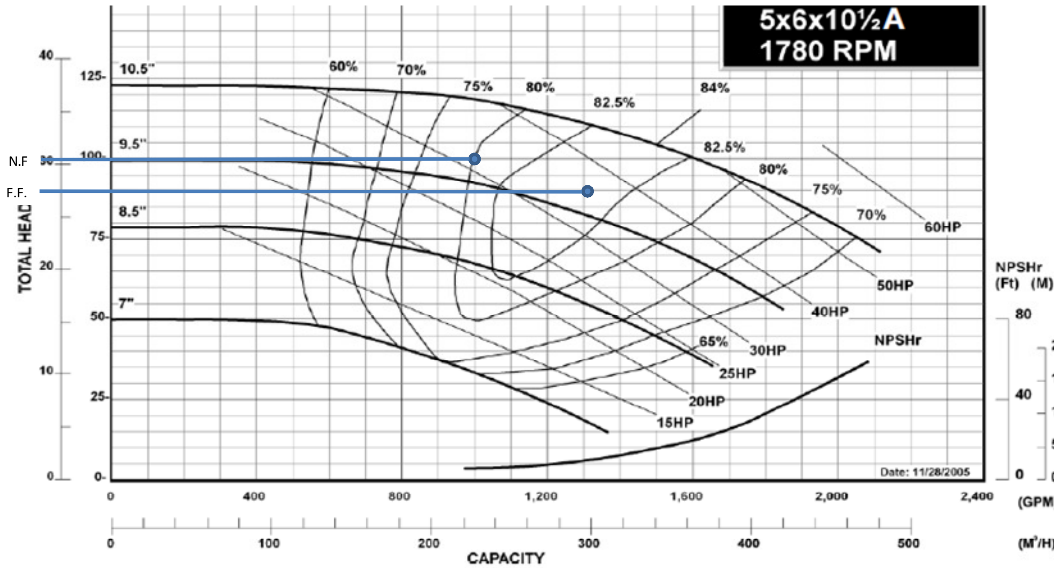
The IPMVP describes specific actions for verifying savings associated with energy conservation measures (ECMs) and strategies, LEED EA credit 5 expands upon typical IPMVP M&V objectives. M&V activities should not necessarily be confined to energy systems where ECMs or energy conservation strategies have been implemented. The IPMVP provides guidance on M&V strategies and their appropriate applications for various situations. These strategies should be used in conjunction with monitoring and trend logging of significant energy systems to provide for the ongoing accountability of building energy performance.

Any facility that has installed the necessary metering equipment to measure energy use has already taken the necessary steps toward M&V. Developing a plan to utilize the available data to make decisions is an important next step. An effective M&V strategy evaluates overall facility energy performance and the primary energy users to evaluate inefficient operations from a facility, systems and individual equipment standpoint.

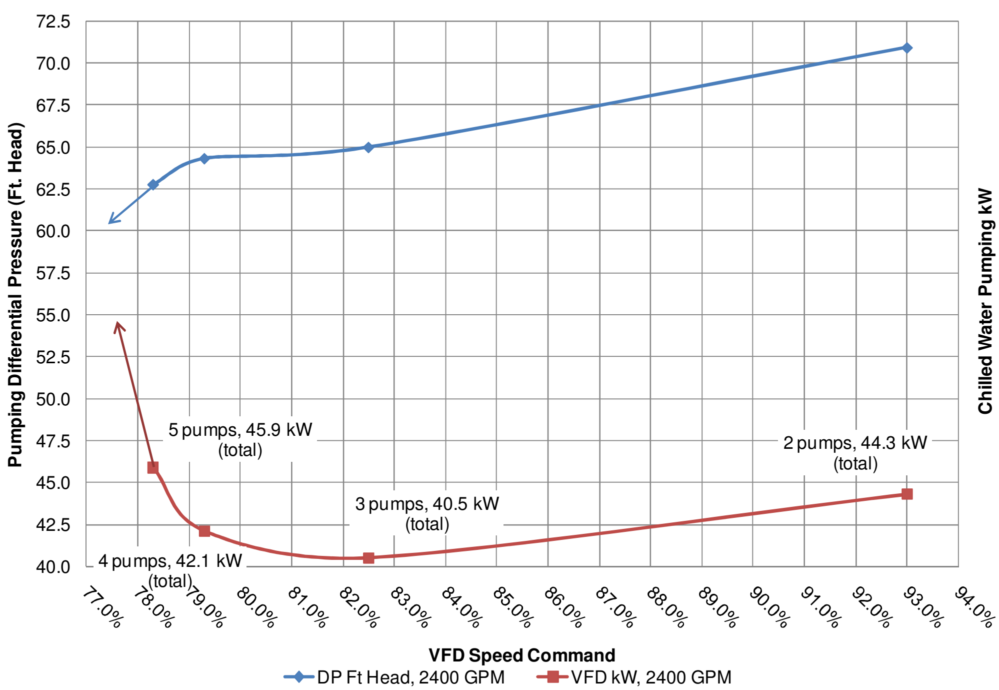
This report provides several benchmarking assessments of typical M&V systems and projects evaluated by Critical Systems Testing. The performance and evaluation of the energy using systems was determined to be the primary driver in providing a valid M&V plan.

Chilled Water Pumping

The nature of the performance of the pumps shown in the pump curve shown below provides negligible pumping head below 78% VFD speed with a marginal difference of 10 ft. head (4.3 psi) from full flow to no flow.



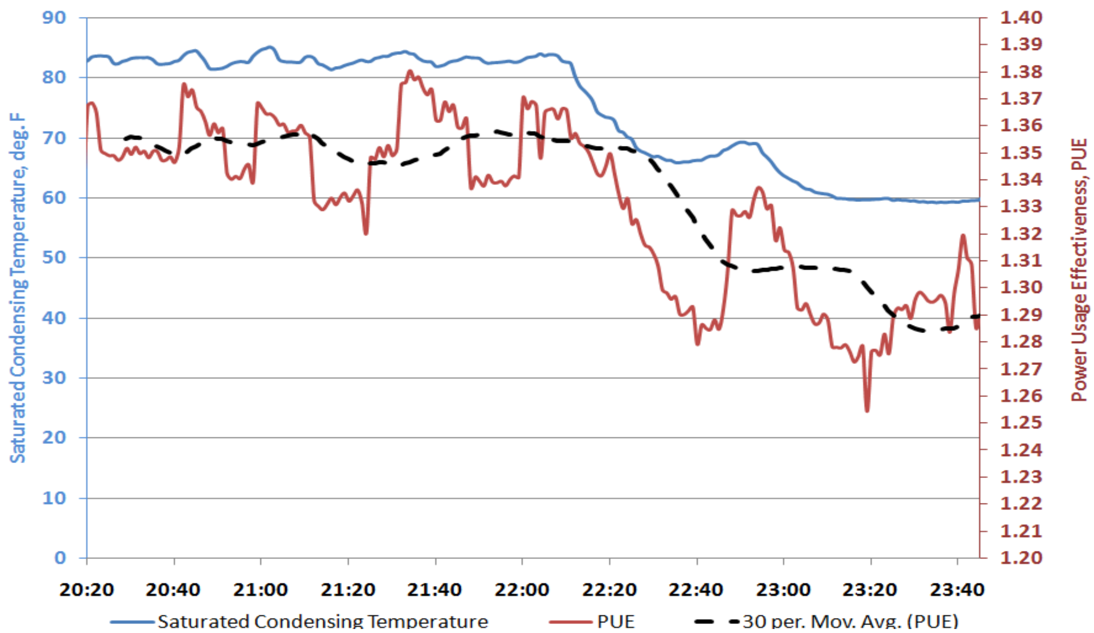
Multiple operational configurations of pumps, AHU chilled water valves and chillers operational were analyzed. Power usage characteristics at 40% load, 2400 GPM scenario is shown below. The M&V data shows that pump speed did not have any impact on system pressurization below 78% VFD speed. At 78% VFD speed and five pumps operational pumping is less efficient and the differential across the pump starts to fall off. At and above 78% VFD speed the impact to pressurization and functionality of the chilled water differential PID control was distinct. The development of the pumping power characteristic curve helped to provide clear direction for the final pumping staging sequence for the most efficient use of pumping energy.

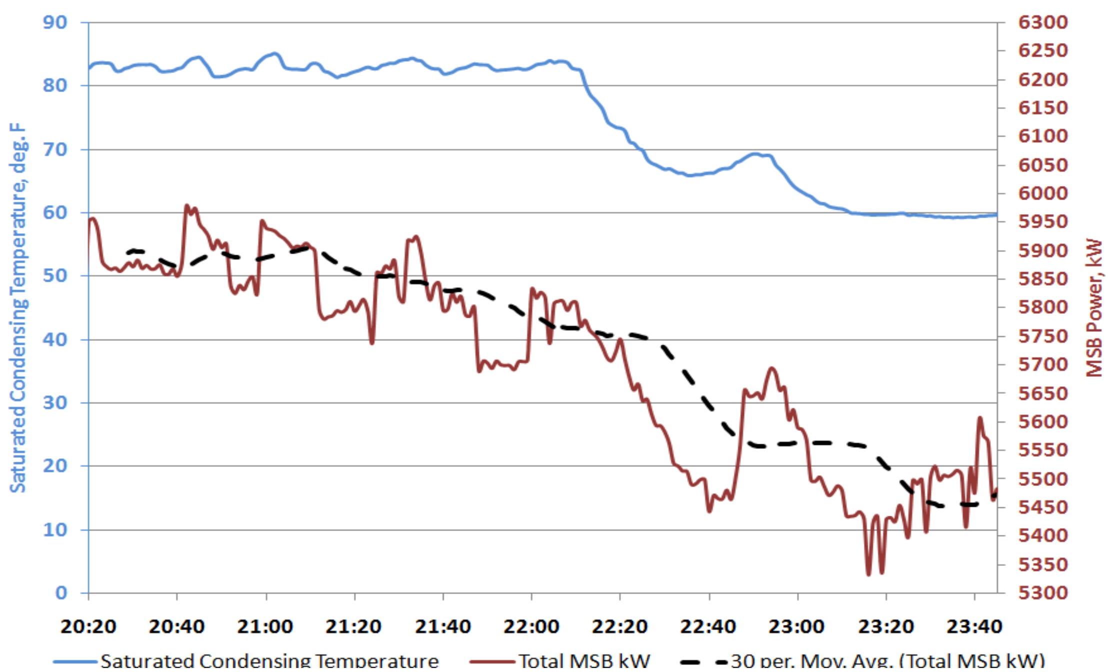


Power Usage Benchmarking

This facility in the present case study utilizes a special mechanical infrastructure with a direct expansion (DX) refrigeration system, scavenger cooling loop and refrigerant economization sequence of control. The uniqueness of this system required a specialized commissioning approach not typical of conventional chilled water cooling plants or DX cooled CRAC units. During the load capacitance verification test a simulation on the reset control of the condenser end of the refrigerant cycle. Prior to the reset verification the facility was loaded 100% on the system compressors. During the reset verification, the scavenger loop and evaporative condensers accommodated an increasing amount of the facility cooling load.

The charts below show reductions in the facility PUE and power consumption during temperature reset validation test. Although, the performance of the system has considerable opportunity for additional energy improvements and staging control, the baseline analysis was able to assist in acquiring $200,000 in utility rebates for energy efficiency.





Chiller Performance Benchmarking

Chiller energy benchmarking requires an understanding of the performance characteristics of the chiller design. A scroll compressor will behave differently from an energy standpoint than a centrifugal or screw compressor with variable speed drive. The chiller shown in Figure 1 has three scroll compressors per chiller. Generally, the most efficient loading for these chillers is at 33-35% which correlates to a single circuit and single compressor fully loaded. When a scroll compressor is operating, the system capacity increases by an incremental step. When the compressor stops, the system capacity drops by an incremental step and the energy flow associated with that compressor stops. These chillers do provide better part load efficiency (IPLV) than chillers with a single large scroll compressor and capacity control valves due to staging. This makes the overall system more efficient at discrete part loads, but not infinite part loading like a centrifugal or screws with VFD.

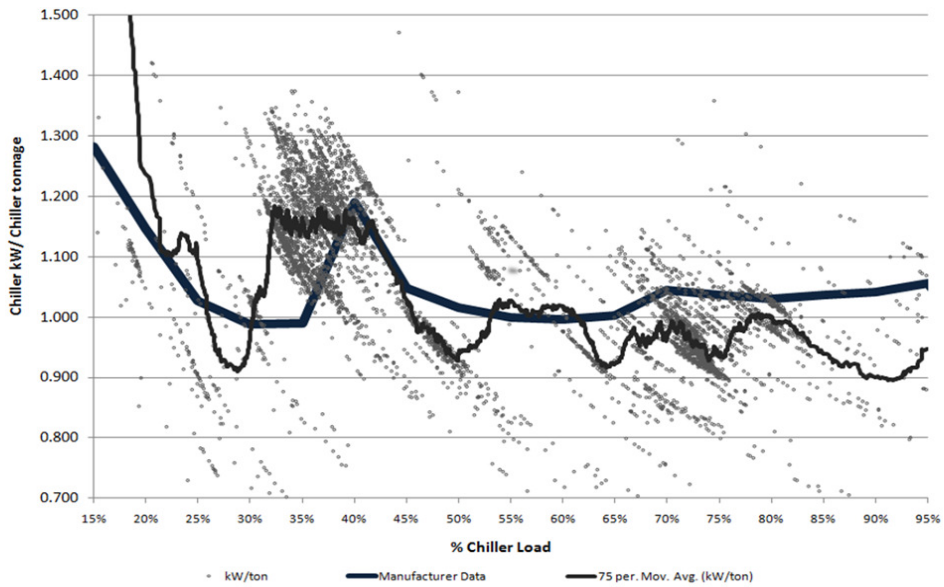


Figure 1 **Chiller with Scroll compressor**

The performance profile shown Figure 2 is for a chiller with centrifugal compressor and variable speed drive. Manufacturer and actual data show that most efficient with the compressor part loaded in the range of 35% to 50% load. The loading characteristics between each type of chiller technology results in significant variations in operational efficiency. The staging sequence, for each compressor type, needed to be established to help assure that the chiller loading is optimized for an overall efficient chiller plant performance. Chiller benchmarking during the M&V period of commissioning validates engineering assumptions and helps assure the most efficient mode of system control and operations.

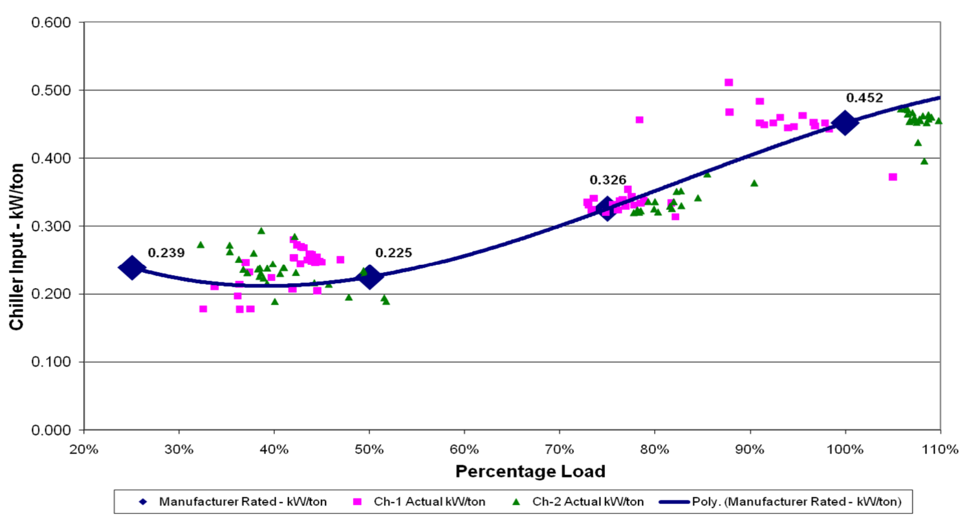


Figure 2 **Chiller with centrifugal compressor and variable speed drive**