Phase I Ex Ante Review Findings

Table -1: Project Information

IOU	Pacific Gas and Electric Company
Application ID	2K12135372 (submitted as 2K12135373)
Application Date	10/09/2012
Program ID	PGE21011
Program Name	Custom Calculated Incentive Program
Program Year	2012
Itron Project ID	X277
IOU Ex Ante Savings Date	Not provided
ED Measure Name	Data Center Hot/Cold Aisle Containment
Project Description	Reduce over-ventilation in server farm
Date of ED Review(s)	March 8, 2013
Primary Reviewer and Firm	Chris Williams, DNV KEMA
Review Supervisor and Firm	Amit Kanungo, DNV KEMA
Type of Review (Desk, On-site, Full M&V, Tool)	On-Site
ED Recommendation	The project is conditionally approved pending the ED-requested actions described below.

Measure Description

The measure is a cold-isle containment strategy for three server rack aisles in a data center located in [redacted]. The strategy involves isolating the rack's hot and cold aisles and readjusting supply and return temperature set points upwards. By containing these server rack aisles, the mixing of the hot exhaust air from the server racks and the cold supply air from the computer room air handlers (CRAHs) will be reduced, effectively lowering the cooling load and subsequently allowing for higher supply air set point temperatures that will more closely match the actual cooling demand necessary for the servers to maintain proper operating temperatures. The reduction in the CRAHs' cooling loads result in energy savings from reduced fan speeds and more efficient operation of the chiller compressors.

Air handler and chilled water plant energy savings were initially claimed by the project application to be 1,491,676 kWh and demand savings were claimed to be 166 kW. Incentive rates of $0.09/kWh and $100/kW were used to estimate a claimed project incentive of $150,850.84; however, project costs are estimated to be only $44,000.

On March 8, 2013, a phone call with EMCOR determined that EMCOR and the customer decided to withdraw claimed savings relating to the reduction in cooling demand from the chilled water plant equipment. Only savings relating to the reduction in air flow from the CRAH units (i.e., fan savings) will be claimed by the program. Based on this change, the new claimed project savings are ***210,671 kWh and 24.13 kW****.*

Summary of Review

Note #1: This ex ante review is for application ID # 2K12135372 (submitted as 2K12135373), which is considered to be the Phase II of the cold aisle containment retrofit project. The phase I portion has been applied under application ID # 2K12109525.

Note #2: This ex ante review covers ***only*** *details pertinent to the fan-related savings in the analysis workbook; the workbook summarizes both fan and chilled water plant (cooling) savings. While the cooling savings appear to be potentially substantial, the customer decided to proceed with claiming fan-related savings only.*

The IOU has submitted the following documents to the ED for the phase I ex ante review:

- Project application and supporting documents including a 12 month billing history, customized solutions program application workbook, pre-field report documenting description of the phase 2 project, and the contact information of PG&E reviewing engineer;
- Project calculations and supporting documents including CRAH specification manuals; CRAH unit list documenting units affected and unaffected by the cold aisle containment (phase 2) project; and savings calculation spreadsheet with one week of 15 minute interval trend data;

The review focused primarily on the project's savings calculation workbook that contains separate savings worksheets for each aisle proposed to be retrofit in the phase 2 project.

The savings worksheet analysis begins with one week of 15-minute interval trend data for each existing CRAH unit serving the proposed aisles selected for containment. The trend data includes the CRAH unit's supply and return air temperature and the supply fan drive speed (in percent full speed). From these trend data, the average temperature difference between supply and return temperature (delta CRAH temperature) for each CRAH unit is calculated. The average supply fan drive speed from the trend data and the rated design airflow of the respective CRAH unit is used to estimate the existing airflow rate (CFM) of the respective CRAH unit. The existing average CRAH fan drive speed and motor capacity (in HP) along with an assumed fan affinity

power exponent of 2.6 is used to calculate the estimated fan motor load for each respective CRAH unit. The reviewer presumed that the IOU fan energy calculations assume equivalent motor efficiencies and motor load factors such that they cancel each other out when calculating fan motor load. The source of the fan affinity power exponent was not given, but the recommended fan affinity power exponent for CRAH units serving open or mostly open aisles is 2.0 (Integral Group, 2012). Using the calculated hourly static motor load of each affected CRAH unit, the baseline CRAH fan 8,760 profiles (kW) are calculated assuming continuous annual operation. These baseline CRAH fan load profiles are reasonable given that pre-M&V trend data and actual rated equipment air flow are used to estimate in situ air flow rates and subsequent fan load; however, M&V efforts should be made to collect a sample of fan motor spot power measurements before and after the aisles are contained. Motor nameplate efficiencies should also be collected. Performing fan motor spot power measurements at various drive speeds (e.g., 30 – 60 Hz in 5-10 Hz increments) can provide data points to develop regression functions relating drive speed to fan motor kW. Pre- and post-containment calculations can then apply modeled fan power as a function of the trended drive speeds.

The proposed case savings analysis uses an assumption regarding ideal CRAH airflow rates; the ideal server air flow requirement used is 120 CFM/kW. This assumption references the PG&E Air Flow Management Binder (calculator) source. To calculate the ideal total air flow rate of each CRAH unit, the analysis assumes a rack power draw of 4 kW. The proposed CRAH fan speeds are the ratio of proposed-to-rated CRAH air flow rates, where the proposed CRAH fan flow rate is the estimated computing load (kW) multiplied by the ideal server air flow requirement (120 CFM/kW), divided by the number of CRAH units serving the estimated computing load. The proposed fan motor load is calculated using the same fan affinity power exponent as the baseline calculation. Using these assumptions of reduced CRAH air flow rates and fan power, the proposed flat 8,760 fan power profiles are calculated. The difference between the baseline and proposed 8,760 profiles is the annual energy savings; the difference between the baseline and proposed fan demand (kW) is the peak demand savings since the operating profile is static.

Based on the proposed CRAH flow rates, some of the proposed CRAH fan drive speeds would be as low as 12%. For some types of fan motors these drive speeds are not obtainable due to turndown limits of the motor. Regardless of the case, there are additional drive losses that need to be taken into account; as drive speeds decrease the drive efficiency decreases and becomes more significant at very low speeds (< 60% or 36 Hz). A discussion with EMCOR on March 8, 2013 alluded to the possibility that these drive speeds will not be possible and will likely be above 30%.

The submitted project documentation does not mention post-implementation M&V plans to collect trend data to substantiate the assumed ideal server air flow rate requirement.

Review Conclusion

The project is conditionally approved pending the ED-requested actions described below.

Summary of ED Requested Action by the IOU

1. Provide age of existing CRAH units (including fan and motor ages if there have been replacements) and VFD equipment. Additionally, collect CRAH fan motor efficiencies (or estimates of efficiencies) and collect spot power measurements of the fan motors at various speeds (e.g., 30 Hz, 40 Hz, 50 Hz, 60 Hz), both before and after aisles are contained (pre- and post-measurements), in order to model fan power as a function of the trended drive speeds;
2. M&V plan - Prior to implementation (1-2 days) collect VFD drive speed trend data for all CRAH fans that will be affected by the retrofit. This step is to confirm that no changes have been made since the last trend report which is included in the savings analysis workbook. Immediately following implementation (i.e., after the containment partitions have been installed and the CRAH fan speeds have been re-commissioned to set points that are adequate for the new CRAH supply temperature set points) of the cold aisle containment strategy, collect VFD drive speed trend data for all CRAH fans serving the affected aisles for a period of 7 days. This "commissioning" period may take several days as IT, facility & HVAC personnel find operating set points that are acceptable for the existing IT equipment in the affected aisles;
3. After implementation, provide actual project costs in the form of contractor invoices and internal costs for material and labor;
4. After implementation and data collection, revise savings analysis workbook to present data pertinent only to the savings claimed by the project. This will ensure that a future project evaluation will have a clear picture of the program-claimed changes that occurred during the project. Additionally, revise the baseline and proposed fan demand estimates with regressed fan power as a function of drive speed (as discussed in #1).

Table 1-2: Project Overview

Description	IOU Proposed Ex Ante Data	ED Recommendations
Project Baseline Type (Early Replacement, Normal Replacement, Capacity Expansion, New Construction, System Optimization,	Retrofit Add On (System Optimization)	Retrofit Add on (System Optimization). The project baseline will use existing equipment and operating

Description	IOU Proposed Ex Ante Data	ED Recommendations
Add-on Measures)		conditions
Project Cost Basis (Full Cost, Incremental Cost)	Full cost	Full cost
RUL (Early retirement projects only, otherwise N/A (not applicable))	N/A	N/A
EUL	10 years (based on DEER 2005 weather sensitive non-residential measure list/DO3-055,"Reducing over ventilation".)	10 years (based on DEER 2008 – Reducing over-ventilation)
First Year kWh Savings	210,671	TBD
First Year Peak kW Savings	24.13	TBD
First Year Therms Savings	N/A	N/A
kWh Savings (RUL Period)	N/A	N/A
Peak kW Savings (RUL Period)	N/A	N/A
Therms Impact (RUL Period)	N/A	N/A
kWh Savings (EUL thru RUL Period)	N/A	N/A
Peak kW Savings (EUL thru RUL Period)	N/A	N/A
Therms Savings (EUL thru RUL Period)	N/A	N/A
Annual Non-IOU Fuel Impact (RUL Period)	N/A	N/A
Annual Non-IOU Fuel Impact (EUL thru RUL Period)	N/A	N/A
Net-to-Gross Ratio	Not provided	Not assessed

Table 1-3: Detailed Review Findings

Reviewed Parameter	Analysis
Project Gross Savings Baseline (for early retirement projects only, include RUL through EUL baseline)	IOU Proposal: Existing equipment (non degraded condition).
	ED Assessment: This is a system optimization project; the physical measure is allowing for reduced ventilation of a space because of optimized temperature set points and heat exchange
	ED Recommendation: None
Project Cost Basis (for early retirement projects only, include RUL through EUL cost basis treatment)	IOU Proposal: Full measure cost
	ED Assessment: Since this is a retrofit (system optimization) project, full cost basis is appropriate
	ED recommendation: None
RUL (required for early retirement projects only, otherwise n/a)	IOU Proposal: N/A
	ED Assessment: N/A
	ED recommendation: N/A
EUL	IOU Proposal: 10 Years
	ED Assessment: 10 years is conditionally appropriate if the IT equipment in the aisle spaces affected by this measure does not change considerably. If the aisle/rack loads increase/decrease from the existing conditions then the appropriateness of the air flow rate set points will change as well
	ED Recommendation: 10 years – DEER 2008 (Reducing over-ventilation)
Savings Assumptions	IOU Proposal: 1. The CRAH units' fan speeds will be reduced to match the "ideal server air flow requirement" of 120 CFM/kW. The kW denominator is server rack power, not fan power. This parameter value was referenced from the PG&E Air Flow Management Binder (calculator).
	ED Assessment: The assumption is reasonable given the relatively predictable internal load locations, as well as locations of the supply & return air pathways & ducts
	ED Recommendation: TBD; post-M&V data collection will estimate the actual CRAH flow rates while a sample of rack powers will be collected in order to estimate the post-implementation CFM/kW values for each CRAH unit.

Reviewed Parameter	Analysis
Calculation Methods/Tool review	IOU Proposal: Calculation submitted by the sponsor along with baseline trend data. The calculation will be revised based on inspection notes made on-site.
	ED Assessment: The calculation method pertinent to the claimed fan savings is reasonable. Note: The savings calculation workbook includes chilled water plant savings (cooling savings) that are not being claimed by this project.
	ED Recommendation: Based on the baseline trend data available; post-implementation M&V should include drive speed trending to confirm the actual CRAH drive speeds chosen after the CRAH units and chilled water set points are tuned/re-commissioned for the new cold-aisle containment strategy.
Pre- or Post-Installation M&V Plan	IOU Proposal: The units' performance (pre- and post- case) will be verified based on the submitted trend data of the units' supply and return temperatures as well as the VFD speed readings.
	ED Assessment: The post-M&V plan is not documented in the project documents
	ED Recommendation: Prior to implementation (1-2 days) collect VFD drive speed trend data for all CRAH fans that will be affected by the retrofit. This step is to confirm that no changes have been made since the last trend report which is included in the savings analysis workbook. Immediately following implementation (i.e., after the containment partitions have been installed and the CRAH fan speeds have been re-commissioned to set points that are adequate for the new CRAH supply temperature set points) of the cold aisle containment strategy, collect VFD drive speed trend data for all CRAH fans serving the affected aisles for a period of 7 days. This "commissioning" period may take several days as IT, facility & HVAC personnel find operating set points that are acceptable for the existing IT equipment in the affected aisles.
Net-to-Gross Review	IOU Proposal: Not provided
	ED Assessment: Not assessed
	ED Recommendation: A net-to-gross review may be warranted for this project