Ex Ante Review Findings

Table Error! No text of specified style in document.**-1: Project Information**

IOU	PG&E
Application ID	FPP-1261-12-034
Application Date	TBD
Program ID	TBD
Program Name	Food Processing Audit and Resource Efficiency Program
Program Year	2012
Itron Project ID	X107
IOU Ex Ante Savings Date	TBD
ED Measure Name	Steam System Optimization – Food Processing
Project Description	Replace Six (6) Steam Jet Ejector Nozzles with (6) New Mechanical Vacuum Pumps
Date of ED Review(s)	5/25/2012
Primary Reviewer and Firm	Joseph Ball/Itron
Review Supervisor and Firm	Nikhil Gandhi/J. Hirsch & Assoc.
Type of Review (Desk, On-site, Full M&V, Tool)	Desk
ED Recommendation	Ex ante savings estimates are not approved, pending proof that the project passes the three-prong for fuel-switching

Measure Description

The dairy processing plant has a six-effect evaporation system which is used to concentrate unspecified products. The evaporation system operates under vacuum, with each succeeding effect at a lower vacuum than the previous. Thermal vapor recompression (TVR) is used to improve the steam economy of the multi-effect evaporator by effectively driving off the liquid from the products. TVR is accomplished by using one or more steam ejectors to recompress some of the low-pressure water vapor so it can be used for evaporation heating. Steam ejectors are also used to help maintain vacuum and remove non-condensing gases from the system. Steam is produced by three natural gas-fired, water-tube steam boilers. The plant runs 24 hours a day, with approximately 20 days of shutdown for maintenance. Thus, it is estimated that the evaporation system runs 8,280 hours per year. According to billing data, during the latest calendar year (2011) the plant consumed [redacted] therms of natural gas.

In order to optimize the steam system vacuum function during evaporation processes, six (6) jet ejector nozzles (at each of the six effect stages) will be replaced with six (6) electric motor-driven mechanical vacuum pumps. This retrofit will reduce the plant's steam requirement and hence, the consumption of natural gas while increasing its electrical consumption and on-peak load.

Summary of Review

The three documents reviewed include the following:

- A third party report dated April 11th, 2012 entitled "Comprehensive Food Processing Audit and Resource Efficiency Program Project Description Report" in MS Word™ format, DR_1261-12-634 XXXXXXX Steam Nozzle Removal Rev1
- Spreadsheet calculations in MS Excel™, EE Calcs 1261-12-634 XXXXXXX Steam Jet Removal Rev1
- A PG&E audit report review dated May 8th, 2012 in MS Word™, XXXXXXX _Vacuum_Jets_Audit_Report_Review_v2

The project documents identify the project as a system optimization of in situ baseline equipment yet further calculates energy savings based on early replacement assumptions even though no RUL of the pre-existing jet ejector nozzles are described. Depending on the RUL and condition of the in situ equipment the technical baseline could be current industry standard practice (ISP). For early replacement projects both the full and incremental costs may be required if a dual baseline is identified. The frozen ex ante impacts for this project will be based upon post installation M&V, using IPMVP Option A; the ex ante baseline claim is theoretical and uses the Choked Flow Nozzle Formula along with measured pre-retrofit parameters and assumptions.

During post-installation inspection, the IOU proposes to collect the following information:

- Steam boiler operating parameters: exhaust stack temperature, combustion air temperature, and exhaust CO2% and O2% to determine baseline boiler efficiency.
- Orifice diameter of steam ejectors replaced with mechanical vacuum pumps.
- Measured power draw of each electric motor driving a mechanical vacuum pump.
- Project invoices.

The energy savings calculations for the proposed measures were prepared with an Excel spreadsheet. The revised calculations are based on calculating the mass flow of steam through a nozzle (orifice). Steam is treated like an ideal gas with a specific heat ratio (k) of 1.3. To determine whether the steam flow is "choked" (sonic through the orifice) the critical pressure ratio (P_1 / P_0) must be less than or equal to 0.5457. Given that the plant's steam pressure (P_0) is about 185 psia, it is reasonable to assume that the steam flow is "choked", and therefore the equation to determine mass flow rate of steam through an orifice can be used. The steam flow for each ejector is assumed to be through a 5.2 mm diameter orifice, but the actual orifice diameter should be measured when the ejector is removed from service. Natural gas savings is calculated with an estimated boiler efficiency of 81.9%. During discussions with TPI, ED learned that during the six-stage re-compression of the steam system, the steam pressures do not drop at each nozzle, but remains constant. ED reviewers would like to verify the 170 psi remains constant at each of the six TVR effect stages. According to the TPI the steam usage cannot be accurately measured with the current system gauges or with clamp-on sonic flow meters.

During subsequent discussions with the third party implementer (TPI) ED learned that both electrically driven mechanical vacuum pumps and steam jet nozzles are both standard practice for this industry, in other words both designs are standard industry practice. The decision to use one technology versus the other is a matter of trade-off between energy savings (the mechanical pumps) and longevity/reliability (the steam nozzles). Even though overall energy savings may be achieved this measure may not go above and beyond ISP. It was also learned from the TPI that the RUL of the steam ejector nozzles (and the steam pipes, in general) are over 20 years, whereas the EUL of the mechanical vacuum pumps will be only 15 years. Therefore, there is no dual baseline for this measure.

Because this project involves indirect fuel switching from natural gas to electricity, **PG&E is responsible for presenting the calculations showing that the project passes the three-prong test, particularly the TRC test**. ED notes that PG&E is both the natural gas and electricity provider for this customer.

The TPI stated that since the vacuum function is not production dependent, the system operates continually and nearly identically throughout the year and year-after-year, and that this part of the steam system does not drive production. The customer is not trying to raise or reduce steam or vacuum requirements; the system will remain constant, and consequently, the normalization of production data is unnecessary. According to the TPI, the customer has a SCADA system that

primarily monitors production parameters, but also the main header pressure and one steam flow meter. There are no natural gas sub-meters at the processing plant.

The incentive application documents an annual savings impact of 255,108 therms per year; an electrical consumption increase of 555,919 kWh, and on-peak load increase of 67.1 kW with an incentive amount of $100,000, that is capped by 50% of the project. The estimated project cost is $200,000.

Review Conclusion

Energy saving estimates are not approved pending post-retrofit inspection M&V, true-up, and that this project passes the three-prong test for fuel switching.

Summary of ED Requested Action by the IOU

In order to complete an ex ante review the ED requests that the IOU submit the following documentation due 14 days after receipt of this ex ante review:

1. Provide nozzle manufacturer's specifications.
2. Provide supporting documents that electrically driven vacuum pumps represents one of the highest efficiency retrofit options for this customer, and that there are no other HE options.
3. Provide calculations that show this project passes the three-prong test for fuel switching, especially the TRC test taking into account same fuel equipment (see CPUC Policy Manual 4.0 Chapter IV Section 10) and meeting any efficiency requirements when fuels are switched.
4. ED suggests true-power measurement on motors after installation.
5. Suggest billing analysis for validation of energy savings.
6. ED requests the opportunity to review the final energy savings after post-retrofit M&V calculations and prior to the freezing of ex ante savings impacts for this project.

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, Add-on Measures)	Described as System Optimization, however, early replacement is assumed in calculation methodology	Early Replacement of in situ equipment
Project Cost Basis (Full Cost, Incremental Cost)	Full cost	Full cost. Because RUL of pre-existing equipment (jet nozzles) is greater than EUL of the proposed system, no incremental costs are needed
RUL	TPI estimated a minimum of 20 years	20 years acceptable for steam ejector nozzles and existing steam pipes
EUL	TBD	15 years from DEER 2008 for motors and mechanical pumping systems
First Year kWh Savings	-555,919	TBD, depending on the size of the pump and motor installed
First Year Peak kW Savings	-67.1	TBD, depending on the size of the pump and motor installed
First Year Therms Savings	255,108	TBD, because the proposed measure does not go above and beyond ISP, it does not meet the requirements as outlined by the Decision
kWh Savings (RUL Period)	-555,919	TBD, depending on the size of the pump and motor installed
Peak kW Savings (RUL Period)	-67.1	TBD, depending on the size of the pump and motor

Description	IOU Proposed Ex Ante Data	ED Recommendations
		installed
Therms Impact (RUL Period)	255,108	TBD, because the proposed measure does not go above and beyond ISP, it does not meet the requirements as outlined by the Decision
kWh Savings (RUL thru EUL Period)	-555,919	TBD, depending on the size of the pump and motor installed
Peak kW Savings (RUL thru EUL Period)	-67.1	TBD, depending on the size of the pump and motor installed
Therms Savings (RUL thru EUL Period)	255,108	TBD, because the proposed measure does not go above and beyond ISP, it does not meet the requirements as outlined by the Decision
Annual Non-IOU Fuel Impact (RUL Period)	NA	NA
Annual Non-IOU Fuel Impact (RUL thru EUL Period)	NA	NA
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: Early replacement of in situ equipment
	ED Assessment: Early replacement
	ED Recommendation: None
Project Cost Basis (for	IOU Proposal: Full cost

Reviewed Parameter	Analysis
early retirement projects only, include RUL through EUL cost basis treatment)	ED Assessment: Because RUL of pre-existing condition is greater than EUL of the proposed system, no incremental costs are needed
	ED recommendation: Full cost
RUL (required for early retirement projects only, otherwise n/a)	IOU Proposal: 20 years
	ED Assessment: 20 years acceptable for long-life steam ejector nozzles
	ED recommendation: None
EUL	IOU Proposal: Not provided
	ED Assessment: 15 year EUL for motors and pumps from DEER 2008
	ED Recommendation: 15 years
Savings Assumptions	IOU Proposal: The primary assumption is that the steam flow is "choked", and therefore the equation to determine mass flow rate of steam through an orifice can be used. Also, 170 psi low vapor pressure steam is assumed constant throughout all six-effect TVR stages. Lastly, the nozzle orifice diameter is assumed to be 5.2 mm.
	ED Assessment: ED would like to verify the 170 psi condition at each of the six-effect stages.
	ED Recommendation: Provide nozzle manufacturer's specifications.
Calculation Methods/Tool review	IOU Proposal: Engineering calculations, MS Excel spreadsheet
	ED Assessment: The theoretical method using the choke nozzle formula for mass flow rate is appropriate, but model inputs will need to be revised pending post-retrofit M&V on the actual motors and mechanical vacuum pumps installed, and the measured nozzle orifice diameter of the replaced nozzles.
	ED Recommendation: TBD, pending post-retrofit M&V and resubmission from IOU for savings true-up. Consider validating the energy savings calculations with a post-retrofit billing data energy analysis.
Pre- or Post-Installation M&V Plan	IOU Proposal: A post M&V plan has been developed using IPMVP option A as mentioned in the Summary of Review section above
	ED Assessment: M&V plan is appropriate
	ED Recommendation: None

Reviewed Parameter	Analysis
Net-to-Gross Review	IOU Proposal: None
	ED Assessment: Not assessed
	ED Recommendation: An ex ante NTG interview may be warranted