

Phase 1 Ex Ante Review Report

Table 1-1: Project Information

IOU	PG&E
Application ID	NC0099153
Application Date	9/25/2009
Program ID	PGE2223
Program Name	Non Residential New Construction Savings by Design
Program Year	2009
Itron Project ID	X185
IOU Ex Ante Savings Date	TBD
ED Measure Name	VFDs on Pumps, Pipeline Size Increase, & Premium Efficient Motors
Project Description	Install VFDs on four (4) hydraulic pumping systems and increase the design diameter of pipeline from 10” to 12”
Date of ED Review(s)	11/7/2012 & 1/14/13
Primary Reviewer and Firm	Blake Ringeisen & Joseph Ball/Itron
Review Supervisor and Firm	Betsy Ricker/ERS & Nikhil Gandhi/ Strategic Energy Technologies, Inc.
Type of Review (Desk, On-site, Full M&V, Tool)	Desk
ED Recommendation	Ex ante savings are not approved pending revised baseline adjustments and energy saving calculations.

Measure Description

The proposed energy efficiency measures of this project include:

Measure Code CPD30: implementing variable frequency drive (VFD) motor control on each of the four (4) pumping systems, eleven (11) VFDs in all.

Measure Code CPD40: increasing the diameter of the pipeline from 10 inches to 12 inches

Summary of Energy Consumption Calculations

Pumping Station	Energy Use – Baseline (kWh)	Demand – Baseline (kW)	Energy Use– EEM (kWh)	Demand – EEM (kW)	Energy Savings (kWh)	Demand Savings (kW)
P-202ABC VFD 40 hp ea	400,254	45.7	262,846	30.0	137,408	15.7
P-222ABC VFD 600 hp ea	7,044,339	804.1	4,519,501	515.9	2,524,838	288.2
P-701ABC VFD 350 hp ea	4,761,410	543.5	4,201,719	479.6	559,691	63.9
P-720AB VFD 20 hp ea	274,756	31.4	256,202	29.2	18,554	2.1
Line Size Increase	5,964,876	680.9	4,875,629	556.6	1,089,247	124.3
Totals	18,445,635	2,105.6	14,115,897	1,611.3	4,329,738	494.2

Summary of Review

The Investor Owned Utility (IOU) submitted the following documents to the Energy Division (ED) for the project’s Ex Ante Review:

- Non Residential New Construction Program CEE Incentive Analysis and Report for 2009 XXXXX XXXXX Westside Produced Water Project (Prepared by Cannon and revised by PG&E)
(Filename: 101546 XXXXX WPWP - Final Pre-Installation Report.docx)

The Energy Division (ED) reviewed the project documentation “Non Residential New Construction Program CEE Incentive Analysis and Report for 2009 XXXXX XXXXX Westside Produced Water Project”. This document defines this as a new construction project. As such, an industry standard practice baseline is applicable in savings calculations.

Based on the analysis submitted in the previously mentioned report, the project includes the installation of variable frequency drive (VFD) motor control on each of the four (4) pumping systems (Measure Code CPD30) - a total of eleven (11) VFDs - and a 12 inch diameter pipe, in lieu of a 10 inch diameter pipeline design, on a nearly six mile long pipeline (Measure Code

CPD40). The four (4) pumping systems include three (3) VFD controlled 40 HP centrifugal pumps (P202 A/B/C), three (3) VFD controlled 600 HP centrifugal injection pumps, two (2) VFD controlled 30 HP centrifugal pumps (P720 A/B), and three (3) VFD controlled 350 HP positive displacement injection pumps (P701 A/B/C).

The baseline for Measure Code CPD30 is claimed to be throttling valves for flow control for the centrifugal pumps, and a recycle loop with pressure control valve (PCV) for flow control of positive displacement pumps. Through interviews conducted with oil field pipe design engineers ED determined that for new construction of hydraulic pipelines for injection into wells, **VFDs are industry standard practice (ISP), and are, therefore, considered to be baseline equipment** for this pipeline including the recycle loop.

The baseline for Measure Code CPD40 is claimed to be a 10" diameter pipe. Through the parallel review process, ED learned that the 10" diameter pipe was a theoretical baseline design used to size pipes for the most optimal and cost effective hydraulic flow of 7 feet/sec (fps). Using 10" pipe the flow was calculated to be 6.3 fps, while using 12" pipe the flow would have reduced to 4.4 fps, much lower than the optimal flow of 7 fps. ED considers this design change a legitimate energy efficiency measure, even though there is nothing particularly special about the 12" steel pipe selected.

Energy savings for the pumping systems were calculated using PG&E's Pumping Systems Energy Savings Calculator v1.2 (PSESC) spreadsheet. Inputs were taken from the pump curve, system curve, pump efficiency curve, and demand profile. The PSESC program calculates power consumption for pumps using the baseline and proposed controls. The baseline control of pumps P-202 A/B/C, P-222 A/B/C, and P-720 A/B is constant speed throttled operation. The baseline control for P-701 A/B/C is a recycle loop with PCV control. The IOU calculated the pump head under different flow requirements based on the pump curve at constant speed and calculated power consumption based on the efficiency data. It also calculated and applied the part load efficiency of an energy efficient motor. The results of these calculations were then used to compute the annual electrical consumption with the baseline throttling valve or recycle loop control. A similar method of calculation was used for the VFD scenario. With a VFD, the pump curve is moved by changing the motor speed and applying the affinity laws. $H_2 = H_1 * (N_2/N_1)^{2.0}$ and $Q_2 = Q_1 * (N_2/N_1)$. The 2.0 exponent is a likely conservative value.

Review Conclusion

At this time, the ex ante savings estimates are not approved pending revision of the calculations with an adjusted baseline to include the selected VFDs, since they are considered to be ISP for new construction.

VSD savings were calculated using part load efficiency of VSD from an EPRI technical report from 1992. The data used are dated and should be replaced with current part load efficiencies for

the specific Toshiba VSD model selected. If such data are unavailable, PG&E should use EERE default part load efficiency values in the future until a complete review of the Customized Solution Tools is performed by ED. Part load efficiencies of electronic control devices such as VSDs, Rectifiers, and UPSs have greatly improved in the last 10 years.

Summary of ED Requested Action by the IOU

The ED requests that the IOU submit the following documentation by **January 31, 2012 (14 days from submittal date to IOU)** to allow the completion of the Ex Ante Review:

1. Adjust the theoretical baseline to include VFDs on all proposed pumps.
2. Revise and submit unlocked “live” non-password protected PSESC calculation tool for the project.
3. Submit post-install M&V logger data, the revised PSESC calculation tool using actual operating parameters, including any adjusted baseline parameters, and the IOU inspection report (IR).

Table 1-1: 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)	New Construction baseline; equipment baselines include constant speed throttling control valves for centrifugal pumps & PCV for the PD pumps. 10” diameter pipe.	New construction. VFD control on hydraulic pumps is ISP for new construction. 10” diameter pipe is acceptable baseline.
Project Cost Basis (Full Cost, Incremental Cost)	Incremental cost VFDs: \$469,610 Pipeline: \$626,060 Incremental cost is estimated considering capital cost only	Incremental cost VFDs: N/A 12” pipeline: \$20,260 (\$82,240 - \$62,480) based on quotations provided. Submit incremental installation and structure cost, if different from that needed for a 10” pipeline.
RUL	N/A	N/A
EUL	Not provided	EUL of steel pipeline is capped at 20 years maximum per the CPUC limit.
First Year kWh Savings	Measure CPD30 (VFDs): 3,240,491 Measure CPD40 (pipe): 1,089,247	Measure CPD30 (VFDs): 0 Measure CPD40 (pipe): TBD
First Year Peak kW Savings	Measure CPD30 (VFDs): 369.9 Measure CPD40 (pipe): 124.3	Measure CPD30 (VFDs): 0 Measure CPD40 (pipe): TBD
First Year Therms Savings	N/A	N/A

Ex Ante Review Findings

Description	IOU Proposed Ex Ante Data	ED Recommendations
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 (RUL thru EUL Period)	N/A	N/A
Peak kW Savings (RUL thru EUL Period)	N/A	N/A
Therms Savings (RUL thru EUL Period)	N/A	N/A
Annual Non-IOU Fuel Impact (RUL Period)	N/A	N/A
Annual Non-IOU Fuel Impact (RUL thru EUL Period)	N/A	N/A
Net-to-Gross Ratio	Not provided	An ex ante NTG interview may be warranted

Table 1-2: Detailed Review Findings

Reviewed Parameter	Analysis
Project Gross Savings Baseline (for early retirement projects only, include RUL through EUL baseline)	IOU Proposal: N/A
	ED Assessment: N/A
	ED Recommendation: N/A
Project Cost Basis (for early retirement projects only, include RUL through EUL cost basis treatment)	IOU Proposal: N/A
	ED Assessment: N/A
	ED recommendation: N/A
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: Not provided
	ED Assessment: VFD's are not applicable. ED estimates 20 years for steel pipe.
	ED Recommendation: 20 years for pipe
Savings Assumptions	<p>IOU Proposal:</p> <p><u>Baseline System</u></p> <ul style="list-style-type: none"> ▪ The product pumped is water. ▪ Pipeline theoretical design is 10" in diameter with a 6.3 fps flow. ▪ Estimated operating hours at various flow rates. ▪ The baseline control of pumps P-202 A/B/C, P-222 A/B/C, and P-720 A/B is constant speed throttled operation. The baseline control for P-701 A/B/C is a recycle loop with PCV control. <p><u>Proposed System</u></p> <ul style="list-style-type: none"> ▪ VFD motor control to be installed on all four (4) pump systems. ▪ 12" diameter steel pipe ▪ Estimated operating hours at various flow rates. <p><u>The major assumptions are:</u></p> <ol style="list-style-type: none"> 1. In calculating the energy savings, for the baseline condition it was assumed that operators would use the optimum/minimum number of pumps necessary to provide the required flows. 2. Energy savings for this report are calculated using PG&E's Pumping

Ex Ante Review Findings

Reviewed Parameter	Analysis
	<p>System Upgrade Tool, which is part of the SPC Customized Calculation Tool 2011.</p> <p>3. Pump affinity laws used with a coefficient of 2.0.</p>
	<p>ED Assessment: VFDs are ISP for new contraction of hydraulic pipelines. The baselines will need to be adjusted and calculations revised.</p>
	<p>ED Recommendation: Revise baseline equipment to be the same as the proposed VFDs and revise energy savings calculations for a more accurate energy savings estimates. Incentives will be reduced and be based on the incremental cost of the 12” pipeline over the 10” pipeline.</p>
Calculation Methods/Tool review	<p>IOU Proposal: MS Excel spreadsheets, PG&E’s PSESC calculator</p>
	<p>ED Assessment: PSESC Tool appears to use the pump affinity laws and is an acceptable method to estimate energy usage and savings until a full review of the calculation tool is done by ED.</p>
	<p>ED Recommendation: Revise PSESC calculator estimates based on the adjustment of baseline equipment to include the VFDs and current part load efficiencies.</p>
Pre- or Post-Installation M&V Plan	<p>IOU Proposal: After installation of the EEM’s, the following information will be collected:</p> <ol style="list-style-type: none"> 1. Invoices for the pumps, VFDs, and piping. 2. Make, model, and other available pump, motor, and VFD nameplate information. 3. A minimum of one-month worth of typical pump operating data to confirm the flow profiles and operating hours for each pump. This data shall include pump status and instantaneous flow taken at hourly intervals. 4. Final test and balance and/or commissioning reports indicating the test verified performance curves for each pump. 5. Field notes taken by a PG&E representative to confirm the physical installation of all EEMs. <p>If necessary, energy savings estimates for the EEMs will be recalculated based on the actual systems installed and a revised incentive payment will be determined.</p>
	<p>ED Assessment: Post-install M&V plan is appropriate</p>

Ex Ante Review Findings

Reviewed Parameter	Analysis
	ED Recommendation: None
Net-to-Gross Review	IOU Proposal: Not provided
	ED Assessment: Not assessed
	ED Recommendation: TBD