

Phase II Ex Ante Review Findings

Table 1-1: Project Information

IOU	PG&E
Application ID	1440-13-1237 (formerly 1261-12-860)
Application Date	11/5/2012
Program ID	PGE23036
Program Name	Comprehensive Food Process Audit & Resource Efficiency Pgm
Program Year	2014
Itron Project ID	X239
IOU Ex Ante Savings Date	5/19/2014
Measure Name	Compressed Air System Modifications
Project Description	Install new air compressor trim station (one 350 HP and one 397 HP air compressor with a VFD), compressor controls, two new air dryers, two 5,000 gallon air receivers, a pressure flow controller and four no loss condensate drains.
Date of CPUC Staff Review	2/7/2013, 6/13/2014
Primary Reviewer / Firm	Keith Rothenberg/Energy Metrics
Review Supervisor / Firm	JJ Hirsch & Associates
CPUC Staff Project Manager	[REDACTED]
CPUC Staff Policy Authorization (as needed)	
Type of Review (Desk, On-site, Full M&V, Tool)	Desk
CPUC Staff Recommendation	The ex ante savings estimates submitted by the IOU are not approved. The IOU should review Commission staff comments and requests. Resubmit documentation and savings analysis as requested for Commission staff review.

Measure Description

The project included the following measures:

- Replace two air compressors with a new air compressor trim station which includes one 350 HP oil flooded rotary screw air compressor and one 397 HP oil flooded rotary screw air compressor with a VFD.
- Install sequencing controls for the two new compressors,
- Replace two air dryers with two new air dryers (air dryer description not provided),
- Replace air receivers with a two new 5,000 gallon receivers.
- Install a pressure flow controller
- Install four no loss condensate drains.

Summary of Review

The Investor-Owned-Utility (IOU) submitted the following documents on for this Phase II review:

- M&V Report Review - 1440-13-1237 C&H rev 2014.05.19.docx;
- CR_1440-13-1237_R3_Final.docx
- CR_1440-13-1237_EE_Results_Calcs_Rev4.xlsx
- Invoices
- CPC Signed.pdf.

The IOU documents indicate that the implementer submitted a post project ex ante savings estimate of 4,078,222 kWh and 361.1 kW with an incentive of \$403,149. The IOU made several adjustments to the savings calculations and the IOU approved ex ante savings estimate is 2,448,954 kWh and 245.1 kW with an incentive of \$244,907.

The CPUC review staff have reviewed the submitted documents and have several concerns as described below.

The IOU requested an expedited review of the project at the end of 2012. Commission staff representatives contacted the IOU Program Manager and it was agreed that a phone call between Commission staff representatives and IOU's implementation team would be a good approach to clarify the project scope and answer Commission staff's questions about the project. Commission staff had numerous questions and it became evident that Commission staff would not be able to complete the review for this project before the end of 2012. Phone call notes were issued for the 12/14/12 phone call by Commission staff representatives and the IOU responded to the notes provided by Commission staff representatives. Additional phone conference calls were

conducted to further clarify the scope and answer details regarding the project calculation methodology and M&V plan.

During the course of this communication, Commission staff representatives stated that the final ex ante savings analysis should be based on the pre and post project measurements of system specific power (kW/CFM) for all measures effecting system efficiency, with other methods employed for measures with impacts such as reducing system air demand. The IOU responded that the savings analysis would be normalized to air flow. A revised M&V plan dated February 7, 2013 was submitted by the IOU showing a calculation methodology based on pre and post project measurements of system specific power.

During the initial project review Commission staff observed that the compressed air system included a steam turbine driven air compressor. It was unclear how the project might affect the steam turbine driven compressor. Commission staff requested that the IOU collect baseline and post installation data to show that the steam turbine driven compressor remained base loaded in both the pre-project and post project operating conditions.

The IOU resubmitted an M&V plan in February 2013 which included calculation methodology that appeared to indicate that the project impacts would be analyzed using a comparison of the pre and post project specific power as had been discussed during the December 2012 phone call. Commission staff representatives have reviewed the data and analysis provided in the recently submitted documents. The analysis calculation methodology is difficult to follow. The methodology does not appear to follow the guidance provided by Commission staff representatives. Using the data provided for the project, Commission staff representatives have estimated the impacts of the project as shown below. Detailed Commission staff representative analysis is shown in the separately provided MS Excel Spreadsheet file named “CR_1440-13-1237_EE_Results_Calcs_Rev4 CS Review 2014_0609.xlsx”. This spreadsheet includes the post installation data and analysis submitted by the IOU with three additional spreadsheet tabs containing Commission staff representative’s analysis added to the spreadsheet.

Steam Turbine Compressor:

Commission staff reviewed the data provided by the IOU and found that the average baseline flow rate from data collected between 3/8/13-6/30/13 was 2,315 CFM for the steam turbine driven compressor. The average flow from Post project data collected between 12/30/13-1/28/14 was 2,451 CFM. The difference is a 6% increase in compressed air flow in the post project measurement period. Commission staff concur with the IOU assumption that no significant change in the operation of the steam turbine driven compressor is a reasonable assumption for the analysis.

Analysis of Electric Air Compressor System Impacts:

The following measures directly impact the specific power of the electric compressors serving the compressed air system:

- Install two compressors.
- Install sequencing controls for the two new compressors,
- Replace air receivers with two new 5,000 gallon receivers.
- Reduced air compressor supply pressure (unclear if this has been implemented since pressure flow controller high side pressure not provided)

The impact of these measures is estimated by comparing the specific power of the system before and after the project was implemented:

Exhibit 1 summarizes the data provided by the IOU

Exhibit 1 Pre and Post Project Data Summary

Baseline Electric Compressors from IOU Analysis					Source
	Average kW	Average CFM	Hours	Average kW/CFM	
Mon-Sat	747	3,227	7,488	0.231	Calculated from IOU data
Sun	737	3,081	1,200	0.239	Calculated from IOU data
Post Project Electric Compressors, 4 weeks IOU data					
	Average kW	Average CFM	Average kW/CFM	Average % on	
Mon-Sun	437.10	2,594.58	0.168	88%	Calculated from IOU data
				Average kW/CFM	
Average Hourly weighted kW/CFM Baseline				0.2325	Calculated from IOU data
Average Hourly weighted kW/CFM Post Project				0.1685	Calculated from IOU data

The savings impact for these measures are calculated as follows:

$$kW = (kW/CFM_{pre} - kW/CFM_{post}) \times CFM_{post}$$

$$kWh = kW \times 8,760 \text{ hrs./yr.} \times \% \text{ on post}$$

$$kW = (0.2325 - 0.1685) \text{ kW/CFM} \times 2,594.58 \text{ CFM} = \mathbf{166.2 \text{ kW}}$$

$$kWh = 166.22 \text{ kW} \times 8,760 \text{ hours} \times 0.8835 = \mathbf{1,286,403 \text{ kWh}}$$

The following measures directly impact the demand for compressed air:

- Install four no loss condensate drains.
- Reduced system pressure-decreases artificial demand

The IOU provided an estimate for the savings impact associated with the installation of the no loss drains. The savings are estimated to be 0.9 kW and 7,819 kWh. Commission staff waive review of this measure for this project.

Based on data provided by the IOU the system pressure has been reduced from an average of 95.8 psig to 87.3 psig. Reducing the system pressure decreases artificial demand for compressed air. Documentation from the Compressed Air Challenge estimates that artificial demand constitutes 30-50% of the system air demand. In the absence of better information Commission staff have assumed 40% artificial demand for this project.

Commission staff's estimate of the energy savings impacts associated with this measure are shown below in Exhibit 2

Exhibit 2 Reduction of Artificial Demand Estimated Impacts

	psig	psia	Source
Average operating Pre project pressure	95.8	110.3	IOU data
Average operating post project pressure	87.3	101.8	IOU data
Average pre project CFM	5,521		IOU data-all compressor flows since the electric compressors are trim
Average post project CFM	4,841		IOU data-all compressors
Average post project kW/CFM	0.168		IOU data-electric compressors
Average system % on	88.35%		IOU data-electric compressors
Average % CFM unregulated users	40%		DOE Compressed Air challenge, 30-50% of usage is unregulated in typical system, no better information provided by IOU, assume 40%
Artificial demand maximum % CFM savings	7.7%		$= (1 - (\text{Average operating post project pressure psia}) / (\text{Average operating pre project pressure psia}))$
Average artificial demand CFM savings	170.4		$= (\text{Artificial demand \% CFM savings}) \times (\text{Average pre project CFM}) \times (\text{Average \% CFM unregulated users})$
Average artificial demand kW demand reduction	28.7		$= (\text{Average artificial demand CFM savings}) \times (\text{Average post project kW/CFM})$
Annual artificial demand kWh savings	222,131		$= (\text{Average artificial demand kW demand reduction}) \times (8,760 \text{ hours}) \times (\text{Average system \% on})$

The following measure reduces compressed air system energy usage:

- Replace two air dryers with two new air dryers (post project air dryer description not provided),

The IOU review states that this measure was added to the project impacts after the initial project documents were submitted. The IOU has not provided a detailed description for this measure. Commission staff are unable to comprehend the baseline and installed measures for the air dryers because of the lack of detail provided by the IOU. The IOU provided an estimate for the savings

impact associated with the installation of the no loss drains. The savings are estimated to be 15.7 kW and 135,968 kWh. Commission staff waive review of this measure for this project. Commission staff request that a detailed description of this measure be provided in a revised installation report.

Exhibit 3 below summarizes the Commission staff representative’s estimated savings impacts and the IOU reported savings impacts. Commission staff estimate the project RUL period impacts to be 1,652,321 kWh annual energy savings with a peak demand reduction of 211.5 kW. The IOU estimates the project RUL impacts to be 2,448,954 kWh annual energy savings with a peak demand reduction of 245.0 kW.

Exhibit 3 Summary of Commission Staff Estimated RUL Period Ex Ante Savings Impacts:

Ex Ante Savings Impacts	kW	kWh
New Compressors, sequencing controller, pres./ flow controller, air pressure reduction	166.22	1,286,403
No Loss Drains	0.9	7,819
Artificial Demand Reduction	28.7	222,131
Air Dryers	15.7	135,968
Total Commission Staff Estimated Ex Ante Impacts	211.5	1,652,321
IOU Claimed Impacts	245.0	2,448,954
Difference	(33.5)	(796,634)
% Difference	-14%	-33%

It is unclear which compressors (if any) have been removed from the site. The pre-project system diagram showed numerous compressors that are not shown on the post-project system diagram.

Commission staff note that the EUL for air compressors is 15 years, not 20 years as shown in the IOU documentation.

The IOU documents simply state that the RUL is in excess of one year however the estimated RUL period has not been provided. In the absence of better information, Commission staff recommend that the IOU use 1/3 of the EUL or 15 years for the RUL.

Savings impacts for EUL-RUL period have not been provided. A file referred to in the IOU documentation “Second Baseline C&H Compressor Savings Calculator” has not been provided. As discussed in December 2012, the T24 standards which will become effective on July 1, 2014 may affect the second baseline savings estimate.

Commission staff request that the IOU carefully review the analysis of the project impacts provided above and offer any comments in a clear and concise response.

Review Conclusion

The ex ante savings estimates provided by the IOU are not approved. The IOU should review Commission staff comments, calculations and requests. Resubmit documentation and savings analysis as appropriate for Commission Staff review.

Summary of CPUC Staff Requested Action by the IOU

CPUC Staff requests that the IOU undertake the recommended steps and submit the following information **due on, or before, 7/7/2014** (or 14 days from submittal date to IOU):

For this project, commission staff request that the IOU:

1. Review Commission staff's savings analysis for this project described above and shown in the separately provided MS Excel file. Revise the IOU savings analysis or provide a comprehensive and concise explanation as to why the IOU ex ante analysis should not be revised.
2. Review the second baseline savings estimate which is referenced in the IOU documents but has not submitted. Commission staff request that the IOU carefully review the applicability of the T24 Standards for compressed air systems effective on 7/1/2014 and submit the savings impact estimates for the EUL-RUL period. Submit the second baseline savings estimate for this project.
3. Revise the EUL to 15 years or provide justification for the IOU proposed 20 year EUL.
4. Use the default RUL value of 5 or provide an alternate estimate of the RUL for the project and evidence that support deviation from the CPUC recommended value.
5. Provide the cost basis for the EUL-RUL period and ensure that the incentive is calculated based on the Commission decision for dual baseline projects. From CPUC Decision D.12-05-015 page 349
"The measure or project cost utilized in an early-retirement case is the full cost incurred to install the new high-efficiency measure or project, reduced by the net present value of the full cost that would have been incurred to install the standard efficiency second baseline equipment at the end of the remaining-useful-life period. Thus, the early-retirement cost is higher than the incremental cost used in a replace-on-burnout or normal-replacement case, only by the time value of the dollar amount of the standard equipment full installed cost, using our adopted cost-effectiveness discount rate to calculate that time valuation. As with all measures, our policy expects that incentives offered for early retirement will not exceed the actual early retirement cost."

If PC=project total cost, INC=incremental cost over code/ISP, D=discount rate, and RUL

is the remaining life of early retired equipment, then the TRC cost at time of project installation is: $TRC \text{ cost} = PC - (PC - INC)/(1 + D)^{RUL}$).

6. Commission staff note that there were eight air compressors identified in the pre-project system. It is unclear which air compressors remain on site, which compressors are operational and which compressors have been removed from the site in association with the project. Provide a description of the post project compressed air system.
7. Electric power data have only been provided for the two new electric air compressors. The M&V plan dated 2/7/2013 stated on page 2 that “Electrical compressors connected to the plant air system will have kW loggers connected to them in order to collect data sample averages to verify operations”. Describe why the electric power data have not been provided for other post project system electric compressors. If other compressors are connected to the system, include their impact in the final submitted savings analysis. Providing data for all compressors is important for establishing the specific power for the compressed air system and verifying the operation of the system over the measurement periods.

For all future projects (submitted after receipt of this review) Commission staff require that the IOU:

1. Provide well organized documentation which is easily comprehensible to facilitate industry peer review.
2. Provide precise step-by-step calculation methodology and equations proposed to be used to estimate the ex ante impacts for each custom project with detailed descriptions associating the proposed methodology with specific equipment and systems affected by the project. Provide system diagrams to facilitate the review of the project. The energy savings principle for each measure should be discussed. The calculation methodology description should be comprehensive and complete leaving only the final verified variables and data to be determined after project completion. All that should be required after the project is completed is to input final project post verified data and assumptions into the proposed formulae to determine the ex ante impacts. Generic methodology lacking such detailed specific associations is not acceptable.
3. Where M&V is proposed, the M&V plan should provide concise descriptions including measurement points, measurement period, measurement interval, measurement equipment, system diagrams, discussion of the accuracy measurement equipment and uncertainty associated with the results.
4. When deviations from proposed calculation methodology and/or M&V plans are necessary, the IOU should provide a well-documented explanation regarding the reasons for the variation from the original plan and a detailed description of the proposed changes to the previously approved (by Commission staff) approach to estimating savings

impacts. Substantial changes to an approved project would normally invalidate any previously issued approval, so this information must be supplied to Commission staff as soon as possible once the changes are identified and before the project proceeds.

For this project, Commission staff found that the savings analysis required reviewers to hunt through numerous documents and analysis spreadsheet cells to investigate the ex ante savings impacts. This is not acceptable.

5. Where important assumptions or project parameters which may affect the ex ante savings impacts have been verified, they should be clearly described in the documentation.

For example, for this project Commission staff requested that the IOU verify the assumption that the steam turbine driven compressor operation did not change significantly before and after the project was implemented. The IOU review document simply states that the “base loaded air compressor and operation did not change between the baseline and installed cases”. Commission staff reviewed the IOU’s analysis and found that the average baseline flow rate from data collected between 3/8/13-6/30/13 was 2,315 CFM for the steam turbine driven compressor. The average flow from Post project data collected between 12/30/13-1/28/14 was 2,451 CFM. The difference is a 6% increase. We concur that the IOU assumption that no significant change in the operation of the steam turbine driven compressor is reasonable, however a more detailed and precise analysis should have been presented in the IOU project documentation for this important project parameter.

6. Commission staff have observed a wide variety of project documentation templates for custom projects. Many of the templates lack consideration for compliance with Commission ex ante policies which have been the subject of past ex ante reviews and process discussions between Commission staff and the IOUs over the past two years. Commission staff recommend that the IOU require that all custom project documentation include a more standardized summary of important project parameters.
7. Carefully review past guidance provided by Commission staff regarding project documentation compliance with Commission staff previous issued policy guidance and dispositions. Please refer to the ED issued guidance document Named “Project Basis (RET, ROB, etc.), EUL/RUL Definitions, & Preponderance of Evidence”.¹

For example, documentation for this project claims early replacement for the air compressors and simply states that the RUL is more than one year when justifying this as an early replacement project. Justification for early replacement treatment and a specific estimate for the RUL if an alternate to the default is being proposed should be provided

¹ <http://www.energydataweb.com/cpuc/search.aspx?did=1035>

as applicable. Where Industry Standard Practice (ISP) or code applies to a first or second baseline, the specific code or ISP basis should be discussed in the project documentation.

8. For dual baseline projects, provide the cost basis for the EUL-RUL period and ensure that the incentive is calculated based on the Commission decision for dual baseline projects. From CPUC Decision D.12-05-015 page 349

“The measure or project cost utilized in an early-retirement case is the full cost incurred to install the new high-efficiency measure or project, reduced by the net present value of the full cost that would have been incurred to install the standard efficiency second baseline equipment at the end of the remaining-useful-life period. Thus, the early-retirement cost is higher than the incremental cost used in a replace-on-burnout or normal-replacement case, only by the time value of the dollar amount of the standard equipment full installed cost, using our adopted cost-effectiveness discount rate to calculate that time valuation. As with all measures, our policy expects that incentives offered for early retirement will not exceed the actual early retirement cost.”

9. When M&V is recommended for a project, Commission staff observe that it may be necessary to require the implementation team to collect additional baseline data before the project commences. Many projects are developed with a basic level of monitoring during the project feasibility stage. Commission staff understand the need to minimize project development costs before a customer is committed to implementing a project. However, once the project feasibility is established and the customer expresses interest in proceeding with the project, collecting additional baseline data can significantly enhance the accuracy of the ex ante savings results. In general, a one week measurement period is inadequate to establish a baseline. A two week period should be considered the absolute minimum period, and four or more weeks more acceptable.

For this project, the implementer measured the electric power on three compressors for one week and used a simulation to estimate the air flow associated with the power consumption. Based on Commission staff’s request, the implementer installed air flow metering as the first phase of the project to establish the baseline operation of the steam turbine driven compressor. The project could have been further enhanced at this point by installing power data loggers on the electric compressors for a four week or more period to more accurately establish the baseline specific power which is one of the most important parameters in the analysis of this project.

Table 1-3 Energy Savings Summary, Project Costs & Incentive

Description	IOU Ex Ante Claim	CPUC Staff Recommendations
First Year kWh Savings	2,448,954	1,652,321
First Year Peak kW Savings	245.0	211.5
First Year Therms Savings	0	0
kWh Savings (RUL Period)	2,448,954	TBD
Peak kW Savings (RUL Period)	245.0	TBD
Therms Impact (RUL Period)	0	0
kWh Savings (RUL thru EUL Period)	Not provided	TBD
Peak kW Savings (RUL thru EUL Period)	Not provided	TBD
Therms Savings (RUL thru EUL Period)	Not provided	0
Annual Non-IOU Fuel Impact (RUL Period)	NA	NA
Annual Non-IOU Fuel Impact (RUL thru EUL Period)	NA	NA
Project Costs for Baseline #1 (RUL or EUL)	\$939,951	\$939,951
Project Costs for Baseline #2 (EUL minus RUL period)	Not provided	TBD
Project Incentive Amount	\$244,907	TBD