

## Final Ex Ante Review Findings

**Table 1-1: Project Information**

<b>PA</b>	PG&E
<b>Application ID</b>	2K13216098
<b>Application Date</b>	8/28/2013
<b>Program ID</b>	PGE21011
<b>Program Name</b>	Customized Retrofit
<b>Program Year</b>	2013
<b>CPUC Project ID</b>	X450
<b>PA Ex Ante Savings Date</b>	11/7/2013
<b>Measure Name</b>	Outside Air Damper
<b>Project Description</b>	Install outside air dampers and controls on three AHUs to allow heat recovery from return air
<b>Date of CPUC Staff Review</b>	9/30/14, 12/5/14
<b>Primary Reviewer / Firm</b>	Patrick Hewlett / ERS
<b>Review Supervisor / Firm</b>	Keith Rothenberg/Energy Metrics
<b>CPUC Staff Project Manager</b>	██████████ / California Public Utilities Commission, Energy Division
<b>CPUC Staff Policy Authorization (as needed)</b>	
<b>Type of Review (Desk, On-site, Full M&amp;V, Tool)</b>	Desk
<b>CPUC Staff Recommendation</b>	<p>This project was previously approved for classification as retrofit add-on (REA). A NTG review has not been performed for this project. The measure EUL for this project is 5 years.</p> <p>The PA is required to revise the ex ante savings analysis with a more thorough examination of potential electric impacts resulting from the controls retrofit project. These include fan penalties from previously disconnected RAFs as well as possible savings from OA reduction during cooling periods. Additionally, the analysis should more accurately model the OA fraction as a function of OAT, as indicated in EMS trends. Any adjustments made to the savings</p>

	<p>analysis should be reflected in the final ex ante claim for this project, clearly described in the documentation and uploaded to the CMPA folder for this application.</p> <p>CPUC Staff waive further review of this project. The claim ID number and the quarter this project is claimed information must be uploaded to the CMPA folder for this project.</p>
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## **Measure Description**

The customer installed outside air dampers and associated controls to reintegrate previously inactive return air fans on three AHUs serving the facility's office and retail spaces. The pre-project AHUs drew 100 percent outside air during all occupied periods. The installed OA dampers and return air fan VFDs and associated controls allow for heat recovery from the return air stream to reduce the amount of outside air conditioning required during the heating season.

## **Summary of Review**

The Program Administrator (PA) submitted the following pertinent documents for this Final review:

- 2K13216098-COM-[CUSTOMER NAME]-Conversation Record.docx
- 2K13216098-COM-[CUSTOMER NAME]-Approved Energy Savings.xlsx
- 2K13216098-COM-[CUSTOMER NAME]-Project Cost Quotes.pdf
- 2K13216098-COM-[CUSTOMER NAME]-PA Review Form v2.2.xlsx
- 2K13216098-COM-[REVIEWER NAME]-Combustion Efficiency Test.pdf
- 2K13216098-COM-[REVIEWER NAME]-IR therm Calcs REV1.xlsx
- 2K13216098-COM-[REVIEWER NAME]-Raw Trends.zip
- 2K13216098-COM-[CUSTOMER NAME]-IR Review Form v2.4 REV2.xlsx

*The following five paragraphs summarize the PA's internal review and initial CPUC staff review that led to claimed ex ante savings.*

The vendor initially submitted calculation files and the project feasibility study on 10/10/2013. The vendor's initial savings impacts were estimated to be 0 kWh, 0 kW peak demand reduction and 150,762 therms. The proposed system was assumed to save only during heating periods, as 100% outside air (OA) would continue to be drawn during cooling periods. Further, the project was assumed to result in no electric penalties, as the volume of air removed by the exhaust air fans (XAFs) in the preexisting case was assumed to be equal to the summed volume of air drawn through the return air fans (RAFs) and XAFs in the proposed case. Supply air fans (SAFs) and XAFs on the three affected AHUs were outfitted with VFDs prior to the project, while VFDs were installed on all RAFs as a part of this project.

The PA noted that the vendor's savings claim reflected unrealistic OA temperature (OAT) bin estimates for the facility's location. For example, the savings claim reflected 240 hours per month of OAT with an average temperature of 45°F. The PA cited Climate Zone 3 (CZ03) typical weather data, which indicates only 174 hours annually during which the building is occupied and OAT is less than 48°F. The PA requested that the vendor clarify this issue and resubmit the project savings claim.

PA submitted its review of the project on 11/7/13, after adjusting the savings claim to reflect CZ03 OAT bins. Additionally, the revised PA analysis included more site-specific information on supply air temperature (SAT) setpoints, fan speeds, and OA fractions for the three AHUs affected by the project. The PA's savings claim also reflected revised supply air cfm values as referenced from the coil schedules in mechanical drawings. The revised PA savings impacts were 0 kWh, 0 kW peak demand reduction, and 60,955 therms.

CPUC staff reviewed the submitted documentation and requested that the PA support the savings analysis's operating assumptions with spot measurements and at least two weeks of trended (or metered) data on fan system parameters such as SAT, mixed air temperature (MAT), return air temperature (RAT), OAT, OA damper position, balance-point temperature, and SAF, XAF, and RAF speeds. CPUC staff requested a testing, adjustment, and balancing (TAB) report to support the outside air fraction and supply air cfm values assumed in the analysis. Finally, CPUC staff requested boiler combustion test data to confirm the boiler efficiencies assumed in the savings analysis.

The PA responded to CPUC staff's requests. Spot measurements (SAF and XAF amperage and power factor) and one month of EMS trended data (fan speeds, OA damper position, OAT, SAT, RAT, and MAT) were provided to support the revised savings analysis inputs. Combustion efficiency tests results were provided for all four boilers at high-, medium-, and low-fire levels. However, the PA was not able to provide a TAB report to substantiate the assumed OA fraction. Adjustments were made to savings analysis inputs as a result of this additional information. The revised PA savings impacts were 0 kWh, 0 kW peak demand reduction, and 66,100 therms.

*The following paragraphs detail CPUC Staff review of the PA's most recent submission.*

CPUC Staff have reviewed the PA's most recent submission for this project provided on 11/25/2014. The submission includes the installation report for the project, revised calculations prepared by the PA reviewer, a summary of PA responses to CPUC staff requests, post-installation trend data, equipment specification data, and invoices for the project. As requested, the PA provided boiler combustion efficiency tests and correctly referenced their efficiency values in the revised savings analysis. The RATs and average SAF speeds used in the PA analysis now accurately reflect average RATs and SAF speeds, respectively, over one month of facility operation (June 2014).

The PA provided spot power measurements of affected SAFs and XAFs as requested by CPUC Staff; however, RAF spot measurements could not be performed during either site visit, as the facility was not in heating mode. The PA installation report assumes no electric impact on any AHU fans as a result of the project, as the total power of as-built RAFs and XAFs was expected to be equal to the baseline power of the XAFs. However, without RAF spot measurements, CPUC Staff cannot fully verify this claim. Included in one month of EMS trended data are

interval SAF, RAF, and XAF amperages and speeds. These data indicate no turndown of XAF speeds when the RAFs are operating; this operation contradicts the PA's assumption of zero overall electric impacts among affected fans.

CPUC Staff requested that pertinent parameters such as OA fraction, MAT, and balance-point temperatures are supported by EMS trend data. However, these parameters were either incorrectly computed or not revised as requested. The trend data indicates that OA fraction varies with OAT; however, the PA's revised analysis includes an assumption of constant OA fraction (20-40% depending on AHU) during heating periods. As a result, the PA analysis currently overestimates the MAT at several OAT bins, leading to higher-than-actual claimed savings. The balance-point temperature—when the building switches from cooling to heating—was not revised as recommended by CPUC staff. Trend data indicates that SAF speed reaches a minimum during the transition from heating to cooling, as predicted by CPUC staff, but this method was not followed in the PA's revised calculation. Trend data indicates that space heating actually occurs for one AHU up to 64°F OAT, compared to 61°F OAT assumed by the PA, thereby leading to potentially higher actual project savings than claimed.

The PA documentation indicates that “According to the Chief Engineer, when in cooling mode, the system will still be operated on 100% outside air.” However, trended temperature and OA damper position data indicates that OA dampers begin to close and return air fans are activated at OATs of 72°F and higher. For example, the average OA fraction at 75°F is 20% for one AHU. Therefore, the CPUC Staff believes the project results in electric savings at OATs of 75°F and higher that were not claimed by the PA.

The “Early Retirement Using Preponderance of Evidence ver 1.01” document provides guidance on the EUL for REA measures. The EUL of REA measures is capped at the RUL of the equipment being retrofitted. This means that REA measures utilize the RUL of the preexisting equipment up to and not to exceed the EUL for the REA measure. The age of the preexisting HVAC system has not been provided; however, project files indicate that “The return air system is in place and includes return fans and necessary hardware but has not been utilized since the building was constructed in 1960.” Invoices indicate that at least two preexisting RAFs were replaced with new models during the project. Though EUL might have been exceeded for some system components, CPUC Staff believe that a system-wide replacement of the total HVAC system once EUL is exceeded is not realistic at this facility. In the absence of better information, the RUL of the HVAC system is set at 1/3 of the DEER EUL, which is 15 years for air conditioning systems.  $1/3$  of 15 years = 5 years. 5 years is the EUL of this measure for this project.

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<sup>1</sup> Ex Ante Review Custom Process Guidance Documents may be found at the following web address:  
<http://www.cpuc.ca.gov/PUC/energy/Energy+Efficiency/Ex+Ante+Review+Custom+Process+Guidance+Documents.htm>

## **Review Conclusion**

The measure EUL for this project is 5 years. The PA is required to revise the analysis with a more thorough examination of potential electric impacts resulting from the controls retrofit project. These include fan penalties from previously inactive RAFs as well as possible savings from OA reduction during space cooling periods. Additionally, the analysis should more accurately model the OA fraction as a function of OAT, as reflected in EMS trend data. Any adjustments made to the savings analysis should be reflected in the final ex ante claim for this project and clearly described in the documentation. CPUC Staff waive further review of this project. The claim ID number and the quarter this project is claimed information must be uploaded to the CMPA folder for this project.

## **Summary of CPUC Staff Required Action by the PA**

CPUC Staff require that the PA undertake the recommended steps and submit the following information:

For this project:

1. Demonstrate that the analysis accurately accounts for any electric impacts resulting from the project, including fan penalties from re-commissioned RAFs and affected SAFs and XAFs, as well as possible cooling coil savings from OA reduction at warmer OATs.
2. Revise the analysis to more accurately reflect patterns indicated in EMS trend data. Specifically, the OA fraction does not remain constant for any AHU; rather, it varies with OAT. OA fractions directly affect MATs and subsequent AHU coil savings and should be more accurately modeled as a function of OAT for all bins.
3. Provide an update on any commissioning or testing and balancing that might have occurred in the last year. If commissioning or TAB reports are available, submit and revise airflow values per the report findings.
4. Include a more detailed description of the facility's overall HVAC system, from plant level to terminal units. This description should address the interactivity and control sequencing between the primary radiant heating/cooling system and the makeup air system of the three affected AHUs. Without information on the facility's chiller plant or a full description of the distribution system and controls, Commission staff cannot fully assess the accuracy of claimed savings.
5. Revise the EUL for the measure to 5 years as described above.
6. Revise calculations, savings claim and installation report to address issues 1, 2, and 3 above.

7. Upload all final documents to the CMPA folder for this project. Include a separate document with a file name “Claim ID” with the submission. The Claim ID document will include the PA claim ID number and quarter claimed.

For all future projects (submitted after receipt of this review):

1. When CPUC Staff requirements are described in a review document, the PA should make a diligent effort to ensure that the PA response provided clearly addresses the requested action. The requested action should either clearly lead to revision in the savings calculation or a clear explanation when parameters are not revised. If the requested action or proper response is unclear, the PA should seek guidance before proceeding.

For this project, CPUC Staff requested that the PA confirm that the project does not result in interactive electric impacts, through spot measurements and analysis of trended data. The PA’s post-install visits occurred during periods when the facility was not heated and the return fans were therefore not active. Therefore, no spot power measurements of RAFs and XAFs could be compared; however, one month of EMS trended data indicates no turndown of XAF speed when RAFs are active, indicating likely electric penalties resulting from the project. The PA did not make this comparison or investigate further.

Additionally, CPUC Staff requested that the PA use EMS trended data to support parameter assumptions in the savings calculation. Though parameters such as RAT and SAF speed were appropriately revised, other revised parameters such as OA fraction and balance-point temperature were not indicative of EMS trends.

2. Provide precise step-by-step calculation methodology used to estimate the ex ante impacts for each custom project with clear references of each pertinent parameter. When several sets of trended data are analyzed to support savings parameters, these trends should be consolidated into a single spreadsheet to allow live cell links and clearer review of parameter derivation. When spreadsheet consolidation is not possible due to file size constraints, clear explanation of parameter derivation (via cell comments or text boxes with associated file/tab names) is requested.

For this project, twelve sets of EMS trends were used to support savings parameters. The trends were often analyzed in unorthodox ways to determine average parameter values, which were often hard-coded into the overall savings spreadsheet without reference. This disorganization led to difficulty when reviewing PA calculation revisions. The twelve sets of EMS data could have been consolidated into three master sets (one for each AHU) and inserted into the overall savings calculation as three tabs and pivot tables. This would allow clearer parameter referencing and easier CPUC staff review, at only a nominal increase in file size.

3. For custom HVAC controls projects, the final submitted ex ante savings should reflect any post-install commissioning or balancing report findings. Such projects often require iterative airflow balancing and controls programming steps to ensure the desired pressure setpoint is maintained in the building. Original assumptions in the savings calculation are often obsolete as a result of this testing and balancing; the final ex ante savings value should incorporate the latest operational data possible.

This project involved the re-commissioning of previously installed but offline RAFs. The PA indicated that no testing and balancing reports were available. This information would more accurately inform the supply air and OA cfm values assumed in the savings analysis.

4. Provide a more detailed description of the overall system affected by REA measures, including relevant nameplate data, equipment counts, and control strategies. This information will allow Commission staff to more accurately assess the interactive impacts of REA measures.

For this project, the PA review documents did not provide any information on the facility's chiller plant or the VAV distribution system. Further, the interaction and sequencing between the facility's primary radiant panel heating/cooling system and the AHUs' makeup air system were not fully explained in project documents. More detailed background on the existing HVAC system would allow CPUC staff to fully assess the potential cooling savings and fan interactivities resulting from the measure.

5. The EUL of REA measures is capped at the RUL of the equipment being retrofitted. This means that REA measures utilize the RUL of the pre-existing equipment up to and not to exceed the EUL for the REA measure. The PA reviewer should carefully review guidance documents and ensure that all future reviews incorporate consideration of the guidance.

For this project, the PA reviewer did not provide any clear EUL claim or RUL information, so it is unclear whether the EUL was correctly identified.

**Table 1-2 Review Findings**

Reviewed Parameter	Analysis
<b>Project Baseline Type</b> (Early Replacement, Normal Replacement, Capacity Expansion, New Construction, System Optimization, Add-on Measures, Major Renovation) Note: For early retirement projects only, include RUL through EUL baseline)	PA Proposal: Retrofit add-on
	CPUC Staff Assessment: accept
	CPUC Staff Recommendation: none
<b>Project Baseline Technology</b> (in situ equipment, Title 24 (specify year), other code or other efficiency level (specify), industry standard practice - ISP)	PA Proposal: in situ
	CPUC Staff Assessment: accept
	CPUC Staff Recommendation: none
<b>Project Cost Basis</b> (Full Incremental, or Both. Note: For early retirement projects, include RUL through EUL cost basis treatment)	PA Proposal: Full cost
	CPUC Staff Assessment: accept
	CPUC Staff Recommendation: none
<b>RUL</b> (required for early retirement projects only, otherwise N/A)	PA Proposal: N/A
	CPUC Staff Assessment: accept
	CPUC Staff Recommendation: none
<b>EUL</b> (for each measure)	PA Proposal: None listed
	CPUC Staff Assessment: 5 years
	CPUC Staff Recommendation: The EUL of REA measures is capped at the RUL of the equipment being retrofitted. This means that REA measures utilize the RUL of the pre-existing equipment up to and not to exceed the EUL for the REA measure. Due to unknown RUL, CPUC staff assume an RUL of one-third of the EUL for air conditioning equipment (15 years per DEER).
<b>Savings Assumptions</b>	PA Proposal: Custom spreadsheet analysis created by the implementer and revised by the PA. OA fraction assumed constant at all OAT bins. No project

Reviewed Parameter	Analysis
	<p>electric impacts assumed.</p> <p>CPUC Staff Assessment: The savings analysis does not fully examine the interactive electric impacts of the project, either from potential fan penalties or coil savings during occupied periods of OAT &gt; 75°F. The analysis was not accurately updated with EMS trend data as originally recommended by CPUC staff. The PA’s assumption of constant OA fraction is not reflective of trended data and leads to higher-than-actual claimed savings.</p> <p>CPUC Staff Recommendation: CPUC Staff require that the PA examine the electric impacts of the project, through measurement of RAFs and XAFs and longer-term analysis of fan speeds. CPUC Staff require that the PA investigate cooling coil savings due to the project’s reduction of OA during warmer OATs. OA fraction should be modeled as a function of OAT, as patterns in EMS trend data indicate.</p>
<b>Calculation Methods/Tool review</b>	<p>PA Proposal: Custom bin analysis created by the implementer and revised by the PA. EMS trend data analyzed via separate spreadsheets leading to average values in the savings calculation.</p> <p>CPUC Staff Assessment: Bin spreadsheet analysis is an appropriate method, but EMS trend spreadsheets feature unorthodox analysis methods leading to inaccurate average values in final savings spreadsheet.</p> <p>CPUC Staff Recommendation: Use pivot tables and occupied/unoccupied flags to determine parameter averages and bins in EMS trend data, instead of data filters. Clearly indicate calculation steps when deviations occur from typical EMS trend analysis methods.</p>
<b>Pre- or Post-Installation M&amp;V Plan</b>	<p>PA Proposal: Spot power measurements and one month of EMS trends from the three affected AHUs were used to true up the savings calculation inputs after the completion of the project. Boiler combustion tests were used to more accurately estimate boiler thermal efficiencies in the savings calculation.</p> <p>CPUC Staff Assessment: Spot measurements and EMS trend averages do not accurately characterize measure operation. Boiler combustion efficiencies were appropriately applied and lead to more realistic thermal efficiencies.</p> <p>CPUC Staff Recommendation: Spot or long-term power measurements must be performed on all affected RAFs and XAFs to determine potential fan impacts resulting from project. Trended RAF and XAF speed data indicate likely electric fan penalties.</p>
<b>Net-to-Gross Review</b>	<p>PA Proposal: Not addressed</p> <p>CPUC Staff Assessment: TBD</p> <p>CPUC Staff Recommendation: TBD</p>

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

Description	PA Ex Ante Claim	CPUC Staff Recommendations
First Year kWh Savings	0	Waived
First Year Peak kW Savings	0	Waived
First Year Therms Savings	66,100	Waived
kWh Savings (RUL Period)	NA	Waived
Peak kW Savings (RUL Period)	NA	Waived
Therms Impact (RUL Period)	NA	Waived
kWh Savings (RUL thru EUL Period)	0	Waived
Peak kW Savings (RUL thru EUL Period)	0	Waived
Therms Savings (RUL thru EUL Period)	66,100	Waived
Annual Non-PA Fuel Impact (RUL Period)	NA	Waived
Annual Non-PA Fuel Impact (RUL thru EUL Period)	NA	Waived
Project Costs for Baseline #1 (RUL or EUL)	\$119,442	Waived
Project Costs for Baseline #2 (EUL minus RUL period)	NA	Waived
Project Incentive Amount	\$59,721	Waived