Phase 1 Ex Ante Review Findings

Table 1-1: Project Information

PA PG&E
Application ID ICRx 080
Application Date Not provided
Program ID PGE210210
Program Name Industrial Recommissioning Program
Program Year 2014
CPUC Project ID X533
PA Ex Ante Savings Date Not provided
Measure Name Compressed air system modifications
Project Description
Replace air compressor sequencing controller, repair air leaks, adjust system pressure set points, and replace timer drains with no loss drains.
Date of CPUC Staff Review 1/26/2015
Primary Reviewer / Firm Keith Rothenberg/Energy Metrics
Review Supervisor / Firm Jeff Hirsch/JJH & 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 are not approved. CPUC staff will continue to review this project pending the PA's response to CPUC staff requirements listed below.

Measure Description

The following compressed air system measures are proposed for the project:

• Replace existing air compressor controls which control compressors based on the rate of pressure rise/decay with new controls which will ensure the most efficient compressor operation sequences, fully utilize the existing 50,000 gallons of storage and pressure flow control valve.

The description of the existing compressed air system controls was not sufficiently detailed in the submitted report. The existing system is a hybrid combination of an Air Science Engineering control system installed in 2007, and add-on control boards installed in 2013 by Pneu-Logic.

The hybrid system is now comprised of three independent control systems. The Pneu-Logic controls are operating the Pad 1 compressors with a target pressure and narrow pressure band, but the three independent controls are also operating all compressors at elevated pressures with the compressors upstream of the pressure flow controller base-loaded, and with the downstream compressor acting as trim. There is no data recording or display for the system with the hybrid control system, and outside technicians are required to adjust pressures or sequencing of compressors. No site personnel are able to work with the hybrid system, and the lack of an interface makes evaluation of compressed air system operations impossible for plant personnel.

The proposed enhancement of the controls will include establishing a central control to all three compressor pads with additional control equipment, and the installation of some new sensors. However, existing sensors, wiring, conduits, and compatible equipment will be retained with additional flow meters and other sensors added to allow facility operators to see real-time performance of the compressors and the compressed air system including flow, pressure, and power.

• Reduce compressor discharge pressure from 110 psig to 95 psig for base loaded Quincy compressors downstream of the pressure flow controller; reduce the discharge pressure of the Kaeser compressors upstream of the pressure control valve to 100 psig.

• Tune compressor #4 to resolve problems with loaded operations.

• Reduce compressed air demand through leak repairs.

• Reduce compressed air demand by replacing seven timer drains with no air loss drains.
The PA ex ante savings estimates are 565,596 kWh annually and 106.1 kW demand reduction. The project cost is estimated to be $112,853 and the incentive is estimated to be $56,427.

Summary of Review

The Program Administrator (PA) submitted the following documents on 12/8/2014 for this Phase 1 review:

- Air Compressor Savings Calculator Methodology.pdf;

- IRCx 080 – [CUSTOMER NAME] PPA Report_v5.docx; and

- IRCx-080 Checklist 120514apf3.xlxs.

The CPUC staff review has identified potential "show stopper issues" that must be addressed before further CPUC staff review of this project is performed:

The project documents state that the existing compressed air system is controlled by a Pneu-Logic system. The Pneu-Logic system is proposed to be replaced with a new control system. Replacing an existing control system with a new control system is a retrofit measure, not an RCx measure. The project appears to be a normal replacement, and the correct baseline is a properly function control system, not a poorly functioning control system. The PA did not provide the baseline air compressor raw measurement data, however CPUC staff note that graphs provided in the project documentation appear to indicate that there are periods of time when more than one air compressor is operating unloaded. Using the in situ, poorly operating control system constitutes a regressive baseline which is not allowed by CPUC policy. The PA must address the regressive baseline issue for this project.

Additionally, the age and condition of all compressed air system equipment must be provided along with a statement regarding the recent replacement or addition of air compressors or air dryers to the facility.

A cursory review of the proposed M&V plan indicates additional issues that will need to be addressed in a future review for this project. In general, simply measuring the power before and after a project is implemented is not an acceptable approach to determine savings impacts for compressed air projects. CPUC Staff have issued several dispositions addressing this issue in the past.

CPUC Staff view the repair of compressed air leaks as normal maintenance, a measure that is ineligible for Program participation. CPUC Staff expect that the PA will advise the customer that compressed air leak repair and a compressed air leak maintenance program are recommended standard practices.

A signed, countersigned and dated program application has not been provided. The PA technical review was not provided.

Review Conclusion

The ex ante savings are not approved. CPUC staff will continue to review this project pending the PA's response to CPUC staff requirements listed below.

Summary of CPUC Staff Required Action by the PA

For this project:

CPUC Staff require that the PA take the following action due on 2/13/2015 (or 14 days from submittal date to PA):

1. CPUC staff advise that replacing the air compressor sequencing controller that is not functioning properly is normal maintenance and replacement of like equipment in order to maintain the intended level of service is not energy efficiency. These are not retrocommissioning measures. Installation of like equipment under the non-regressive baseline rule has no system impact and results in zero gross savings. CPUC staff require that eligible technologies should be more efficient than standard practice and more efficient than existing equipment being removed. The PA must demonstrate that the proposed air compressor system controller is more efficient than standard practice and more efficient than the properly functioning existing compressor system controller being removed. If the PA is not able to provide this demonstration, then this measure should be removed from the project. This measure, if found eligible should be a retrofit measure, not an RCx measure. The measure type should be correctly classified and the proper baseline established.

Nexant believes that the enhancement of the control system is an eligible IRCx measures based on the following reasons that are discussed in detail below,

- Commission Staff approved in January 2014 a similar measure (IRCx 034, X256) and did not raise any questions about industry standard or retrofit definitions. The measure was approved as an eligible RCx measure that brought the system to best practice[1] levels, beyond what is industry standard[2].
- Industry Standard Practice for compressed air controls has not changed since Commission Staff approved the similar project in January 2014
- Similar to the project approved by commission staff, the proposed enhancement of controls for IRCx 080 is best practice
- Existing controls are not malfunctioning, they are functioning as they were intended by the hybrid design and are in fact more efficient than industry standard
- The proposed enhancement of controls will further improve the operation of the compressors from the existing operation

A very similar project was reviewed through the parallel review process one year ago (IRCx 034, X256); the existing control system for that project was a cascading pressure sequencer that was not capable of managing the system as well as the proposed master control system, and the measure to update the controls was approved by Commission Staff under the IRCx program as an eligible RCx measure. Industry Standard Practice, with strong evidence pointing to local cascading pressure controls on the majority of compressed air systems, has not changed in the one year since approval of IRCx 034 by Commission Staff.

In the roughly five years that Nexant has been implementing industrial compressed air RCx projects through the IRCx program, 39 projects have been audited. Of those 39 projects, seven

[1] Compressed Air Challenge, "Improving Compressed Air System Performance", Page 38, November 2003.
[2] Aspen System Corporation, "Compressed Air System Market Assessment in the Public Service Electric and Gas Service Territory", Page 2.25, July 2003

(7) of the compressed air systems had a master controller or sequencer of any kind; of the seven, all were considered to be operating less than optimally for compressor or capacity control. In consultations with other Nexant offices, including Nexant's Madison Wisconsin office, similar market penetration rates were reported. Jeff Bartels, Project Manager for Nexant's Madison, WI office noted that less than 20% of the roughly 200 systems they have surveyed over the past years had a master controller in place, and very few of those were functioning as intended. Additional more detailed research into recent projects from that office revealed that only five (5) out of 20 projects had either simple sequencers, PLC controls, or a master controller in place. As with our experience in the IRCx program, the Madison office's review of controls noted that every one of the systems with some sort of sequencer or master controller was operating below design intent.

Nexant conducted a literature review of industry studies related to existing compressed air systems. This review shows that there are several journal articles[3,4,5,6(]) and studies[7] (also provided as attachments) which document in detail that few compressed air systems are equipped with master controllers or sequencers. Based on conversations with highly regarded industry professionals and backed up by more recent journal articles in trade publications, there is practically universal agreement that there has been no rapid increase in market penetration by any of the major equipment manufacturers of master controllers. Industry professionals that were consulted include Jeff Yarnall, Project Manager for Auditing and Consulting from Rogers Machinery, Tim Dugan President and CEO from Compression Engineering Corporation, and Dean Smith, Senior Systems Auditor from IZ systems.

The three independent existing control systems at Christopher Ranch, rate of pressure rise controls associated with each engine room and their compressors, are each already more efficient than what is the ISP for the overwhelming majority of compressed air systems, which is local cascading pressure controls. And as explained earlier, the existing control system is not a malfunctioning control system. It meets all production requirements, and operates without interventions of the facility staff as per the hybrid design implemented by Pneu-Logic.

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[3] Compressed Air Best Practices Magazine, "A Compressed Air Management System for Five Compressors", March 04, 2015, http://www.airbestpractices.com/technology/compressor-controls/compressed-air-management-system-five-compressors

[4]Compressed Air Best Practices Magazine, Don van Ormer, "Central Monitoring and Control for Multiple Air Compressors", August 5, 2015, http://www.airbestpractices.com/technology/compressor-controls/compressed-air-management-system-five-compressors

5 Compressed Air Best Practices Magazine, "Meat Packager Retrofits a Compressor with a VFD and Master Controls", January 21, 2015, http://www.airbestpractices.com/industries/food/meat-packager-retrofits-compressor-vfd-and-master-controls?page=11

[6] Compressed Air Best Practices Magazine, "Real-World $mart Sequencer® Controls", November 5, 2015, http://www.airbestpractices.com/technology/compressor-controls/real-world-mart-sequencer%C2%AE-controls

[7] Aspen System Corporation, "Compressed Air System Market Assessment In the Public Service Electric and Gas Service Territory", Page 2.25, July 2003.

Nexant's analysis of the existing compressor operations showed that the compressors on Pad #1 are serving as baseload compressors at the highest discharge pressure with the compressors downstream of the pressure flow controller operating as trim compressors at slightly lower, but similar and unnecessarily high discharge pressures. That operational strategy is not caused by a malfunctioning control system; it is how the hybrid Pneu-Logics/Air Science controls have been designed so that the three compressor pads are controlled separately. The current controls lacks the ability to record or show performance data that might be used by facility staff to keep the system operating at integrated and optimal efficiency level. Without data they cannot assess how the system operates. The only way staff can currently assess a problem with the system is catastrophic type failures where production requirements aren't met; actual performance metrics on how the system is operating are invisible to facility staff. It is virtually impossible to optimize something that is not measured.

Nexant's proposed strategy in this project is to fully optimize the staging and discharge pressures of all compressors in the three compressor rooms in real time and provide the tools to facility staff to manage their system with objective data on the real time system efficiency. The proposed enhancements will result in the most efficient use of the compressors on all the three pads and within each pad to achieve the best specific power combination of compressors to meet the plant load. That cannot happen with the existing hybrid Pneu-Logic/Air Science controls, as operators have no way of actually seeing the real time performance with the existing hybridized control system. The optimization involves establishing reliable hard wired communications between the three compressor pads and using rate of pressure rise control approach for each compressor pad, but converting the system to a reliable system with split pressure controls and to give the operators the tools they currently lack to keep the system in optimal operating conditions. This will bring the system to best practice standard.

Implementation of the proposed controls does not encompass installation of an entirely new control system; additional components will be added to accomplish the goal of an integrated control system that is capable of optimizing all compressors that are on-line. As detailed in the proposed cost table included in the PPA report, equipment to be installed includes an automation panel, 19" color HMI PLC, communications cards for air compressor data, additional analog inputs at each of the engine room compressor panels, wiring to each engine room for remote control of the other compressors, enclosures, fan kits, and remote communications cell links to track system performance data. The front end logic will be replaced as part of the project, but much of the existing equipment will be retained including sensors and instrumentation on each pad that reports that data back to the current independent controls. The equipment proposed will result in more robust and reliable communications back to the engine room control panels to enable integrated system control and collection of real-time trend data on power, flow, and pressure for all energy consuming components in the system.

Expected control equipment costs were listed at $29,150, with another $28,500 in labor to integrate the new front end equipment into the existing control equipment and compressors. Two

additional items include interface bricks for each compressor, including digital inputs and outputs listed at $8,400 with labor included, and instrumentation that will be added including four (4) flow meters to track system flow in critical paths, a dew-point pressure transmitter assembly for tracking plant air quality, four (4) pressure transducers, and eight (8) True-kW monitoring transducers for compressors. The instrumentation that will be critical in maintaining the persistence of system performance is listed at $18,853 with labor included in the first line item for all controls equipment

To summarize, the energy division approved a similar project in the IRCx program (IRCx 034, X256), where the same enhancement was implemented to the compressed air controls. Commission Staff did not raise any concerns about this project being a retrofit measure or about the measure not going beyond industry standard practice. As IRCx 034, IRCx 080 enhancement of controls is best practices and an eligible RCx measure.

2. Replacing timer drains with no loss drains appears to be a retrofit measure. Provide justification for including this measure in a retro-commissioning program.

Nexant: CPUC staff approved an identical measure on January 31, 2014 at the conclusion of the parallel review process for the project “PG&E IRCx 034 (X256) Compressed Air System Opt”. In addition to the no-loss air drains that were approved for the project, installation of a new compressed air receiver, pressure flow controller, and enhancements of the existing control system (which had similar issues with respect to controls capabilities and visibility of real-time performance data) were approved in the Phase II disposition. The savings for no loss drains were approved by the CPUC for IRCx 034 as a part of an overall compressed air system optimization at the facility.

3. Provide the raw measured data that were used for the analysis.

Nexant: The calculations and raw data will be provided as requested. The file name is “IRCx 080 - Raw Data.csv” and the data has been saved on the tab named “IRCx 080 – Raw Data”. Columns B to I show the kW measured for each of the compressors. Column J and K show the pressure trend data collected on the 50,000-gallon wet-receiver of Pad 1 and on the header downstream of the flow controller.

4. Describe what tuning compressor #4 to resolve problems with loaded operations entails. Provide justification of why this is not normal maintenance.

Nexant: During the investigation of the existing compressed air system, and only through efforts of the on-site auditors, was this problem uncovered with respect to operations of the #4 Kaeser compressor on Pad #1. The local compressor control panel includes an indicator which lights up

when the compressor is loading; all outward appearances for this compressors suggested it was operating normally. In addition, the facility has contracted with Quincy with an ongoing compressor maintenance contract. Technicians visit the facility and perform routine light maintenance on all compressed air equipment once per quarter with a heavy maintenance site visit once per year. The light maintenance entails the following: blow off all the coolers, change oil and air filters, take oil samples for analysis and check all the condensate drains. The heavy maintenance entails all the light maintenance work plus changing the air/oil separator filter and changing lubricant. The recommended maintenance practices and schedules from Quincy[8] and Kaeser[9] are included as attachment; neither document suggests performance testing as a normal or expected part of either routine, or heavy annual maintenance activities. Because of the lack of performance data in this system, facility staff and/or maintenance personnel cannot see that a problem exists in a compressor unless that problem overwhelms the system's capacity to deliver required volumes of compressed air at the required pressure, and causes production problems. For Compressor #4, the problem was internal to the compressor and essentially invisible; compressed air system operations would have continued for the foreseeable future without correction, or adverse impacts on production in the plant. Once identified through our monitoring and data analysis, the correction of the loading issues is necessary in order to implement the controls optimization. Without this step, the system optimization cannot be completed and the system will continue to waste significant amounts of energy and affect overall sequencing for the lowest system specific power.

5. Provide live calculation spreadsheets.

Nexant: As noted for #3, the live calculation spreadsheets and calculation tools will be provided as requested. The file name is the following: "IRCx 080 - PPA Calculations_v2.xlsm". There are 7 tabs in the excel file:

- Tab named "CA Profiles Pre and Post": Summarizes the baseline and post installation operating hours, flow, energy demand and energy usage as well as the savings for each of the three types of days: Peak Production, Light Production and Weekend.
- Tab named "Peak Production Data": The peak production period is defined from 8am to 12am during weekdays and the raw data (columns B to K) has been filtered to only show the compressor data during those times. Then, based on the monitored electrical load in kW and the performance specifications from Manufacturer specifications for each compressor, the compressor flow was calculated for each trended kW value (columns L to S).
- Tab named "Light Production Data": The light production period is defined from 12am to 8am during weekdays. The raw data (columns B to K) has been filtered to only show the

[8] Quincy Compressor, "Quincy QSI Series Instruction Manual", Page 58, February 2013.
[9] Kaeser Compressors, "Kaeser's Preventative Maintenance Program"

compressor data during those times. Then, based on the monitored electrical load in kW and the performance specifications from Manufacturer specifications for each compressor, the compressor flow was calculated for each trended kW value (columns L to S).

- Tab named "Weekend Production Data": The weekend production period is defined as the period from midnight on Friday to midnight on Sunday. The raw data (columns B to K) has been filtered to only show the compressor data during those times. Then, based on the monitored electrical load in kW and the performance specifications from Manufacturer specifications for each compressor, the compressor flow was calculated for each trended kW value (columns L to S).
- The "Peak Production", "Light Production" and "Weekend Production" tabs use the PG&E Air Compressor Savings Calculator to calculate the savings for each of the three types of production days.

6. Provide the age and condition of all compressed air system components including air compressors, air dryers, and the air compressor sequencing controller.

Nexant: Table 1 below shows the equipment for the compressed air system, the approximate installation date, and the compressor pad # where the equipment is located.

Compressor #	Mfr.	Model	Date Installed	Pad #
1	Kaeser	DS-140	1995	1
2	Kaeser	DS-140	1995	1
3	Kaeser	DS-140	1995	1
4	Kaeser	DS-140	1995	1
5	Quincy	QSI-750	March, 2014	2
6	Kaeser	DS-200	1996	2
7	Quincy	QSI-1500	2006	3
8	Quincy	QSI-1500	2005	3
Dryers and Filters				
	Dominick Hunter	DRD3000	2009	1
	Dominick Hunter	DRD1600	2008	2
	Dominick Hunter	DRD3000	2008	3
Pressure Flow Controller				
	Unknown		2005	1
Automation Controls				
	Air Science Engineering		2007	all
	Pneu-Logic Add-On Boards		2013	all

A maintenance contract between Quincy Compressor and the customer has been in effect for many years; Quincy Compressor technicians perform light maintenance on compressed air equipment quarterly, with a heavy maintenance site visit one time per year.

7. Provide statement from describing air compressor system component replacement or additions in the past 18 months.

Nexant: This will be provided as requested. The file name is the following: "IRCx 080 - Incentive Application & Statement (for addition or replacements in system).pdf". The statement is in the second page of the document.

8. The project measure and saving analysis must be revised to remove ineligible measures and to use the correct baselines for eligible measures.

Nexant: Per CPUC's guidance in the disposition, the Air Leak measure, 34,959 kWh, 3.4 kW, is removed.

However, Commission staff approved a similar project on January 31, 2014 at the conclusion of Ex Ante review process for the project "PG&E IRCx 034 (X256) Compressed Air System Opt". The measures approved for this project included, no-loss air drains, installation of a new compressed air receiver, pressure flow controller, enhancements of the existing control system and repair of air leaks.

Nexant has provided arguments as to why the correct baselines were used for all measures. In addition, Nexant reviewed literature on best practices for compressed air systems, and searched for current studies that might help in documenting current ISP regarding how facilities operate their compressed air systems and how they operate once they are beyond any initial commissioning periods when they would be expected to hit their target efficiencies. All references highlighted that systems typically operated with no central controls, continue to use timer drains for condensate removal, and minimizing leakage was important in minimizing costs to operate a compressed air system. But we found zero references to systems that could be considered leak-free. A particularly detailed market assessment study from PSE&G [10]noted that of all the participants in the study only 7% regularly checked for leaks, and only 56% of that 7% actually repaired leaks when they were found. One of the conclusions from the study is that the compressed air market for energy efficiency was far from mature.

A second study conducted for the Department of Energy, confirms that only 35% of those interviewed during the assessment confirmed having a leak prevention program. In addition, the primary activity included in the leak prevention program was to only check for leaks near compressors and dryers.[11]

[10] Aspen System Corporation, "Compressed Air System Market Assessment In the Public Service Electric and Gas Service Territory", Page 2.26, July 2003.
[11] U.S. Department of Energy, "Assessment of the Market for Compressed Air Efficiency Services", 2001.

No other studies were found that contradict these types of conclusions from either earlier peer reviewed studies, or more recent journal articles[12], a reasonable conclusion is that ISP is to ignore all but the most obvious compressed air leaks in large industrial systems.

ISP for leaks is to repair those that cause problems with production, are safety issues, or are too obvious to ignore. However, many leaks are not audible, especially in loud industrial environments, and wouldn't be discovered unless the customer started a best practice routine to identify and correct leak issues. Those types of leak ID and repair programs do not appear to be standard practice in any of our literature review, our own experience with customers, nor the experience of the industry professionals we interviewed. Correcting demand side issues with a persistence strategy that helps customers to both achieve and maintain a lower demand from a compressed air system cannot be classified as a simple maintenance issue as demonstrated by the sheer lack of these types of programs in the industry. The approval of the IRCx program five years ago, our success with the program since its inception, and our explicitly targeted types of retrocommissioning opportunities including optimizing entire compressed air systems points out how far from ISP an effective leak ID and repair program actually is, as well as all of the other measures that have been elements of our compressed air project work to date. All of the measures identified for this project as ineligible by Commission Staff, were approved under the IRCx 034 parallel review process by Commission Staff in January 2014, and all of the measures in this project are also eligible under that guidance.

The breakdown of the savings by measure is summarized below:

Description	kWh	kW
No loss air drains	13,363	1.6
Air Leaks	34,959	3.4
Pressure Reduction	129,709	26.5
Controls Enhancement	387,565	74.6
Tune Compressor #4 – associated with controls enhancement as a necessary step; no savings are attributed to this action.		
Totals	**565,596**	**106.1**
Revised Totals (without Air Leaks)	**530,637**	**102.7**

[12] Kaeser Compressors, "Compressed Air System Leaks: The Cost, Common Culprits, Detection and Repair", January 2014.

9. A signed, countersigned and dated application must be provided.

Nexant: This will be provided as requested. The file name is the following: “IRCx 080 - Incentive Application & Statement (for addition or replacements in system).pdf”

10. The PA’s technical review has not been provided. Provide the PA technical review for this project.

Nexant: This will be provided as requested. The file name is the following: “Copy of IRCx-080 Checklist 5-11-15apf3.xlxs”. Summary of comments from technical reviewer are included in Comments section of the checklist.

11. CPUC Staff view the repair of compressed air leaks as normal maintenance, a measure that is ineligible for Program participation. CPUC Staff expect that the PA will advise the customer that compressed air leak repair and a compressed air leak maintenance program are recommended standard practices.

Nexant: Per CPUC’s guidance in the disposition, the Air Leak measure has been removed and the customer will be notified that CPUC considers compressed air leak repair and a compressed air leak maintenance program are recommended standard practices.

In our responses to Item #1, #2, and #8 above, CPUC staff has previously approved energy savings for repair of air leaks through the Ex Ante Review of the project “PG&E IRCx 034 (X256) Compressed Air System Opt”. Keith Rothenberg, representative of the CPUC, visited the facility on March 12, 2013 and along with Nexant, AALD and customer representatives, confirmed that the 16 air leaks had been repaired. The Ex Ante Process and the savings achieved by fixing the 16 air leaks were included in the final disposition for approved energy savings for that project.

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

1. For all future projects, the PA should be diligent in following Commission guidance, seeking clarification where guidance is unclear, and not deviate from guidance without approval from Commission staff.

For this project, replacing the air compressor sequencing controller that is not functioning properly is normal maintenance and replacement of like equipment in order to maintain the intended level of service is not energy efficiency. These are not retro-commissioning measures. Installation of like equipment under the non-regressive baseline rule has no system impact and results in zero gross savings. CPUC staff require that eligible technologies should be more efficient than standard practice and more efficient than existing equipment being removed.

2. For all future projects, the PA should be diligent in assessing measure eligibility, determining the correct project type and establishing the proper baseline.

For this project it appears that the PA has incorrectly classified retrofit measures and maintenance measures as retro-commissioning. The incorrect classification of measures leads to improper baseline selection and ex ante savings estimates that are not in conformance with Commission policy requirements.

3. For future projects, the PA should carefully compile documents for submission to CPUC Staff to ensure that they are complete and concise.

For this project, the PA did not provide live calculation spreadsheets or raw data that were used for the analysis. A signed, countersigned, and dated application has not been provided. Measure EULs have not been provided. The PA technical review has not been provided. Incomplete submissions result in inefficient use of time for both the PA and CPUC Staff.

ATTACHMENTS