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ATTACHMENT

PG&E Advanced Metering Assessment Report

Commissioned by the

California Public Utilities Commission

Prepared and Presented by Structure Consulting Group, LLC.



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September 2, 2010

Ms. Julie Fitch, Director
Energy Division
California Public Utilities Commission

Dear Ms. Fitch:

We are pleased to present our final report, “PG&E Advanced Metering Assessment”, focused on Smart Meter accuracy and Customer High Bill Complaints as contracted for by the California Public Utilities Commission on April1, 2010, and completed on September 2, 2010.

Sincerely,

Stacey Wood
Principal
The Structure Group

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Structure Consulting Group Overview

Structure Consulting Group, LLC ("Structure"), is a global consulting firm focused exclusively on the energy and utility industry, providing services and technology solutions in North America and Europe. Since opening the doors in 1998, Structure has served over 100 organizations through all stages of business transformation, from the beginning of wholesale energy markets to the Smart Grid revolution.

Structure focuses in providing a spectrum of services across business advisory, program management, solution delivery and implementation, and performance improvements and was recognized as the Advisory Firm of the Year 2010 by Energy Risk Magazine.

Structure assists companies in implementing their Smart Grid initiatives through comprehensive strategy development, business case creation and refinement, vendor and system selection, program management, process re-engineering, system implementation, legacy system integration, and testing of components and/or end-to-end solutions.

The Structure workforce is comprised of diverse utility and energy professionals with extensive experience in the energy industry, as well as regulatory program development with NERC, FERC, and other compliance standards.

Structure specializes in key energy industry areas including Smart Grid/Distribution Operations/Distribution Automation, SCADA & Energy Management Systems, Energy Trading & Risk Management, and Competitive Energy Market Solutions.

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Report is considered Final by
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Limitations

In connection with preparing this Report, Structure Consulting Group ("Structure") examined reproductions of documents provided by Pacific Gas & Electric ("PG&E") and the California Public Utilities Commission ("CPUC"). Structure relied upon the completeness and accuracy of all documents and other information requested by and provided to Structure, as well as such other records, agreements, test results, and documents requested from the CPUC and PG&E and deemed necessary or relevant as the basis for our Report. In such examinations, Structure assumed (i) the genuineness of all documents reviewed by Structure, (ii) the conformity of the copies received by Structure to the original documents, and (iii) the authenticity of the original documents. Structure further assumed that each of the parties to the documents and agreements reviewed by Structure had the full power, authority, and legal right under its governing documents, corporate legislation, and applicable laws and regulations to execute and perform its obligations under all documents executed by it. Structure assumed that the documents reviewed by Structure were free from any fraud or misrepresentation and the truth, as were the accuracy of representations and warranties in our interviews with PG&E employees and other representatives. This Report was based solely upon the information received by Structure from the CPUC, PG&E employees, PG&E Customers, PG&E vendors and representatives. Structure assumed that the information received was accurate and complete information and documentation.

Subject to the foregoing, Structure has conducted an independent assessment of the matters that Structure believes to be reasonably necessary to produce this Report. Structure was limited in scope and was not requested nor performed an exhaustive review of all Smart Meter system deployment documentations, configurations, and meter installations. Structure has used its reasonable efforts and impartial assessment to ensure the independence and accuracy of the facts contained in this Report.

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Executive Summary

A. Introduction

Pursuant to California Public Utilities Commission ("CPUC") decisions D.06-07-027 and D.09-03-026, Pacific Gas and Electric ("PG&E") was given approval for full deployment of an Advanced Meter Infrastructure (AMI) Project that included upgrading both metering and communications networks as well as the related computerized systems and software for 5.1 million electric meters and 4.2 million gas meters within the PG&E territory. PG&E's AMI Project, subsequently named the SmartMeter™ Program, initiated meter deployment in 2007. During the first half of 2010, PG&E actively deployed Smart Meters at an average rate of 176,000 gas and electric meters per month. As of June 2010, 3,146,000 electric and 3,101,000 gas Smart Meters had been installed throughout PG&E's service territory.

By the fall of 2009, the CPUC had received over 600 Smart Meter consumer complaints about "unexpectedly high" bills and allegations that the new electric Smart Meters were not accurately recording electric usage, almost all of which were from PG&E's service area. The initial CPUC complaints were supplemented by complaints provided by Senators Dean Florez (D-Shafter) and Roy Ashburn (R-Bakersfield), identified during town hall meetings in Bakersfield and Fresno. In response to these complaints, the CPUC committed to conduct an independent review to determine whether PG&E's Smart Meter system was correctly measuring and billing electric usage.

On April 1, 2010, the CPUC contracted with Structure Consulting Group LLC ("Structure") to provide an independent report related to testing and validating meter and billing accuracy of PG&E's residential electric Smart Meters. The five month evaluation, labeled the PG&E Advanced Metering Assessment Report and hereafter referred to as "The Assessment", culminated in the production of this report, issued on September 2, 2010.

The Assessment focused on addressing residential electric Customer concerns that Smart Meters caused higher energy bills. The Assessment's scope and objective was to independently assess whether PG&E's electric Smart Meter system and related billing system had been measuring and calculating electric usage accurately, and billing PG&E Customers appropriately for their usage. The Assessment included meter testing, end-to-end system testing, an evaluation of high bill complaints, and an evaluation of PG&E's Smart Meter deployment as compared to industry best practices.

Structure segregated The Assessment's scope into the following areas:

Structure's PG&E AMI Assessment Scope	
Area	Focus
Laboratory Meter Testing	Conducted to establish whether the meters used by PG&E tested accurately at a functional level and under normal and extreme environmental conditions.
Field Meter Testing	Involved testing Customer meters at their premises to determine Registration Accuracy within an established tolerance range. Customers were selected to provide a representative cross-section of PG&E's population base, as applicable to the field testing scenarios.
End-to-End System Testing	Comprised of a combination of laboratory and field tests, to determine the effectiveness of PG&E SmartMeter and billing systems' efficacy to capture meter data information.

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Structure's PG&E AMI Assessment Scope	
Area	Focus
High Bill Complaint Analysis	Performed on a subset of the Customers identified as part of the High Bill Complaint population to determine trends in high bills associated with meter type, usage patterns, and billing issues. The Customer base for this analysis was drawn from complaints received by the CPUC, town hall meetings organized by state senators, and PG&E. Customer interviews were conducted from the High Bill Complaint group to evalute the circumstances related to the complaint, PG&E's handling of the complaint, and any associated resolutions.
Best Practices Associated with Smart Meters	Assessed across the energy industry to provide insight into Smart Meter operations compared to PG&E's Smart Meter program.
Security Assessment	Performed a review of PG&E's cyber security framework focused on PG&E's Smart Meter system as part of the evaluation. The review was limited and conducted with a focus on the smart grid system utilizing the applicable sections of the "AMI System Security Requirements" developed by the Smart Grid industry's OpenSG AMI-SEC Task Force. The security assessment was performed to determine whether controls were established and documented around industry-standard criteria.

Figure 1: Structure's PG&E AMI Assessment Scope

Structure performed an impartial and independent evaluation, employing reasonable efforts to complete the engagement work agreed to by the CPUC within a reasonable timeframe, and with the understanding that supporting documentation and information was provided by the CPUC and PG&E on a timely basis.

Throughout the duration of the Assessment, Structure did not share the results or findings of the Assessment with PG&E, with the exception of results for a limited number of field meter tests that showed an out of tolerance or unable to test condition. This limited disclosure to PG&E was done independently of this report to allow PG&E the opportunity to promptly investigate the situation and take any mitigation measure at their discretion to minimize the impact on the Customer. The findings from this study were developed independently of the CPUC and PG&E with regards to previous or current litigation and or regulatory actions. While this report may be utilized by the CPUC to determine future requirements related to Smart Meters and the impact of Smart Meters on Customers, Structure's obligation associated with this evaluation should be considered complete upon delivery of this report to the CPUC. Dissemination of the report and its contents will be at the discretion of the CPUC in accordance with applicable State of California regulations.

This Executive Summary should not be taken stand alone from the entirety of the report, and should be considered a culmination of information, facts, tests, explanations, and limitations described throughout the entirety of the report.

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B. Summary of Key Findings

From April 1, 2010, to August 25, 2010, Structure reviewed relevant documentation related to PG&E's SmartMeter™ equipment, systems, and processes and compared it to industry standards, independently-performed customer interviews, and PG&E-provided vendor specifications and internal documentation. This evaluation principally consisted of an assessment of PG&E's accuracy and conformity to meter standards, analytical procedures applied to customer data, business processes, and practices. Due to the number of systems and process within the PG&E framework, this Assessment reflects Structure's opinion on only the scope of work which Structure was requested to perform.

The CPUC tasked Structure with addressing three broad questions related to PG&E's SmartMeter™ system, focusing on residential electric Customers. Working independently and with the facilitation of the CPUC, Structure's Assessment yielded the following findings related to CPUC's inquiries involving PG&E's residential electric SmartMeters™:

1. Does PG&E's SmartMeter™ system measure and bill electric usage accurately, both now and since PG&E's Smart Meter deployment began?

   PRESENT: While Structure cannot ensure that all issues related to the SmartMeter™ program have been identified or that future issues may not develop at a later date due to process, controls, or technical modifications instituted after the completion of The Assessment, Structure's evaluation provides the reasonable conclusion that PG&E's SmartMeters™ are accurately recording electric usage within acceptable CPUC tolerances, and are being accurately utilized in Customer billing.

   SINCE DEPLOYMENT: Although Structure was unable to test electromechanical and Smart Meters since PG&E's program began, Structure reviewed PG&E's SmartMeter™ program documentation issue logs, incident reports, and analysis of historical customer complaints and did not identify systemic issues in the measuring and billing of electric usage within PG&E's SmartMeter™ system for the deployment period prior to our Assessment beyond those that had already been previously reported to the CPUC. Identified exceptions related to meter and billing issues appeared to have been limited and did not appear to have been prevalent in the overall deployed Smart Meter population.

2. What factors contributed to Smart Meter high bill complaints?

   High bill Customer complaint analysis took the form of scrutinizing PG&E's internal meter data processing activities, reviewing historical data provided by PG&E, and performing Customer interviews related to high bill complaints. Structure's Assessment identified multiple factors that appeared to contribute to the escalation of Smart Meter high bill complaints during late 2009 and early 2010, including:

   - *Customer Usage:*
     - *Meter deployment schedules coincided with increased energy usage caused by a heat wave.*
     - *Some Customers experienced load changes that were reflective of changes in personal circumstances. Examples included room additions, pool additions, and equipment malfunctions.*
     - *Electromechanical meter degradation that was also identified as part of Structure's field meter testing.*
   - *Rates:*

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- *Rate increases compounded the financial impact of the additional weather-related usage, resulting in higher bills that occurred as Smart Meters were being installed.*
- *Incorrectly applied rates that were based upon historical premise assumptions.*
- *Rate-based inquires that increased as Customer bills escalated. Requests for new or renewed financial assistance through California Alternate Rates for Energy (CARE) were identified as potential reductions of financial impacts related to higher bills.*

- *Customer Service:*
  - *PG&E processes did not address the Customer concerns associated with the new equipment and usage changes.*
  - *Customer skepticism regarding the new advanced meter technology was not effectively addressed by PG&E on a timely basis.*
  - *Customers interviewed during this assessment did not consider their complaint resolved, despite indications from PG&E and CPUC that the Customer agreed with the resolution*
  - *PG&E Customer complaint resolution did not provide of interval read information available with Smart Meters, which may have assisted Customers' understanding of hourly usage patterns.*
- *Process Issues:*
  - *Customers indicated that communications/notifications surrounding physical meter installation were lacking, or that the Customer had issues with the installation personnel.*
  - *PG&E utilized field meter readers for an average of 131 days after Smart Meters were installed, resulting in similar meter reading errors as electromechanical meters. The transition to automate the Smart Meter data for use in billing was not clearly addressed with Customers.*
  - *PG&E's system tolerances related to billing quality control were not stringent enough, resulting in multiple bill cancelations and re-billings, which were confusing to Customers.*

3. *How does PG&E's SmartMeter™ Program's past and current operational and deployment compare against the framework of industry best practices?*

   Structure found PG&E to have been historically in compliance, or have recently come into compliance, with the majority of Best Practices Associated with Smart Meters. Structure identified several items of partial or non-compliance related to industry best practices during The Assessment, which have been recognized by PG&E through their presentations of information as shortcomings to be addressed:

   a. *The lack of documentation verifying compliance with the Meter Deployment best practice to deploy WAN/LAN collectors prior to meter deployment.*
      i. *By not deploying the communication backbone prior to meter deployment, the time to transition meter reading from manual to Advanced Metering Infrastructure (AMI) system readings is exacerbated, extending to an average of 131 days over the implementation period. This allows a continuation of the higher error rate associated with manual meter reading, and may contribute to the perception that the Smart Meters are inaccurate.*
   b. *The inability to verify compliance around:*

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i. *The Meter Data Managements (MDMS)Interface best practice to correlate AMI meter events and alarms with Validation, Estimating and Editing (VEE) and Customer Information System (CIS) audits and checks for automated exception handling; and*
ii. *The VEE Best Practice of MDMS must provide an on-line method, with workflow, resolving validation errors rather than reports.*

These lapses have created a situation where data required manual editing, causing cancel/re-bills and delayed processing of Customer data in a relatively small portion of the bills processed. The cancel/re-bills and delayed processing potentially increased the days within a billing cycle presented in Customer's bills, as reflected in a portion of the High Bill complaints, and furthered Customer perception that Smart Meters may not have been accurate.

Based upon Structure's review of requested PG&E documentation and Structure's associated testing, Structure determined that previously-identified issues brought to CPUC's attention were being appropriately addressed by PG&E. Structure's testing did not uncover issues that would challenge that PG&E's Smart Meters were accurately measuring and recording electric usage, or that PG&E's internal systems were accurately utilizing this data for billing purposes. Structure identified no relevant correlation between installed Smart Meters, impacts to billing on installed Smart Meters, and residential Customer Smart Meter high bill complaints. Structure did identify certain events and circumstances, including sub-optimal Customer service and variable implementations of industry best practices that contributed to the increase in Smart Meter high bill complaints. The concerns uncovered should be addressed, but did not appear to be related to the ability of PG&E's Smart Meter System to measure and bill electric usage correctly.

Overall, Structure found that the AMI technology deployed by PG&E appears to be 1) consistent with industry standards, based upon the goals of the AMI implementation and upgrades approved by the CPUC, and 2) accurate from a metering and billing perspective. Structure identified gaps in Customer services and processes related to high bill complaints, and determined certain PG&E practices to be partially non-compliant relative to industry best practices.

The following Figure provides a high-level summary of Structure's findings for each of the PG&E AMI Assessment's areas of focus.

Structure's PG&E AMI Assessment Findings Summary	
Area	**Finding**
Laboratory Meter Testing	All of the Smart Meters tested in Structure's independent laboratory passed the accuracy testing. The Smart Meters subjected to environmental stress testing in a controlled temperature chamber at reference, high, and low temperatures all fell within the American National Standards Institute (ANSI) standards.

Structure's PG&E AMI Assessment Findings Summary	
Area	**Finding**
Field Meter Testing	• Structure's Pass/Fail Criteria was based upon the CPUC Standard of ±2.0% for electromechanical meters and Smart Meters. • Of the 613 Smart Meter field tests, 611 meters were successfully tested and 100% passed Average Registration Accuracy. One meter was found to have serious errors and be malfunctioning on arrival, and one was found to have serious event errors upon installation; these meters were therefore excluded from testing. • Of the 147 completed electromechanical meter field tests, 141 meters passed and 6 failed Average Registration Accuracy. One meter was found to be non-functional, registering zero on all tests, and was therefore excluded from testing.
End-to-End System Testing	By utilizing a representative, small sample size to confirm meter-to-bill system accuracy, Structure did not identify deviations during testing that indicated a systemic problem in the meter billing system's accuracy.
High Bill Complaint Analysis	After reviewing and analyzing over 1,378 High Bill complaints, Structure did not identify pervasive issues with meter data or billing systems. Results from 20 High Bill Complaint Customer interviews identified service issues around complaint management by PG&E and the CPUC.
Best Practices Associated with Smart Meters	Structure found PG&E to have been historically in compliance, or have recently come into compliance, with the majority of industry best practices associated with Smart Meters. Structure identified several items of some concern during the Assessment, which have been recognized by PG&E, through their presentation of information, as shortcomings to be addressed.
Security Assessment	Structure concluded that PG&E has developed a cyber security framework that meets the objectives established in the Smart Grid industry's OpenSG AMI-SEC Task Force "AMI System Security Requirements" that were reviewed as part of this evaluation.

Figure 2: Structure's PG&E AMI Assessment Findings Summary

C. Work Scope

Structure's evaluation focused primarily on evaluating meter accuracy and advanced metering system capabilities to accurately determine and bill Customer electric usage for PG&E's residential electric Smart Meter installations. Structure also evaluated PG&E's Smart Meter system deployment current and historical business practices against industry best practices and standards and assessed PG&E's AMI security framework. The Assessment also included addressing the influx of high bill complaints that were perceived by Customers as being Smart Meter-related. Historical meter accuracy and associated meter replacement firmware upgrades were not tested as part of the scope of this engagement, as Structure was not able to evaluate the meters at the time that those complaints were initiated.

During project planning and initiation, PG&E provided a system overview that included previous meter testing performed, meter reading and billing transition scheduling, and high bill complaints received. Based upon the overview provided, Structure consulted with the CPUC to increase the meter accuracy testing and associated Customer complaint analysis on PG&E's electric Customers as part of The Assessment. Structure worked with the CPUC to modify the project scope to better evaluate PG&E's AMI systems based upon data availability, budget constraints, and the available timeframe. Some scope modifications resulted from additional efforts required to complete the proposed work, as discussed in the Scope of Work section of this report.

During the course of The Assessment that spanned April to August of 2010, Structure independently tested over 750 Smart Meters and 147 electromechanical meters. Structure also reviewed the 1,378 electric Smart Meter Customer accounts from a PG&E provided list of 2,915 Smart Meter electric and gas high bill-based complaints. Structure requested that PG&E provide a detailed explanation of 73 accounts where Structure identified billing data anomalies that could not be attributed to the Customer's usage profile. Structure also attempted to contact over 100 of the high-bill complaint Customers, resulting in 20 high-bill complaint phone interviews. Structure reviewed the accounts of each of the interviews with PG&E's complaint resolution team for further analysis.

Throughout the evaluation, less than a 1,000 pages of double sided hard-copy sheets were transmitted in consideration of California's green initiatives. Approximately 6GB of zipped compressed data in the form of 1,600 documents was provided by PG&E, which contained approximately 27,000 pages or slides and 2,000 worksheets. Structure electronically pulled 2.4 million sample Customer stratifications from over 5.2 million Customer meter locations.

During the course of the project, Structure reviewed manufacturer specifications, procedures, and relevant data associated with meter manufacturers, communication network, and meter data management and billing systems. Structure also held interviews with PG&E vendors and performed site visits to PG&E and vendor facilities to observe processes and procedures. Detailed methodology, procedures, test results, and identified issues can be found in the appropriate sections of this Assessment.

Structure's work included meetings and interviews with PG&E resources and subject matter experts and Customers to obtain insight and information relevant to our evaluation. Structure also maintained a call center associated with the field meter testing that allowed Customers to address questions associated with the evaluation meter testing. In addition, a meeting was held with the TURN consumer advocacy group at their request. As part of the assessment, Structure reviewed documents and held over numerous interviews with PG&E personnel, focused on process and methodology. Additional time was spent with PG&E security personnel to conduct the security assessment.

The number of meter tests and customer interviews performed was based upon cost/benefit analysis conducted by Structure in conjunction with the CPUC at various points throughout the project. The sample

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sizes selected were determined to provide a reasonable representation of the PG&E meter and high bill complaint populations based upon the CPUC-requested scope of work.

The project scope was divided into the following areas:

- Laboratory Meter Testing
- Field Meter Testing
- End-to-End System Testing
- High Bill Complaint Analysis
- Best Practices Associated with Smart Meters
- Security Assessment

From the initial RFP response throughout the project, Structure contracted for the services of Trimark Associates ("Trimark"). Trimark's credentials included certification as a Meter Service Provider (MSP) in California by the CPUC. Trimark has provided metering and meter data management services for over nine years within California and throughout North America. The synergy between the two companies allowed Structure to utilize Trimark as a dedicated contractor to perform the meter-based field and laboratory testing defined throughout this report. As the sole contractor to Structure for this Assessment, further reference to Trimark work within this report may be included under the Structure reference.

The following sections provide scope overviews associated with each of the key project areas.

C.1 Laboratory Meter Testing

Laboratory meter testing was performed in a qualified, non-PG&E laboratory located within the PG&E territory and overseen by Structure resources. Structure verified meter accuracy and factory programming laboratory tests on a representative meter sample set obtained from PG&E's warehouse facilities. Structure allocated a portion of the sample set meters for end-to-end and environmental testing, and the remainder for installation at residential Customer premises.

Structure utilized a subset of the PG&E warehouse randomly selected meters to perform environmental testing in the laboratory, where the meters were subjected to temperature-based stress tests. An additional set of meters were used for end-to-end system testing to monitor meter activity from installation through billing. The tests are highlighted in the following Figure, Summary of Structure's Test Scenarios, Scenarios 1 and 2.

Summary of Structure's Test Scenarios		
Location of Test	**Scenario**	**Description**
Laboratory	Scenario 1	Environmental and End-to-End Smart Meter Laboratory Test
Laboratory	Scenario 2	Warehouse Stock Smart Meter Accuracy Laboratory Test
Field	Scenario 3	Electromechanical Meter Test & Smart Meter Field Replacement
Field	Scenario 4	Non-High Bill Complaint Smart Meter Field Test
Field	Scenario 5	High Bill Complaint Smart Meter Field Test
Field	Scenario 6	High Bill Complaint Shadow Meter Field Test
Field	Scenario 7	Non-High Bill Complaint Electromechanical Meter Field Test
Field	Scenario 8	High Bill Complaint PG&E Installed Shadow Meter Test Verification

Figure 3: Summary of Structure's Test Scenarios

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The laboratory and field test scenarios were developed as a representative set of tests normally used by utility companies to determine compliance to Public Utility Commission accuracy standards based on ANSI Standard C12.20.

C.2 Field Meter Testing

The Assessment's field meter testing utilized the Standards for Meter Installation, Maintenance, Testing and Calibration as set forth in the Direct Access Standards for Metering and Meter Data (DASMMD) and American National Standards Institute (ANSI) standards to verify the accuracy associated with PG&E's Smart Meters. Structure also performed field testing on a sample of electromechanical meters installed at electric residential Customer locations in order to confirm meter accuracy. The guidelines for testing were based on DASMMD standards that were established in 1998, which provided for electromechanical meters and did not include updates applicable to Smart Meter systems. Meter accuracy was monitored based upon the DASMMD requirements. Based upon discussion with CPUC, the DASMMD standards were the established regulatory guidelines to be followed. The PG&E and manufacturer comparisons were utilized for reference purposes only.

Field meter testing was conducted using six scenarios that were identified by Structure to test both the electromechanical and Smart Meters in the field and evaluate both the accuracy of Customers' electromechanical and Smart Meters and the associated procedures. The conducted tests are summarized in Figure 3, Scenario 3 through Scenario 8. Customers whose meters were selected for testing were contacted by mail and/or by a Structure representative to describe the process and test coordination.

Each of the field testing scenarios was conducted by Structure and accompanied by PG&E's meter technicians, and followed industry-standard established procedures as described in this report and associated documentation. All meter testing was performed by Structure technicians for Scenarios 3-7; in Scenario 8, Structure observed PG&E's field processes for shadow meter tests. The field meter testing included:

- Site verification
- Meter type and form factor verification
- Proper installation
- Meter program and accuracy verification

Field-based testing focused on residential meters; thus, testing of commercial meters was excluded from the scope and the test scenarios.

C.3 End-to-End System Testing

End-to-End System Testing included both laboratory and field testing.

End-to-End laboratory testing was performed on five PG&E Smart meters, with five Elster™ digital meters used as "shadow" meters. Each of these meter pairs were subjected to a different amount of load, reflecting measurement at various rate tiers over the test period. In addition, the end-to-end "shadow" meters were also subjected to common exceptions to normal conditions, including power outages, voltage swells, voltage sags, and loss of Radio Frequency reception. Inclusion of common exceptions facilitated testing PG&E's capability to perform validation, editing, and estimation (VEE) processes in compliance with CPUC rules, and without introducing errors into Customer bills.

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"Proxy" Customer accounts were created within PG&E's billing system for each of the end-to-end meters, giving Structure the ability to determine PG&E's application of billing determinants and rate assignments, as well as the accuracy and the timeliness of physical bill issuance to residential electric Customers. The end-to-end test process was designed for completion over the course of one PG&E billing cycle.

End-to-End field testing utilized the field testing shadow meter installations for selected High Bill Complaint Customers as part of field meter testing Scenario 6. The field testing shadow meter setup used the existing installed PG&E Smart Meter and an Elster digital shadow meter installed side-by-side to measure the Customer's usage simultaneously through both meters. Structure also utilized these same installations to verify the flow of meter usage and event data from the Customer premise, through the AMI and Billing systems, to the Customer's receipt of the printed bill.

A PG&E-provided representation of PG&E's metering and billing system connectivity is found in the Figure below. The information tested in end-to-end system testing was processed through these systems.

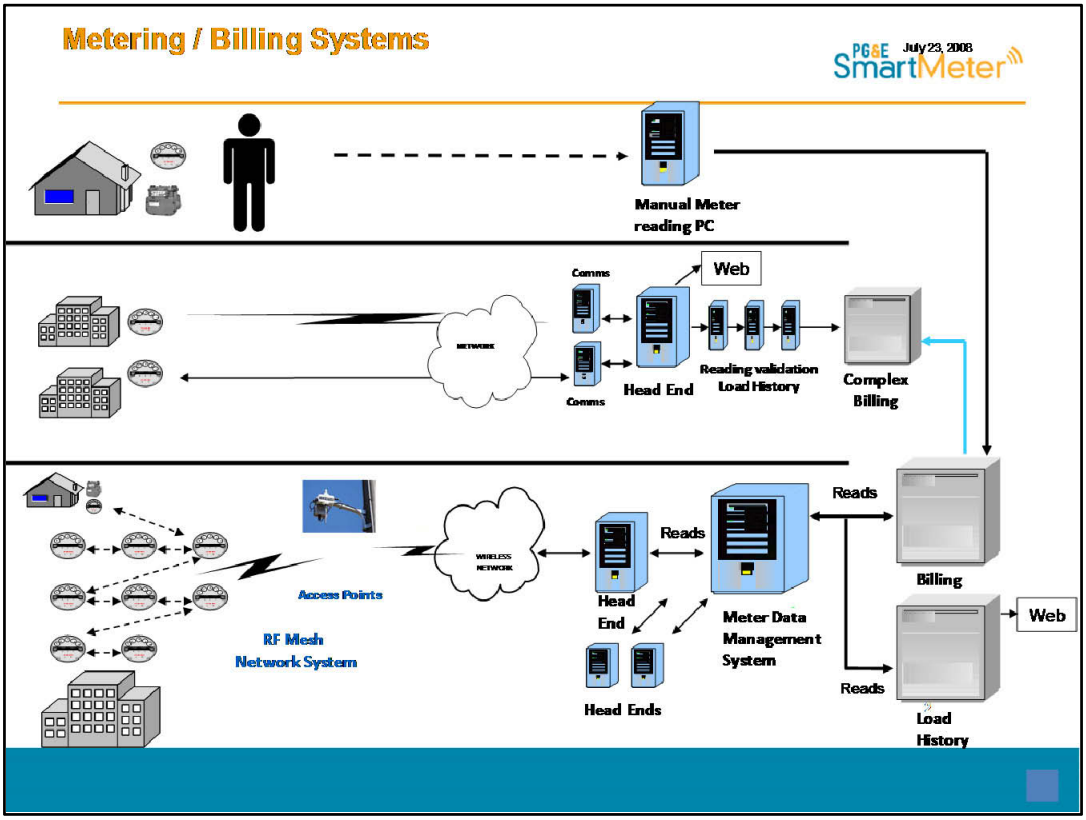


Figure 4: PG&E-Provided Representation of PG&E's Metering/Billing Systems Connectivity

C.4 High Bill Complaint Analysis

To perform the High Bill Complaint Analysis, Structure examined the entire population of 1,378 Smart Meter electric high bill complaints consisting of those officially filed with the CPUC, those provided by the office of Senate Majority Leader Dean Florez (D-Shafter), and Smart Meter High Bill Complaints specifically identified

and provided by PG&E for the period September 17, 2007 to April 30, 2010. Structure further refined the High Bill complaint list to focus on determining the underlying nature of the complaint by utilizing account information and reviewing detailed historical usage for 1,066 of the Customer complaint accounts with available historical usage data specifically related to residential electric Smart Meters. The detailed analysis of 1,066 accounts was done by evaluating the High Bill Complaint Customers' usage patterns and account specific information prior to and after Smart Meter installation to identify impacts of weather, extended bill cycles, cancel/re-bills, estimated meter reads, and usage spikes on Customer complaints.

A targeted selection of 73 Customer complaints was chosen based on account activity that suggested the potential for identifying underlying system or process issues, and was further analyzed to identify contributing factors for the complaints. The analysis on the 73 complaints included a detailed review of complaint resolution documentation, usage analysis, complaint history, account history, and Customer Service and Customer interaction notes. Structure utilized the 73 complaints reviewed and an additional 27 complaints with similar profiles to contact Customers for potential interviews. Of the 100 potential Customer interview participants, 20 agreed to participate in one-on-one interviews focused on documenting Customer rationale when initiating the complaint process, the Customer's experiences, premise conditions, energy usage, and the Customer's insight into the subsequent PG&E resolution process. Structure followed the 20 Customer interviews with an examination of each of their accounts with the PG&E Escalated Complaints team, to better understand the PG&E processes followed and the PG&E outcome of the Customer complaint.

Structure also specifically reviewed Customer usage and resolution status associated with 231 of 300 Bakersfield and Fresno electric Smart Meter town hall complaints, including the underlying analysis performed by PG&E and the associated resolution process for these accounts.

C.5 Best Practices Associated with Smart Meters

To evaluate Best Practices, Structure reviewed PG&E's documentation of past and current operational and deployment policies, processes, and procedures against a framework of industry best practices. The framework was developed by Structure subject matter experts with combined electric and gas field, operations, and billing experience of over 75 years, and presented to three independent Smart Meter industry experts for review and input. Structure compiled the contributions of these experts, applied it to the framework, and compared PG&E's policies, processes, and procedures against the established framework.

The Best Practices work included review of eight key areas associated with Smart Meters:

- Meter manufacturing quality control
- Meter installation standards
- Meter equipment safety
- Meter deployment
- Meter Data Management interfaces
- Validating, Estimating and Editing for monthly and interval data
- Account billing
- High bill complaint troubleshooting

The Best Practice analysis also identified business process improvements initiated by PG&E since January 2010 to enhance meter accuracy and increase customer satisfaction. Inclusion of the improvements was intended to document PG&E's efforts to align with industry Best Practices associated with Smart Meters.

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Best Practices included in this report are reflective of the current industry environment for the areas addressed, as provided by Structure and industry experts retained by Structure. The views and opinions expressed in The Assessment may not reflect the views or opinions of all industry experts, and may change as Smart Meter systems continue to mature.

C.6 Security Assessment

Structure performed a review of PG&E's cyber security framework focused on the smart grid system as part of The Assessment. The review was limited based on priority, time, and budget, and was conducted with a focus on the smart grid system, utilizing the applicable sections of the "AMI System Security Requirements" developed by the Smart Grid industry's OpenSG AMI-SEC Task Force. The security assessment was performed to provide a confirmation that controls were established and documented around:

- Corporate Cyber Security Approach
- Confidentiality and Privacy
- Data and System Integrity
- System Availability
- Identification and Authentication of Users
- Authorization of Users
- Accounting and Non-Repudiation
- Anomaly Detection Services
- Boundary Services and Interfaces
- Cryptographic Services
- Resource Management Services
- Development Rigor
- Organization Rigor
- Handling and Operating Rigor
- Accountability

Per The Assessment's scope, Structure utilized several methods to perform the review, including interviews and documentation reviews of PG&E policies and procedures, referred to as a "paper" review of PG&E's security framework. The review included interviews with key PG&E personnel tasked with managing security, inspection of relevant PG&E documents, and review of third-party audit reports where applicable and available. The information obtained through these methods was then compared against the applicable sections of the "AMI System Security Requirements" standards developed by the Smart Grid industry's OpenSG AMI-SEC Task Force. A comparison to cyber security "best practices" was also performed.

An in-depth qualitative assessment of PG&E's framework implementation was beyond the scope of this Assessment. An evaluation of this nature would have taken several months to evaluate each major sub-system within the Smart Grid system, as well as additional time to evaluate the implementation within PG&E's security framework. An in-depth review would involve reviewing firewall rules, system configurations, user permissions, training, background checks, etc.

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D. Detailed Summary of Observations and Findings

The following summary of Structure's findings reflects the results of The Assessment's testing and analysis. Structure found the summarized results to be representative of the overall PG&E AMI program; however, due to the accelerated nature of the engagement, Structure's Assessment was limited its ability to express an opinion on all of the AMI processes and procedures used at PG&E. Accordingly, the results should be taken in the context of the data reviewed.

D.1 Laboratory Meter Testing

D.1.1 Laboratory Meter Testing Findings Summary

Structure utilized a laboratory testing facility that was independent from PG&E to conduct tests for meter accuracy, environmental stresses, and end-to-end system functionality. Structure selected 174 Smart Meters from PG&E's warehouses using a randomized selection process based on representative vendor and meter type criteria, and then tested the meters for accuracy in the independent laboratory. All of the tested Smart Meters passed the accuracy testing. Structure then utilized a portion of the selected Smart Meters for environmental stress testing, and found all of the meters to fall within the American National Standards Institute (ANSI) standards when tested in a controlled temperature chamber at reference, high, and low temperatures.

D.1.2 Laboratory Meter Testing Findings Details

Structure set aside 18 of the 174 meters selected from the warehouses as "spares", and conducted laboratory-based accuracy tests on the remaining 156 stock PG&E Smart Meters selected from the five randomly selected PG&E warehouses. The sample set consisted of a range of meter types and meter manufacturers representing a representative sample of meters available in the PG&E in-stock inventory, which were procured using a random meter selection methodology.

The Results of the Laboratory Accuracy Tests were:

- 100% of the 156 PG&E stock Smart Meters tested were within an accuracy range of 99.81% to 100.15%, with an average accuracy of 100.01% and a standard deviation of 0.0408%.
- The meters passed the ±0.2% acceptable accuracy standard established by the meter manufacturer, which also satisfied the CPUC accuracy requirement of ±2.0%.

Following an initial test to verify the accuracy of the meters at full load, light load, and with a 50% power factor in accordance with ANSI standards, a subset of these meters were used in Structure's laboratory and field test scenarios.

Environmental testing consisted of subjecting six of the PG&E Smart Meters to extreme hot and cold conditions in a controlled environmental chamber designed to accurately replicate these conditions in accordance with ANSI C12.20 specifications. The meters were placed into the environmental chamber for 24 hours and allowed to reach "equilibrium". The temperature was then adjusted, and the test performed.

The summary findings from the Environmental Laboratory Meter Tests were:

- When subjected to +50 degrees Celsius (+122 degrees Fahrenheit) for 24 hours, all of the meters tested within the ±2% CPUC standard; however, one out of the six meters did not conform to the ANSI C12.20 maximum deviation of ±0.5% from reference test temperature standard used by the meter

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manufacturer. The non-conforming meter exceeded the allowed 0.5% deviation by 0.07% during the full load test. The non-conforming meter's deviation was slightly out of tolerance on the Full Load and Light Load test, but the meter passed the CPUC standard for accuracy when adjusted for Average Meter Registration Accuracy (Full Load Test + Light Load Test)/2.

- When subjected to -20 degrees Celsius (-4 degrees Fahrenheit) for 24 hours, all of the meters tested within the PG&E and CPUC criteria of ±0.5% and ±2%, respectively. All of the meters passed the ANSI C12.20 maximum deviation of ±0.5% from the reference test temperature standard used by the meter manufacturer.

D.2 Field Meter Testing

D.2.1 Field Meter Testing Findings Summary

Structure conducted field tests on 797 meters using defined procedures and protocols for each of the following six scenarios:

- Scenario 3: Electromechanical Meter Test and Smart Meter Field Replacement
- Scenario 4: Non-High Bill Complaint Smart Meter Field Test
- Scenario 5: High Bill Complaint Smart Meter Field Test
- Scenario 6: High Bill Complaint Shadow Meter Field Test
- Scenario 7: Non-High Bill Complaint Electromechanical Meter Field Test
- Scenario 8: High Bill Complaint PG&E-Installed Shadow Meter Test Verification

Structure's field tests measured accuracy of the meters at full load, light load, and with an applied power factor. The results were tracked to acceptance levels for the CPUC (±2% for both Smart Meters and electromechanical meters), PG&E (±0.5% for Smart Meters, ±2% for electromechanical meters), and the manufacturer (±0.2% for Smart Meters, ±2% for electromechanical meters). Structure's Pass/Fail criterion used in this report was based upon the CPUC standard of ±2.0% for electromechanical meters and Smart Meters.

Structure attempted 897 field meter tests and completed 797 field meter tests, including both Smart Meters and electromechanical meters. Structure was unable to complete the remaining 100 meters due to normal reasons, such as meter banks on apartment buildings preventing the installation of the dual socket required for testing and meters locations that required extension ladders for access. Overall, a statistically valid, randomized sample of Smart Meters representing the entire installed base of Smart Meters in the P&GE territory was found to pass accuracy reading. Using the CPUC pass/fail criterion of ±2.0%, 611 of the 613 Smart Meter field tests were completed, with 100% passing CPUC registration accuracy readings. Two Smart Meters were found to have serious errors and be malfunctioning. One meter was found to have serious errors and be malfunctioning on arrival, and one was found to have serious event errors upon installation; these meters were therefore excluded from testing. The Average Registration Accuracy of the 611 meters tested was 100.067%, with a Standard Deviation of 0.271%. Of the 147 completed electromechanical meter field tests, 141 meters, or 95.92%, passed and 6, or 4.08%, failed accuracy readings.

Structure identified one meter that was registering a zero read during the field meter testing. After further examination of PG&E's issue logs, the error was identified as a "data storage" issue. These data storage issues had been identified by PG&E in 12,735 meters as of May 2010, potentially resulting in a subset of Customers receiving zero usage or lower estimated bills. Data storage issues are one type of exception disclosed by PG&E, and may include:

- Negative intervals

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- Large intervals
- Zero table
- Negative register readings
- Table resets

Structure noted that these data storage issues were identified in early October 2009, with replacements starting in May 2010. These errors were disclosed to the public and to the CPUC in May 2010. PG&E subsequently initiated processes to address these issues in a timely and effective manner. As of July 2010, the outstanding data storage issues had been reduced to 1,526 meters.

The following Figure illustrates the number of meters that passed and failed the accuracy test for all of the Structure Field Meter Testing Scenarios, delineated by electromechanical meter tests in blue, and Smart Meter tests in yellow. The field testing scenarios were referred to as "High Bill Complaint" and "Non-High Bill Complaint" populations. The High Bill Complaint population was derived from complaints received directly by the CPUC or PG&E and those received at the town hall meetings organized by state senators. Non-High Bill Complaint refers to Customers who had not filed a high bill complaint through one of these channels.

Pass/Fail Results of Structure Field Meter Accuracy Tests by Scenario			
Scenario	**Total Meters**	**Pass**	**Fail**
3: Replace Electromechanical Meter with Smart Meter – Electromechanical Meter Test	47	41	6
3: Replace Electromechanical Meter with Smart Meter – Smart Meter Test	44	44	0
4: Smart Meters (Non-Complaint)	531	531	0
5: Smart Meters (High Bill Complaint)	36	36	0
6: Shadow Meters (High Bill Complaint, Structure)	*19*	*N/A-S*	*N/A-S*
7: Test Electromechanical Meter	100	100	0
8: Shadow Meters (High Bill Complaint, Structure-PG&E)	*18*	*N/A-S*	*N/A-S*
Total of all Field-Tested Meters	**795**	752	6
Total - Smart Meters	**611**	611	0
Total - Electromechanical Meters	**147**	141	6
Percentage of Total Smart Meters Tested	**-**	**100.00%**	**0.00%**
Percentage of Total Electromechanical Meters Tested	**-**	**95.92%**	**4.08%**

Figure 5: Structure's Field Meter Testing Pass/Fail Accuracy Results by Field Test Scenario

N/A–S: Not Applicable–Shadow Meter

Of the 613 completed Smart Meter field tests, 611 meters were successfully tested and 100% passed Average Registration Accuracy. One meter was found to have serious errors and be malfunctioning on arrival, and one was found to have serious event errors upon installation; these meters were therefore excluded from testing.

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D.2.2 Field Meter Testing Findings Details

A description of Structure's field testing scenarios and summary of the scenario-based testing results are presented in the following Figure. The field testing scenarios were referred to as "High Bill Complaint" and "Non-High Bill Complaint" populations. The High Bill Complaint population was derived from complaints received directly by the CPUC or PG&E and those received at the town hall meetings organized by state senators. Non-High Bill Complaint refers to Customers who had not filed a high bill complaint through one of these channels. Average registration accuracy is calculated using the equation (Light Load Test + Full Load Test)/2 and refers to the average accuracy of a "register," which maintains a measure of the total power consumption that passed through the meter over time.

Each of the following scenarios was performed independently of each other, and involved a unique Customer premise.

Structure Field Testing Scenarios and Results			
Scenario	**Description**	**Synopsis**	**Results**

Structure Field Testing Scenarios and Results			
Scenario	**Description**	**Synopsis**	**Results**
Scenario 3	Electromechanical Meter Test & Smart Meter Field Replacement	Structure used a representative sample of 50 Customers that were scheduled to have their electromechanical meter replaced by PG&E. The electromechanical meters were removed and accuracy tested in the field at full load, light load, and 50% power factor. A laboratory-tested Smart Meter was then accuracy-tested in the field before being installed in the Customer's premise. The results of each of these tests were recorded by the Structure contractor. 47 successful electromechanical meter tests and 44 successful Smart Meter tests were conducted for this Scenario. The difference in number of electromechanical tests and Smart Meter tests was due to 6 electromechanical meters that failed. These meters subsequently did not receive a Smart Meter installation at the time of the test; therefore, Structure did not conduct a Smart Meter test at that premise.	• One Smart Meter was found to have a serious event error and be malfunctioning upon installation, and was therefore excluded from testing. • 100% of the 44 tested Smart Meters used for this scenario passed CPUC's accuracy testing acceptance standard of ±2.0% in the field test. • Field test results of 44 of the previously laboratory-tested Smart Meters indicated an Average Registration Accuracy of 100.27% during the field tests with a standard deviation of 0.112%. • One electromechanical meter was not found to be functional, registering zero on all tests; and was therefore excluded from testing. • 41 of 47 tested electromechanical meters passed the CPUC's accuracy testing standard of ±2.0% in the field test. • Six of the 47 tested electromechanical meters failed the CPUC Accuracy Standard of ±2.0%, with one failing the Full Load and Power Factor tests, one failing the Light Load test, one failing the Power Factor test, and three meters failing the Light Load and Power Factor standard tests. • Two of the six electromechanical meter failures failed the Average Registration Accuracy standard. All field-tested electromechanical meters that were replaced with Smart Meters were returned to PG&E with an indication of whether or not they passed the field test. • The 47 tested electromechanical meters had an Average Registration Accuracy of 99.556%, with a Standard Deviation of 1.343% for the successful tests.

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Structure Field Testing Scenarios and Results			
Scenario	**Description**	**Synopsis**	**Results**
Scenario 4	Non-High Bill Complaint Smart Meter Field Test	A representative sample of 532 Smart Meters was chosen from the population of PG&E Customers where a Smart Meter had previously been installed by PG&E and the Customers were not in the High Bill Complaint list. These meters were removed from the Customer's meter socket and placed in a calibrated field test set on-site at the Customer's premise, where the meters were then accuracy-tested at full load, light load and a 50% power factor. In addition, the existing internal meter program was verified to confirm proper functionality.	• One Smart Meter (of the 532) was found to have a serious event error and was malfunctioning, and was thus excluded from testing. The communication module on this device was functional and had been reporting zero usage for almost six months. • 100% of the 531 tested meters tested within the CPUC accuracy standard of ±2.0%.Average Registration Accuracy ranged from 98.345 % to 100.78% with an average of 100.075% and a standard deviation of 0.275%.
Scenario 5	High Bill Complaint Smart Meter Field Test	Structure selected 50 Smart Meter installations from the High Bill Complaint population to verify that the meter was properly installed and to field test the registration accuracy of the installed Smart Meter. 36 Smart Meter tests were conducted for this Scenario. At each location, the Smart Meter was removed and installed in a calibrated field test set, where the meter was accuracy tested at full load, light load and a 50% power factor. In addition, the existing internal meter program was verified as functioning properly.	• All 36 Smart Meters tested passed the CPUC acceptance standard of ±2.0%. • The Average Registration Accuracy for the Scenario 5 meters was 100.004%, with a Standard Deviation of 0.351%.
Scenario 6	High Bill Complaint Shadow Meter Field Test	Structure selected 20 locations from the High Bill Complaint population to install a Field Shadow Meter setup, and completed tests at 19 locations. The Field Shadow meter setup consisted of the existing installed PG&E Smart Meter and an Elster digital Shadow meter installed side-by-side to measure the Customer's usage simultaneously through both meters. These meters were used to establish the accuracy of the Customer meters already installed by performing a weekly accuracy check and comparing the readings from the two meters. In addition to verifying Smart Meter accuracy, these installations were also used to verify the end-to-end accuracy thru the PG&E AMI system to the customer bill.	• The results of the 19 shadow meter tests showed that the shadow meter reads were in concert with the Smart Meter reads. • The bills from both the lab-tested shadow meters and the field-tested shadow meters matched the expected results from manual bill calculations. • Structure encountered four unauthorized PG&E meter swaps/meter tests during the execution of this scenario, as noted in the "Unauthorized PG&E Meter Swaps" section of this report, and in Appendix F: Unauthorized Scenario 6 Meter Swaps Exhibitions. These meters were subsequently not tested by Structure in the field, but were retrieved from PG&E and evaluated in the laboratory with no noted issues. Structure selected additional accounts to test in lieu of the meters excluded from test sample due to the unauthorized meter swap.

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Structure Field Testing Scenarios and Results			
Scenario	**Description**	**Synopsis**	**Results**
Scenario 7	Non-High Bill Complaint Electromechanical Meter Field Test	Structure used a representative sample of 100 installed PG&E electromechanical meters to verify the accuracy of these meters in the field. The meters were removed from the customer installation and placed in a calibrated field test set to verify their accuracy at full load, light load, and at a 50% power factor.	• Scenario 7's test included 100 installed PG&E electromechanical meters, with no failures on the CPUC Standard of ± 2.0%. • The 100 meters had an Average Meter Registration Accuracy of 99.798% with a Standard Deviation of 0.528%. • The minimum Registration across all tests (Full Load, Power Factor, and Light Load) was 98.1%, and the maximum registration across all tests was 101.95%.
Scenario 8	High Bill Complaint PG&E Installed Shadow Meter Test Verification	Structure accompanied PG&E Meter personnel during the installation of 18 shadow meter tests performed by PG&E. These installations consisted of the installation of a side-by-side electromechanical meter and Smart Meter at the site of Structure-selected High Bill Complaint Customer's premises. Structure reviewed PG&E's installation practices to determine if they were in line with documented installation, testing and meter reading procedures and to determine if PG&E followed their documented practices and procedures.	• Of the 27 meters selected for Scenario 8, 18 were successfully completed with no identified deviations, and nine were unable to be completed due to premise restrictions and meter installation routing schedules. • In all test cases, PG&E complied with internally documented practices and procedures for the shadow test verification.

Figure 6: Structure's Field Meter Testing Summary of Results

D.3 End-to-End System Testing

D.3.1 End-to-End System Testing Findings Summary

End-to-end system testing was used to verify the accuracy of the PG&E Smart Meters, data communications and associated systems, estimation routines, and the customer billing system, including bill printing. A laboratory end-to-end test scenario was used to simulate system exception handling in a controlled environment, including the addition of a meter access point that served as the collection point for the meter information that was sent back to PG&E.

End-to-End laboratory testing was performed on five PG&E Smart Meters, with five Elster digital meters used as parallel, side-by-side measurement, referred to in this Assessment as "shadow" meters. These end-to-end laboratory tests involved creating a proxy Customer account, installing a Smart Meter for this account and an electronic meter side-by-side to shadow the account's usage, and conducting tests from the time of installation through to receiving a bill. Structure established shadow meter test boards and conditions in the independent laboratory for use in the end-to-end system testing, to determine whether the Smart Meters were accurately

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measuring energy consumption as compared to an independent electronic Meter. A field end-to-end test scenario, Scenario 6, was used to test the actual performance at Customer-installed facilities.

Structure did not identify issues during the testing of the meter billing system accuracy. Structure encountered an issue with PG&E's set-up of the proxy accounts, wherein Structure specified a specific billing address and PG&E sent all of the proxy account bills to the wrong address. PG&E indicated that this occurred because they did not follow their standard practices.

D.3.2 End-to-End System Testing Findings Details

Twenty-six Elster digital meters procured from the Elster meter manufacturer were laboratory-tested for accuracy and utilized as an auxiliary/additional meter to record energy consumption on the secondary meters, hereby referred to as a "shadow" meters in both the laboratory end-to-end testing and the field end-to-end testing scenarios.

End-to-end laboratory testing was performed on five PG&E Smart Meters, with five Elster digital meters used as shadow meters. Each of these meter pairs was subjected to a different amount of load, reflecting measurement at various rate tiers over the test period. In addition, the meters were also subjected to common exceptions to normal conditions often found in the field, including power outages, voltage swells, voltage sags, and loss of Radio Frequency reception. Inclusion of the common exceptions facilitated testing PG&E's capability to perform validation, editing, and estimation (VEE) processes in compliance with CPUC rules, and without introducing errors into Customer bills. The referenced VEE standard was California Interval Data VEE Rules Revision 2.0.

"Proxy" Structure Customer accounts were created within PG&E's billing system for each of the laboratory-based end-to-end meters, giving Structure the ability to determine PG&E's application of billing determinants and rate assignments accuracy and the timeliness of physical bill issuance to residential electric Customers. The end-to-end test process was designed for completion over the course of one PG&E billing cycle.

Structure encountered an issue with PG&E's set-up of the proxy accounts, wherein Structure specified a specific billing address to be used instead of the premise address and PG&E sent all of the proxy account bills to the wrong address. Structure specifically requested use of the billing address instead of the premise address in order to accommodate a specific route and satisfy the specified bill cycle. The proxy bills were sent to the "premise address" that was created for the proxy accounts, which was a fictitious address created by PG&E for internal use for a premise that does not exist. Structure contacted PG&E when the bills were not received, and subsequently received the bills. PG&E indicated that the bills were sent to the incorrect address because they did not follow their standard practices for account setup. PG&E failed to note on the account that bills were to be sent to the billing address, instead of the premise address, and told Structure that the billing system defaulted to the premise address for bill delivery.

End-to-end field testing utilized four Scenario 6 field test shadow meter installations on selected High Bill Complaint Customers. The field test shadow meter setup used the existing installed PG&E Smart Meter and an Elster electronic shadow meter installed side-by-side to measure the Customer's usage simultaneously through both meters. The meter comparison results are discussed in the Field Meter Testing section. Structure also utilized these installations to verify the flow of meter usage and event data from the Customer premise, through the PG&E AMI and Billing systems, to the Customer's receipt of the printed bill.

Structure experienced initial laboratory testing setup challenges that were resolved within the first days of testing. The challenges identified during setup did not impact the overall scope or development of testing conclusions. The results of the end-to-end tests included:

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- End-to-End laboratory system testing verified that the representative sample of five Smart Meters being billed through the PG&E systems had average accuracies compared to the reference Elster meters of 0.06% with a standard deviation of 0.001%. Meter Data Management System (MDMS) validation routines were verified to be working accurately under the tested conditions, and billing matched the expected results.
- Meter readings were verified as accurate between the Advanced Metering Infrastructure (AMI) head-end, the Meter Data Management System (MDMS), and the Customer Care and Billing (CC&B) systems.
- Application of billing determinants were verified as accurate, including the assignment of baseline allocations, transition of billing through seasons, and transition of billing through new tariffs.

D.4 High Bill Complaint Analysis

D.4.1 High Bill Complaint Analysis Findings Summary

Structure obtained the complaint register associated with the electric Smart Meter High Bill Complaints from both PG&E and the CPUC since the implementation of Smart Meters through June 10, 2010, for inclusion in our analysis which included usage history for 1,378 records. A detailed analysis was performed on 1,066 of these records. The records were analyzed for usage sensitivity to weather, unusual spikes, meter problems, manual or system based issues, meter reading issues, rate impacts, and service issues. Structure further analyzed a targeted sample of 73 complaints that were identified as having multiple issues and would likely provide the greatest insight into potential PG&E system or process issues. Structure contacted 100 High Bill Complaint including the 73 researched complaints, and conducted interviews with 20 Customers that had filed complaints during the period and exhibited excessively high bill periods, cancel/re-bills, or complaint resolution codes that reflected a potential problem. The 73 complaint accounts were also included in the field meter tests.

As a result of the high bill complaint analysis, Structure did not identify problems with the Smart Meter data utilized for billing. Structure identified the following factors that contributed to high bill complaints during late 2009 and early 2010:

- *Customer Usage:*
  - *Meter deployment schedules coincided with increased energy usage caused by a heat wave.*
  - *Some Customers experienced load changes that were reflective of changes in personal circumstances. Examples included room additions, pool additions, and equipment malfunctions.*
  - *Electromechanical meter degradation that was also identified as part of Structure's field meter testing.*
- *Rates:*
  - *Rate increases compounded the financial impact of the additional weather-related usage, resulting in higher bills that occurred as Smart Meters were being installed.*
  - *Incorrectly applied rates that were based upon historical premise assumptions.*
  - *Rate-based inquires that increased as Customer bills escalated. Requests for new or renewed financial assistance through California Alternate Rates for Energy (CARE) were identified as potential reductions of financial impacts related to higher bills.*
- *Customer Service:*

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- *PG&E processes did not address the Customer concerns associated with the new equipment and usage changes.*
- *Customer skepticism regarding the new advanced meter technology was not effectively addressed by PG&E on a timely basis.*
- *Customers interviewed during this assessment did not consider their complaint resolved, despite indications from PG&E and CPUC that the Customer agreed with the resolution*
- *PG&E Customer complaint resolution did not provide of interval read information available with Smart Meters, which may have assisted Customers' understanding of hourly usage patterns.*

- *Process Issues:*
  - *Customers indicated that communications/notifications surrounding physical meter installation were lacking, or that the Customer had issues with the installation personnel.*
  - *PG&E utilized field meter readers for an average of 131 days after Smart Meters were installed, resulting in similar meter reading errors as electromechanical meters. The transition to automate the Smart Meter data for use in billing was not clearly addressed with Customers.*
  - *PG&E's system tolerances related to billing quality control were not stringent enough, resulting in multiple bill cancelations and re-billings, which were confusing to Customers.*

Additionally, Structure determined that the PG&E complaint resolution process was inefficient and ineffective in providing Customers with resolution details and education related to Smart Meters. Recent process changes adopted by PG&E created Customer Relations resources that were focused on Smart Meters, along with a group focused on resolving escalated complaints. Structure performed a complaint walkthrough with both the PG&E groups and was satisfied that additional focus was being placed on resolving Customer complaints.

D.4.2 High Bill Complaint Analysis Findings Details

D.4.2.1 Customer Complaint Process

The Customer complaint process followed multiple paths, including contacting the CPUC Consumer Affairs Branch (CAB) to file a complaint and filing directly with PG&E's Customer Relations Department. In some cases, Customers registered complaints with both the CPUC and PG&E. Typically, Customers had filed more than one complaint with PG&E. Included in the CPUC complaint list were complaints received during town halls hosted by Senators Dean Florez (D-Shafter) in October 2009. The complaint process is illustrated in the Findings section of this document.

All complaints filed with the CPUC were provided to PG&E for resolution and expected to either be resolved in 10 days or to provide a required $30 credit to the Customer. CPUC was responsible for communicating results back to the Customer. Complaints filed with PG&E were handled through the Customer Relations call center and logged into the Customer's account profile.

The following Figure illustrates the number of Smart Meter high bill complaints received by PG&E on a monthly basis.

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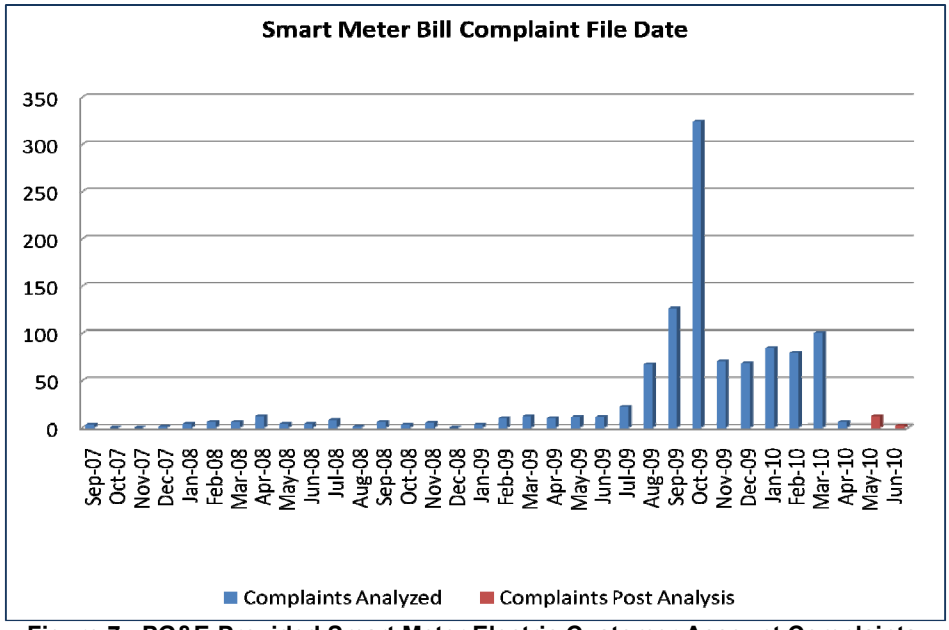
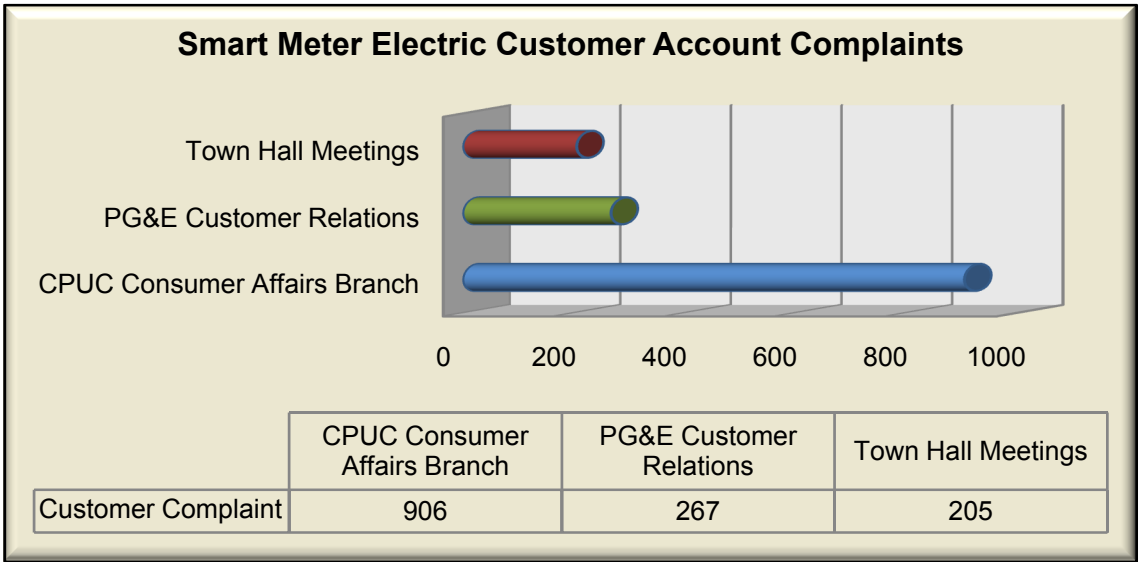


Figure 7: PG&E-Provided Smart Meter Electric Customer Account Complaints

Structure noted a disproportionate number of complaints filed with the CPUC than with PG&E, as indicated in the Figure below.



	CPUC Consumer Affairs Branch	PG&E Customer Relations	Town Hall Meetings
Customer Complaint	906	267	205

Figure 8: Structure-Identified Smart Meter Electric Customer Complaints

Structure was told by PG&E that a complaint was not marked as a Smart Meter complaint if the Customer did not mention that they had a Smart Meter. This approach may result in complaints not being accurately coded

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and reported as Smart Meter complaints. Some Customers interviewed indicated that complaints were registered with both the CPUC and PG&E, although only the CPUC record was identified.

Structure also performed a historical usage analysis utilizing an aggregated Smart Meter complaint inventory file provided by PG&E. The file included identification of the complaint source, relevant complaints, and related account detail. Structure conducted an analysis of the Smart Meter Complaint inventory to remove duplicate and non-Smart Meter billing data, and concluded that of the 2,915 Smart Meter complaints that were filed by PG&E Customers from September 2007 through April 2010, there were 1,378 distinct Customers that filed complaints related to residential electric accounts. Structure's evaluation included a further detailed review that evidenced 1,066 represented electric residential Smart Meter Customer accounts.

Subsequent to the conclusion of our analysis, Structure received additional high complaints from both PG&E and the CPUC. Structure reconciled the lists and determined that an additional 117 CPUC CAB Customer complaints had been excluded from the PG&E-provided consolidated list. Structure utilized the complaint lists and supplemental complaints as the basis for our testing selection, but did not include a complete analysis on these accounts.

As part of a follow-up to the Town Hall meeting complaint process, Structure reviewed the detailed Customer analysis performed by PG&E and the associated complaint resolutions. The PG&E analysis included a comparison of the Customer's average daily usage in kWh vs. the monthly average temperature for the region to demonstrate the trend in usage pre- and post- Smart Meter installation.

Structure reviewed the Town Hall Meeting historical usage profile for each complaint to determine accounts that were impacted by weather. Structure included the Town Hall complaints within the potential selection group for the Customer Interviews and in the Smart Meter High Bill meter tests for further validation.

Structure also performed an independent analysis on the high bill complaint Customer accounts by reviewing the historical usage for 1,378 accounts, and performing detailed analysis on 1,066 accounts. The analysis performed included:

- Weather impacts on average daily usage
- Average Daily Usage prior month prior year
- Extended billing cycles
- Unresolved complaints
- Cancel/re-bill review

Structure compared the historic average daily kilowatt hours (kWh) usage for each of the 1,066 Customer accounts with the objective of determining if the high bill complaint Customers experienced increased kilowatt hour (kWh) usage after installation of Smart Meters due to weather. The comparison utilized the 2006 and 2009 years with similar summer profiles and determined that in 86% of the 2009 complaints, the average daily usage was less than the 2006 summer although the 2006 summer months were hotter. Structure verified that the weather in the same July/August period for 2007 and 2008 was 2 to 3 degrees cooler than in 2009. The remaining 14% of accounts required additional analysis to determine the potential cause for the increased usage.

Structure also reviewed the average daily usage for the same period of the prior year for each Customer Complaint account history, and identified less than 6% of the records for the complaint Customers that exceeded 150% of the same period prior year. Structure utilized the 150% value to reflect the differential in weather between 2008 and 2009 and focus on identifying unusual spikes in energy usage.

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Additional complaint analysis focused on the extent to which bills were included in an extended billing cycle, or delayed bills, outside of the typical (27-32 day) billing cycle. Structure's evaluation discovered that in 2009 and 2010, approximately 9% of the bills reflected a billing period beyond the standard cycle, although less than 0.4% extended past a 45 day window. Extended billing cycles that resulted in higher overall bills were identified as contributing to high bill complaints. Structure recalculated several bills and determined that the appropriate baseline adjustments were included in the bills and that the bills were accurately calculated.

Structure also noted that during late 2009 and early 2010, a significant portion of complaints were not resolved within the CPUC-required 10 day complaint resolution period. PG&E indicated that the resolution time period extended well beyond the 10-day timeframe due to the influx of complaints during the second half of 2009 and early 2010. Structure calculated that PG&E took more than 10 days to resolve complaints for more than 67% of the Customer accounts during this time period. Structure did not review all accounts to identify whether the CPUC credit for account resolution was provided, but did identify that in several cases where detailed review was performed, the adjustment was properly applied after Structure's additional review and discussion with PG&E.

The cancel/re-bills documented by PG&E represented 1% of the total high bill complaints. A portion of the cancel/re-bills related to overbilling from estimated meter reads identified by Customers subsequently required adjustments by PG&E. Billing adjustments were also made to compensate for meter installation issues.

D.4.2.2 Customer Interviews

Structure contacted 100 high-bill complaint Customers for potential in-depth interview participation related to their high bill complaint. Of the 100 Customers contacted, 20 Customers agreed to be interviewed. Some Customers permitted inclusion of their information in The Assessment, and permitted Structure to follow up with PG&E on their behalf. The Customer interviews focused on the nature of the complaint described to PG&E, PG&E's approach to resolving the Customer's complaint, and the current status of the complaint. The 20 Customers participating in interviews were also included in the field meter testing population.

Based upon Customer interviews, Structure identified gaps in PG&E's approach taken to resolve Customer complaints, including but not limited to:

- Some Customer complaints were not logged into the service history on Customer accounts.
- Follow-up with Customer was not performed on a timely basis.
- PG&E indicated that account was resolved did not align with Customer perception.
- Lack of resolution communication back to Customer.
- Customer lacked clear understanding of complaint resolution process.
- Customer consistently treated by PG&E as wrong, until the Customer proved to PG&E that they were right.
- Customer perception of Smart Meter functionality resulted in complaint escalation.
- PG&E front-line customer call representatives lacked professionalism while dealing with Customer complaints.
- Underlying cause of billing issue not discovered in most cases, even when monetary resolution was reached.

Recent process changes adapted by PG&E allocated Customer Relations resources focused on Smart Meters, along with a group focused on resolving escalated complaints. Structure performed a complaint walkthrough

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with both of the PG&E groups and was satisfied that additional focus was being placed on effectively resolving Customer complaints.

In regards to the CPUC complaint resolution process, Structure noted that the Complaint closure letter Customers received from the CPUC provided no further information than had been provided by PG&E, and both were considered to be ineffective.

Structure followed-up on the Customer interviews by reviewing the Customer Complaints with PG&E. As an outcome of Structure's review with PG&E, two accounts were adjusted based upon the Customer's satisfaction of certain criteria, including low income CARE eligibility and major customer equipment malfunctions, which were subsequently repaired by the Customer.

During the interview process, Structure identified discrepancies in the retroactive application of the CARE eligibility for two Customers. These discrepancies were later resolved by PG&E, following Structure's inquiries, in favor of the Customer.

Of the 20 Customer interviews completed, Structure identified the following non-unique account issues:

- 9 Customers experienced unusually high bills in the initial months after the Smart Meter was installed
  - Explanations identified:
    - Estimated meter reads
    - Cancel/re-bill adjustments
    - Weather related
    - Usage pattern adjustments
- 9 Customers do not have an explanation, personally or from PG&E, for the spike in electricity usage.
  - Potential explanation identified:
    - Electromechanical degradation (similar to those found in field testing)
- 5 Customers were on the wrong rate structure, or PG&E changed their rate structure as a result of their complaint.
  - Explanations included:
    - Historical premise classified incorrectly, affecting the baseline applied to the premise
    - Lapse in CARE qualification, or not registered for lower income-based programs
- 1 Customer experienced a 500% increase in kWhs used after Smart Meter installation
  - Explanation included:
    - Correction of estimated meter reads.
    - Note: The lack of adequate PG&E exception and validation controls resulted in the bill being processed.
- 2 Customers interviewed experienced electrical problems due to Smart Meters causing "surges" or interruptions in timed electrical services such as security lights and hot tub pumps.
  - Explanations included:
    - There is a possibility for a meter in close proximity to FCC Part 15 Unlicensed Radio Frequency (RF) devices and transmitting data via a 1 watt radio transmitter to create operational interference (e.g., static, trip, or outage) when the RF signal passes though these devices. This is an issue that is prevalent with any RF device, such as walkie-talkies, garage door openers, etc. Electrical issues may be due to a matter of proximity to the transmitter, strength of the transmitter, frequency of the transmitter, and the impact on the neighboring device.
      - FCC Part 15 Unlicensed RF devices include:

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  - Motion sensors
  - Garage door openers
  - Baby monitors
  - Wireless telephones
  - Wireless speakers
- PG&E has determined that certain models of Ground Fault Interrupter (GFI) breakers (such as those used on hot tubs) may be impacted if they are in close proximity to the meter. PG&E has also engaged Smart Meter manufacturers to develop low power transmitter solutions to the GFI interference issue, and has trained the installation contractors to listen for GFI tripping upon installation of a new meter.

On average, Customers indicated a 4.5 month delay between complaint submission and ultimate resolution. The quickest resolution was reached in four days; however, the longest resolution took 12 months and significant effort on the part of the Customer.

While the Customer interviews and related detail account reviews provided significant insight into potential issues within the Smart Meter program, Structure did not identify recurrent issues that impacted the overall population of High Bill Complaints analyzed.

D.5 Best Practices Associated with Smart Meters

D.5.1 Best Practices Associated with Smart Meters Findings Summary

Structure found PG&E to have been either historically in compliance, or to have recently come into compliance, with the majority of industry best practices associated with Smart Meters. Recognizing that some of these practices have matured over PG&E's three year AMI deployment period, it is reasonable that they have recently come into compliance with standards associated with best practices. Some concerns were noted around PG&E's practices related to Meter Deployment, Meter Data Management Interfaces, and VEE.

The following Figure presents a pictorial representation of Structure's evaluation of PG&E's historical and current adherence to industry best practices.

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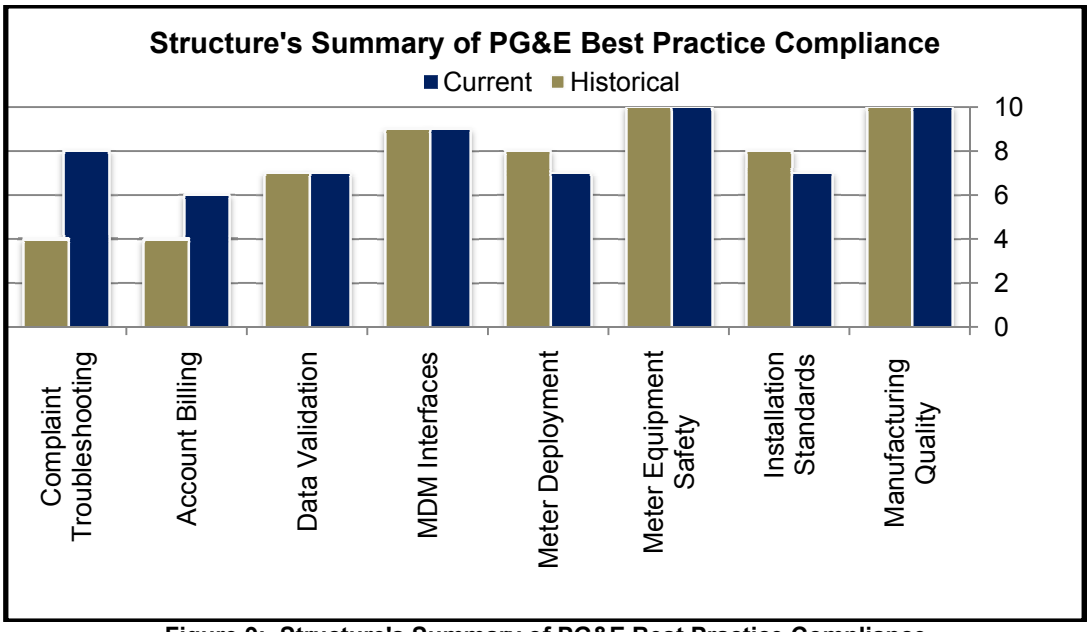


Figure 9: Structure's Summary of PG&E Best Practice Compliance

The Findings section of this report addresses the specific areas in which PG&E is historically and/or currently not compliant with best practices.

D.5.2 Best Practices Associated with Smart Meters Findings Details

Although PG&E was not in compliance with the recommendation to utilize IEC 61968-9 interoperability standards, PG&E provided documentation that it was employing a set of interoperability standards for MDM Interfaces.

Of some concern is the lack of documentation verifying compliance with the Meter Deployment best practice to deploy WAN/LAN collectors prior to meter deployment. By not deploying the communication backbone prior to meter deployment, the time to transition meter reading from manual to AMI system readings is exacerbated, extending to an average of 131 days over the implementation period. This allows a continuation of the higher error rate associated with meter reading and may contribute to the perception that the Smart Meters are inaccurate.

Additionally, the inability to verify compliance around the Meter Data Management Interface best practice to "Correlate AMI meter events and alarms with VEE and CIS audits and checks for automated exception handling" and the VEE Best Practice of "MDMS must provide an on-line method, with workflow, resolving validation errors rather than reports" has created a situation where there is manual editing of data causing numerous cancel/re-bills and delayed processing of Customer data. This, coupled with extensive manual, instead of automated, exception handling of issues has allowed many metering and billing errors to occur on a repetitive basis, over time, furthering the perception that the Smart Meters are not accurate.

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PG&E has recognized, through the presentation of information, their shortcomings on these issues and has been actively pursuing remedies such as process improvements and the recent consolidation of the Billing, VEE, Smart Meter Engineering, and Troubleshooting operations into one Operation Center.

D.6 Security Assessment

D.6.1 Security Assessment Findings Summary

Structure concluded that PG&E has developed a cyber security framework that meets the objectives of the Smart Grid industry's OpenSG AMI-SEC Task Force "AMI System Security Requirements" that were reviewed as part of this evaluation.

D.6.2 Security Assessment Findings Details

Structure independently reviewed PG&E's cyber security framework as it applies to their Smart Meter system. Structure also evaluated PG&E's cyber security framework against industry best practice standards to identify deviations in current and historical business practices. Structure concluded that PG&E had developed a cyber security framework that met the objectives of the OpenSG AMI-SEC Task Force "AMI System Security Requirements" that were reviewed as part of this evaluation. An assessment of the implementation of the cyber security framework was not within Structure's agreed-upon scope of work

D.7 Other Observations

Structure submitted data requests, using PG&E's standard request procedures as agreed to with PG&E and CPUC to obtain information used as the basis for this report. At PG&E's request, Structure assigned priorities to the data requests to facilitate response focus and expedition. While PG&E accommodated the requests, 28% of the requests were substantially delayed due to PG&E's internal processing and legal review. The delayed resulted in Structure requiring additional time and resources to process, integrate and reconcile information in an effective manner once received. While Structure does not feel that the delayed information impacted the results of the Assessment, the receipt of limited data and the differences in data presentation in the received data impacted the amount of time required to complete the planned analysis, and led to scope modifications and a revised project completion date of September 2, 2010.

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1 Background

1.1 Smart Meters

Today's advanced meters, or "Smart Meters", were an integral part of the drive to achieve energy independence, and are projected to contribute to the reduction in the world's carbon footprint by enabling utilities and consumers the ability to manage their energy consumption.

The existing electromechanical meter, utilized by utilities for decades to measure monthly consumption, limited the utilities' ability to provide information and communication needed to enable utility and consumer benefits. While these meters proved to be reliable and accurate over the years, the electromechanical meters required manual reading each month because the meters did not have the ability to electronically store or transmit data, register or record at intervals required to match pricing signals available at the wholesale level, thus making it impossible to accurately provide price signals at times of peak usage. The Smart Meter was the device of choice to enable the benefits required by regulators and demanded by consumers. Smart Meters were required to enable these benefits.

From a utility perspective, Smart Meters and their associated communication infrastructure, "Advanced Metering Infrastructure" (AMI), decreased the need to manually read/change/disconnect the existing electromechanical meters, which allowed utilities to reduce meter reading and maintenance labor, thus helping to control costs that are ultimately passed on to the consumer. AMI also reduced the associated vehicle emissions required to transport meter personnel, thereby reducing the utilities' carbon footprint. The Smart Meter technology allowed utilities to offer a larger array of incentives to the consumers, such as real-time, time-of-use (TOU), and critical peak pricing rates – all of which were designed to reduce consumption during times of peak energy use. This reduction of peak energy usage resulted in the possible delay or elimination of new generation facilities, which are often required to maintain reliable service during times of peak usage. The Smart Meter and AMI could also be used by utilities to improve reliability through automated outage notifications and improved power flow monitoring, and to enable the electric grid to reliably manage the addition of plug-in hybrid electric vehicles (PHEVs) and distributed generation and storage.

From a consumer perspective, Smart Meters provided visibility into consumer energy consumption habits and trends and allowed them to see the cost impacts of their consumption. Consumers were then able to make informed decisions on when and how they consume energy, while understanding the economic impact of those decisions. The Smart Meters and AMI also enabled other products such as Energy Portals and Home Area Networks (HANs), which allowed the consumer the ability to monitor and control their usage over the web. Consumers were provided a choice of incentive rate structures that allowed them to see the energy cost on a near real-time basis and provided Consumers the ability to automatically or manually control devices in their homes, resulting in saving on their electric bill. Smart Meters facilitated the ability of the consumer to generate and store energy at the home or neighborhood, and sell excess energy back to the utility. As PHEVs become available to consumers, they will have the ability to control vehicle charging times, targeting periods of lower cost energy prices.

Smart Meters were only a small part of an overall package of information and technologies that were required to implement the utilities' AMI technology. A communication infrastructure was needed to pass the information from the meter to the utility. This complex communication system needed to have the ability to reliably transmit millions of records over hundreds of miles, with sophisticated monitoring and error processing capabilities required to ensure that the data is accurate. This data was then integrated into the various customer information and billing systems at the utility. The new technology and information also had a huge impact on processes and procedures across the entire utility organization. Customer Service Representatives were required to learn new ways to interact with the Customer using new tools and information. Operations were required to learn not only how to maintain new devices in the field, but how to use and interpret

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voluminous amounts of outage and usage data. The new technology also drove the retooling of skills and knowledge across IT, metering, and many other departments within the organization.

Smart Meter implementations have taken place around the globe; key implementations have thrived outside the U.S. in Europe, Japan, Canada and Australia. One example is the Provence of Ontario in Canada, where over 5 million Smart Meters with AMI technology will be installed by 2013 as mandated by the Ontario Energy Board. In the US, implementations have dramatically increased in the last few years, with Texas and California leading the charge. This was largely driven by regulators who saw the technology as a means to manage a utility's peak demand, thus delaying or eliminating the need to build costly new emissions-producing generation facilities and enabling reliability improvements and consumer choice.

In Texas, the Electric Reliability Council of Texas (ERCOT) authorized CenterPoint to install approximately 2.1 million new electric Smart Meters, Oncor to install approximately 3.4 million electric Smart Meters, and AEP Texas to install 1.1 million electric Smart Meters.

In California, the California Public Utility Commission (CPUC) authorized Southern California Edison to install approximately 5.3 million new Smart Meters, San Diego Gas and Electric Company approximately 1.4 million electric Smart Meters and 900,000 natural gas meters, and Pacific Gas and Electric (PG&E) approximately 5 million electric Smart Meters and 4.2 million natural gas Smart Meters.

Large, complex, multi-year implementation projects like Smart Grid projects have challenges during rollout that are expected and are typically controlled with proper project management. As more of the Smart Meters were rolled out, public concern over the cost, safety, security, and accuracy of the meters began to surface. In Texas, Oncor experienced numerous reports of meter inaccuracies and billing errors including over 138 complaints. In California, the CPUC received approximately 780 unconfirmed consumer complaints about "unexpectedly high" bills and allegations that the new electric Smart Meters were not recording electric usage accurately, almost all from PG&E's service area. In response to these complaints, both Texas and California commissioned independent evaluations into the allegations. The California assessment was the subject of this Report, under the title of "PG&E AMI Assessment Project".

1.2 PG&E Smart Meter Installations

On June 16, 2005, PG&E applied for regulatory approval to begin a five-year effort to install 9.3 million advanced meters for all of its gas and electric Customers. These advanced meters utilized a technology that allowed the meters to be read remotely and provide a wide range of benefits to customers, the utility, and the state. Known as advanced metering infrastructure, or AMI, the technology would improve customer service and provide operational savings through increased efficiencies. AMI allowed Customers to take advantage of prices that vary by time of day, potentially realizing cost savings by shifting use from peak to off-peak hours.

The AMI application stemmed from a 2002 California Public Utilities Commission rulemaking that directed the utilities to consider programs and tools that offer Customers improved options to reduce their electric usage during high-demand situations. California's investor-owned utilities were directed to explore AMI technologies and conduct a two-year statewide pilot program to gauge customer interest in dynamic pricing options.

PG&E's application was approved by the CPUC on July 20, 2006, and PG&E began deployment of the first generation Power Line Carrier DCSI Smart Meters in the Bakersfield area in November 2006. PG&E evaluated Radio Frequency (RF) Mesh Technology with advanced features during this initial meter deployment.

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In December 2007, PG&E filed an Application to upgrade its AMI system by replacing the first generation Smart Meters with "Smarter" meters that allowed Connect/Disconnect, HAN, and utilized Solid State Technology. In August 2008, the final Power Line Carrier Smart Meter was deployed.

During 2008, PG&E researched, piloted, and acceptance-tested solid state meters with upgradeable firmware, integrated connect/disconnect switches, and Home Area Networking (HAN) for future enhancements. PG&E began the second generation RF Mesh Technology deployment in October 2008. In March of 2009, the CPUC approved the PG&E AMI Upgrade application. By February 2010, the deployment of RF Mesh Technology had reached its halfway point, with an average installation of 7,232 electric meters per day throughout the service territory.

The following Figure presents a timeline of the PG&E AMI rollout, as provided by PG&E.

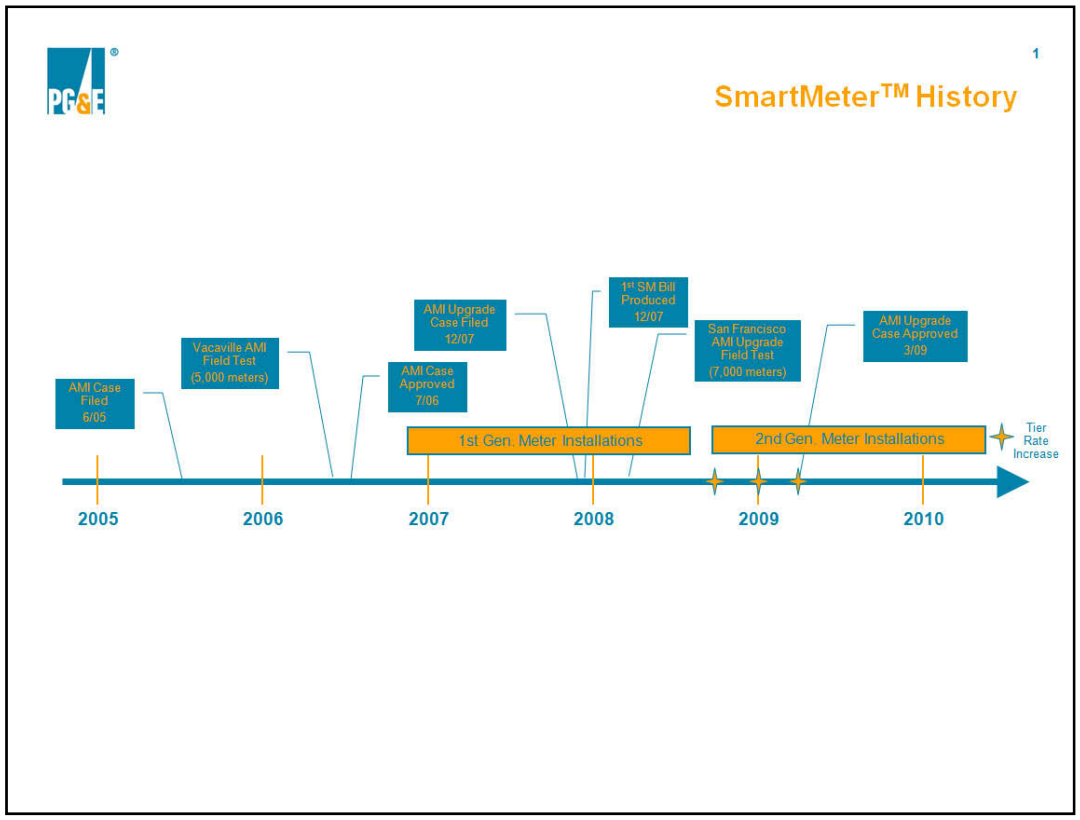


Figure 10: PG&E-Provided AMI Rollout Timeline

2 Scope of Work

2.1 Agreed Scope of Work

Structure was selected by the CPUC to conduct an independent evaluation of PG&E's Smart Meters in response to accuracy complaints received by the CPUC. As noted in the formal Statement of Work document, Structure's scope of work focused on key areas including meter accuracy, end-to-end system performance, Customer high bill complaints, and Smart Meter practices used by PG&E for deployment, operations, and security.

Working independently and with the facilitation of the CPUC, The Assessment addressed the following questions related to PG&E's electric Smart Meters:

- Does PG&E's Smart Meter system measure and bill electric usage accurately, both now and since PG&E's Smart Meter deployment began?
- What factors contributed to Smart Meter high bill complaints?
- How do PG&E's Smart Meter Program's past and current operations and deployment compare against the framework of industry best practices?

To address the first item and to answer the key question associated with meter and billing accuracy, Structure collected test data and examined available data to determine whether PG&E's Smart Meter system was measuring, collecting, and billing electric usage accurately.

Structure independently verified PG&E's installation practices by selecting meter samples to track from meter procurement to installation, testing meter accuracy, and observing installation practices. As part of this process, Structure pulled meters from the PG&E in-stock inventory that were delivered directly from the manufacturer and tested the in-stock meters in a laboratory environment. In addition to laboratory-based accuracy tests, Structure performed laboratory tests on a subset of meters to determine how the meters reacted to various environmental conditions and how the PG&E system recognized and treated abnormal data when introduced in the laboratory testing environment.

Structure also observed the Smart Meter installation process at Customers' premises, and re-tested Smart Meters on-site at the premises. Where applicable, Structure also tested the electromechanical meter being removed to determine if it was outside an established tolerance level. In all cases where a Customer's meter was removed or replaced, PG&E was responsible for the removal and installation of the meter, under Structure's observation.

Additional testing utilizing shadow meters, also referred to in the energy industry as side-by-side or parallel meters, involved the installation of a laboratory-calibrated meter alongside the existing meter at select Customer locations. These shadow meters were used to establish the registration accuracy of the Customer meters already installed at the premise through the performance of a multiple accuracy checks and monitoring the account billings through one bill cycle.

Structure also performed registration accuracy tests of a statistically random selection of previously installed Smart Meters. This testing included the removal of the installed Smart Meter, placing the Smart Meter on on-site meter testing equipment, and running a series of tests on these meters prior to having the meter re-installed. Structure supplemented the Smart Meter accuracy testing with a review of how past data recorded by the meter was received and processed by PG&E's back-end systems, including whether the systems properly handled exception conditions that sometimes occur in a typical Smart Meter system.

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For each test involving PG&E Customer's meters, Structure attempted to contact Customers by mail and/or by a phone call from a Structure representative to describe the test process and coordination. Structure provided CPUC staff with weekly updates related to the Assessment.

To address the second item, Structure conducted analyses of the high bill Customer complaints to determine the underlying nature of the complaint, and evaluated usage patterns prior to the installation of the Smart Meters. The high bill analysis review required interviewing a sample of Customers whose usage patterns were not easily explained through conventional analysis such as comparing usage to weather data.

The Smart Meter high bill analysis was performed across representative samples of the meter population taken from high bill complaints officially filed with the CPUC, those provided by the office of Senate Majority Leader Dean Florez (D-Shafter), and those gathered directly from PG&E.

To address the third item, Structure reviewed PG&E's documentation on past and current operational and deployment policies, processes, and procedures against a framework of industry best practices.

As additional information was obtained throughout the evaluation period, Structure identified scope changes required to address the key questions driving this evaluation and address other challenges arising during the course of the project. The scope modifications were discussed and approved by the CPUC over the duration of the project to more fully address the CPUC's concerns and address challenges during the course of the project. These changes included removal of the initially requested evaluation of system communications errors or deficiencies; inclusion of additional Customer complaint/high bill analysis; and the addition of field meter testing scenarios across a broadened customer population base. Details of the scope changes are outlined in the following section.

2.2 Scope Modifications and Limitations

Throughout the project, Structure provided CPUC staff with weekly updates that summarized the status of their evaluation. The CPUC also participated in exploratory background and data gathering meetings with PG&E and Customers as available and where appropriate.

After project initiation and throughout the project, Structure worked with the CPUC to modify the project scope to better evaluate PG&E's AMI systems based upon timeliness of receipt and presentation of requested data, budget constraints, and the available timeframe. Scope changes were also driven by additional work effort to more effectively perform The Assessment, challenges identified during testing that resulted in increased work effort and data/approach limitations that resulted in scope reductions. The changes occurred throughout the project and were not anticipated when developing the initial project scope. Modifications to the scope were discussed with and agreed to by the CPUC.

Structure was issued two addendums to the initial contract to reflect the agreed upon scope changes. Structure felt that the requested and approved scope modifications were appropriate and did not impact the integrity of the findings included in this report.

The scope changes are noted in the following sections.

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2.2.1 Scope Expansion

- Increased meter testing population from 474 meters to 859 meters, including increased focus on electromechanical registration accuracy and potential impact on high bill complaints.
    - The following Figure provides Structure's initial and revised estimates for meters to be tested as part of The Assessment. The field testing scenarios were referred to as "High Bill Complaint" and "Non-High Bill Complaint" populations. The High Bill Complaint population was derived from complaints received directly by the CPUC or PG&E and those received at the regulator-driven town hall meetings. Non-High Bill Complaint Customers refers to Customers who had not filed a high bill complaint through one of these channels.

Structure's Scope Testing Estimates		
Meters to Test	**Initial Estimate**	**Revised Estimate**
Complaint Smart Meters	100	100 (Included 20 shadow meters pre-tested in Structure's laboratory, 30 PG&E shadow meters, and 50 non-shadow complaint meters.)
Installed Smart Meters (DCSI, SSN) over whole PG&E territory	125	500
Warehouse Smart Meters	25	156 (To be laboratory-tested and used as part of selected field testing scenarios.)
Removed Electromechanical Meters	25	0
Complaint Smart Meters in Kern and Fresno Counties	50	Included as part of the Complaint Meter population.
Non-High Bill Complaint Electromechanical Meter Field Test	0	100
Total	**325**	**856***

Figure 11: Structure's Scope Testing Estimates

*Note: The final number of meters tested was 859.

- Utilization of PG&E protocols and CPUC requirements to prepare and disseminate meter testing materials to customers
- Expansion of High Bill Complaint reconciliation and analysis from 300 records anticipated for Kern and Fresno to over 1,378 total records across PG&E and CPUC complaint databases
- Addition of Structure Customer Call Center function originally anticipated to be performed by PG&E

2.2.2 Scope Reduction

- Removed electromechanical meters laboratory testing due to integrity issues introduced upon meter relocation. A meter's test results may vary once the meter is moved. For the purposes of The Assessment, the valid tests on existing meters at a premise were deemed to be those tests performed on-site at the premise.
- Minimized communication and network connectivity review based upon clarified understanding of billing approach. Communication tested as part of end-to-end testing.
- Modified security review scope.

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2.2.3 Time Management Expansion

- Increased scheduling efforts required to coordinate and route field crews between PG&E and Structure
- Increased field visit attempts resulting from meter and premise access limitations
- Increased field visits due to unplanned quantity of meter tests that were not performed upon site arrival due to meter and premise access limitations
- Increased reconciliation efforts required for data requests related to meter data population provided in multiple sources
- Unanticipated examinations resulting from field meter procedure deviations
- Increased State of California expense management requirements
- Additional effort to review general PG&E metering and billing practices beyond Fresno and Kern counties based upon a broader high bill complaint examination
- Modifications to shadow meter testing procedures to include multiple approaches to utilize Structure meters and PG&E meters based upon scenario
- Increased work effort resulting from delayed receipt of PG&E data requests, with over 28% of requests being provided more than 90 days after request

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3 Approach and Methodology

Structure independently validated the accuracy of PG&E's Smart Meter system based upon testing of residential Customer meters, through laboratory, field, and end-to-end system testing; and review of high bill complaints. Structure also evaluated PG&E's Smart Meter system deployment against industry best practices and standards to identify deviations in current and historical business practices.

The project was divided into the following areas:

- Laboratory Meter Testing
- Field Meter Testing
- End-to-End System Testing
- High Bill Analysis
- Best Practices Associated with Electronic Meters
- Security Assessment

This section provides a summary of the approach and methodology used in each of these areas. Additional detail may also be found in the referenced documents and appendices.

Electromagnetic Field, or Radio Frequency, issues were not reviewed or tested as part of Structure's evaluation, but were raised as a question during the Assessment. Structure obtained the following summary from PG&E, and makes no representation around the accuracy of the statements provided.

PG&E-Provided Electromagnetic (Radio) Frequency Information
• PG&E Silver Spring Networks SmartMeters™ operate in the 900 MHz and 2.4 GHz bands. PG&E Access Points operate in the 900 MHz band in addition to the cellular bands determined by the cellular provider corresponding to the particular Access Points. These are the same FCC-approved frequencies that have been used for many years in devices such as baby monitors, portable phones, remote controlled toys and medical monitors.
• A study of radio frequency fields produced by the transmitting components of SmartMeter™ devices shows they comply with Federal Communications Commission regulations by a wide margin (Study by Richard Tell Associates, Inc.)
• Radio signals generated by SmartMeter™ technology are far below the levels emitted by common household appliances and electronics, including cell phones and microwaves.
• The average SmartMeter™ device transmits only about 45 seconds each day.
• The maximum power in the radio is 1-watt, which is about the same as a cell phone which is held much closer to the body than a SmartMeter.
• At 25 feet from a SmartMeter™, the power density is .005 microwatts per sq cm; the FCC's limit is 601 microwatts per sq cm.

Figure 12: PG&E-Provided Electromagnetic (Radio) Frequency Information

3.1 Laboratory Meter Testing

3.1.1 Specific Scope of Work: Laboratory Meter Testing

This section provides specific requirements outlined in Structure's Statement of Work, as they pertain to laboratory meter testing. As referenced in the Structure's Statement of Work, Structure's scope of work included performing laboratory meter tests on a sub-set of meters selected for testing. These meters were to be removed and sent to independent testing laboratory for in-depth programming and measurement accuracy testing.

Structure was tasked with performing laboratory testing on a representative sample of meters received from the factory prior to installation, utilizing the laboratory meter testing methodology identified below to verify accuracy and factory programming of this subset of meters.

In addition to the laboratory testing of Smart Meters, Structure was to perform laboratory testing on a select number of electromechanical meters that were to be removed during a one week period by PG&E to validate the accuracy of electromechanical meters being replaced with Smart Meters. After initiation of The Assessment, Structure determined that the removal of PG&E customer electromechanical meters and subsequent laboratory testing would be rendered invalid due to integrity issues introduced upon meter relocation - e.g., the meter state in the lab after transportation from the field may no longer be the same state as in the field prior to meter removal at the customer premise. Structure consulted with the CPUC to remove these tests from the scope of work performed.

The laboratory testing methodology to be performed on the meters included:

- Document the original location, customer/warehouse information, serial numbers, and other relevant information for each meter when removed from original location.
- Install the meters in a test board
    - Utilize calibrated phantom load
    - Utilize calibrated National Institute of Standards and Technology (NIST) traceable watt/VAR meter test standard
- Confirm that all meters are energized and functional.
- Reset all meters and zero-out all prior recordings.
- *Light Load & Full Load Test* - Apply a known load to the meters in the test system.
- *Demand Test* - Allow the meters to remain at a constant load for an extended period of time.
- For a percentage of the meters, periodically vary the load over a period and record the times when the variations occur.
- During the test period, interrogate the meters daily both locally and through the PG&E network.
- At the end of the test period, evaluate the interval data compared to the measurements on the calibrated NIST meter standard.
- A percentage of meters will undergo harsh environmental testing in the testing lab.
- Report on findings.

Structure was to utilize the Standards for Meter Installation, Maintenance, Testing and Calibration requirements as approved by the CPUC for both field and lab testing including:

- Out-of-calibration
- Basic Reference Test Standard according to NIST requirements
- Portable Test Standard

Structure was to report any variance from Site Verification and Field Testing. Structure would not perform any re-testing on any out-of-calibration meters identified as a part of the scope for this project.

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In refining the project scope with the CPUC, the following changes were agreed to be made to the laboratory testing specific scope:

- Elimination of the laboratory testing on a select number of electromechanical meters that were scheduled to be removed during a one week period by PG&E, to validate the accuracy of electromechanical meters being replaced with Smart Meters.
- Reallocation of the "Estimated meters to be tested" section from the laboratory testing section to the field meter testing specific scope

3.1.2 Laboratory Meter Testing Approach

Per the statement of work, the laboratory environment provided the opportunity for Structure to select a representative meter sample set received from the factory prior to field installation to verify Smart Meter compliance to manufacturer accuracy and factory programming standards. Structure also stress-tested Smart Meters under environmental conditions and performed a controlled end-to-end test utilizing a variety of extreme but likely conditions, which were introduced and monitored under closely controlled conditions.

Structure classified the laboratory meter testing into two scenarios: meters tested and retained in the laboratory, and meters that were tested and subsequently used for replacing residential electromechanical meters in the field. The laboratory tests were performed on selected meters prior to and in conjunction with the field testing. These scenarios are described in the following Figure, Structure's Laboratory Meter Test Scenario Summary.

Structure's Laboratory Meter Test Scenario Summary		
Scenario	**Description**	**# of Meters**
Scenario 1	Environmental and End-to-End Smart Meter Laboratory Test	11
Scenario 2	Warehouse Stock Smart Meter Accuracy Laboratory Test	163

Figure 13: Structure's Laboratory Meter Test Scenario Summary

The test procedures focused on warehouse stock meters that were procured from PG&E's warehouses. Meters obtained from the warehouses were all factory-tested for full load, light load, and power factor, and calibrated prior to implementation of Structure's chain of custody. Structure requested and received the factory testing and calibration results for these meters.

The selected warehouse meters were all accuracy-tested by Structure in Structure's laboratory prior to use in the laboratory and field meter testing scenarios. All laboratory meter testing was conducted by Structure's contracted certified metering technician in Trimark's laboratory. A randomly selected set of these laboratory-tested meters was subjected to environmental testing in the laboratory, undergoing temperature-based stress tests. An additional randomly selected set of laboratory-tested meters was used for end-to-end system testing, which monitored meter activity from installation through a billing cycle to determine the accuracy of a bill and followed its' processing through PG&E's meter and billing systems.

The specific procedures utilized for selecting the meters to be laboratory tested were based upon a methodical approach. To procure the set of meters for laboratory testing, Structure first randomly selected a set of the Wellington warehouses. The sample selection for the Environmental and End-to-End Smart Meter Laboratory Test and the Warehouse Stock Smart Meter Accuracy Laboratory Test (Test Scenarios 1 and 2) was derived

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using a random number generator to choose five of PG&E's meter installer's (Wellington's) warehouses from which to draw meters for test.

Meters were then selected from the Wellington warehouses using the following Random Meter Selection Methodology:

- From each of the five randomly selected warehouses, Structure pulled a ratio of meter manufacturer and meter forms to projected installations.
- The Structure representative randomly selected meter shipping pallets by manufacturer and form factor.
- To randomly select meters for test, the Structure representative pulled no more than two meters from each randomly selected pallet.
- Only one meter was pulled from two randomly selected boxes on the randomly selected pallet. Pallet sizes ranged from 24 to 28 boxes of meters or 96 to 128 meters per pallet.

Meter forms selected were:

- 1S
- 2S
- 2S-320
- 12S

The ratio of meter forms by meter manufacturer utilized for replacement meters was calculated and applied to each warehouse based upon the ratio of meters in inventory to those needed to satisfy testing requirements. The sample for the laboratory test set reflected the proportion of Smart Meters produced by each of PG&E's meter manufacturers, and thus used in the field by PG&E, at the time of selection. The majority of the meters selected for the sample set were form 1S and 2S meters, with the 2S-320 and 12S meters representing a small portion of the sample set.

Upon completion of Wellington warehouse meter selection and before transporting to the laboratory facility, Structure representatives completed a Meter Inventory Chain of Custody form to confirm receipt of the sample meters. At the Trimark testing facility, the Structure Laboratory/Warehouse Supervisor completed the Meter Inventory Chain of Custody forms with confirmation of his receipt of the meters at the testing facility. The confirmation included the Structure Laboratory/Warehouse Supervisor's signatory approval and the date and time at which the meters were received. Upon successful laboratory testing and completion of defined meter testing criteria, meters were released for field deployment as part of an additional testing scenario to replace electromechanical meters with Smart Meters.

To execute the laboratory tests, Structure utilized the Trimark laboratory facility equipped with NIST Traceable testing equipment necessary to assess PG&E's Smart Meters. The laboratory set-up included:

- Random selection of meters from meter stocks held in PG&E's Smart Meter inventory
- Installation of five PG&E Smart Meters on a test board at the Trimark facility
- Connection of each PG&E Smart Meter to a "shadow" meter of like form and class. These shadow meters were not manufactured for use in the AMI program, and all were pre-tested for accuracy.
- Installation of devices required to issue known levels of load and voltage to test meters:
    - Multi-Amp Epoch 10 (variable voltage and current/load)
    - Variac (Fixed resistance load, variable voltage)
    - Steady-state 1.5 kW heater (variable load)
- Installation and operation of randomly selected Smart Meters for environmental testing within a Test Equity Model 115 Test Chamber that had been pre-tested for accurate calibration

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- The environmental test chamber's test range was set to between -20°C (-4° F) and +50°C (+122° F), simulating proximal high and low temperature ranges of the climate zones selected for testing.
- Installation of a SSN/Access Point by PG&E at the test laboratory facility

3.1.2.1 Accuracy Testing

As with all the meters drawn from PG&E's inventory, Structure's first activity was to observe and record the metering performance of each selected meter when it was connected to a recently calibrated test standard supplying a known amount of full and light load. The records of these tests indicated whether or not the meter measured within the manufacturer's specifications (measured kWh equals ±0.2% of actual kWh) or within PG&E's standard for meters (measured kWh equals ±0.5% of actual kWh). All tests were performed by a certified metering specialist who certified each meter upon completion of a test.

The following steps were performed to conduct the accuracy testing in Structure's laboratory:

- Meters were sorted at the laboratory by manufacturer and meter form factor in order to facilitate an efficient testing process. Meters were visually inspected for damage prior to being accuracy tested. If any physical problems were detected that may cause a safety issue or other problem, the meter defect was noted and the meter would not be tested and a replacement would be requested.
- In order to properly validate the accuracy of the Watthour meters being tested, a validated reference standard was used as a basis for comparison. The reference standard was annually calibrated by a certified lab to a National Institute of Standards (NIST) traceable Watthour standard. The standard used in the laboratory testing was integral to the Probewell test set.
- Along with the reference standard, the Probewell test system current (amperage) source was used to supply the test current to the test meter socket. A separate stable voltage source was provided to the test meter socket to supply the voltage. The test system allowed the tester to control the current levels using a pre-defined set of controls from the Probewell test program.
- Once the meter was ready for testing, all power was removed from the test socket and the meter was installed in the socket by the tester. The reference standard and the meter under test (MUT) were electrically wired in tandem such that the voltages and currents were identical on both instruments. The Probewell test program was then initiated and the meter disc revolutions, represented by infrared pulses, were counted by the Probewell test set and compared to those recorded on the reference standard.
- The test was started manually by the operator; when the correct number of pulses was counted, the hand held controller displayed and held in memory the meter accuracy in percent registration. The accuracy test consisted of three basic tests:
  - Full Load (FL) test, conducted at the rated test current (TA) of the meter at unity power factor. The meter was placed at the full load rating for ten (10) infrared pulse output counts.
  - Power Factor (PF) test, conducted at the rated test current at a 50% power factor. The meter was placed at the full load rating for five (5) infrared pulse output counts.
  - Light Load (LL) test, conducted at 10% of the rated test current at unity power factor. The meter was placed at the LL rating for two (2) infrared pulse output counts.
- At the end of each of the three tests above, the meter accuracy, in percent registration, was then manually entered into the tracking database.

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- The acceptance criterion for these meters was ±0.2% registration as per ANSI C12.20.

3.1.2.2 Environmental Laboratory Testing

In accordance with ANSI Standard C12.20, a set of six Smart Meters were subjected to a period of operation at high (+50°C [+122° F]), low (-20°C [-4° F]), and reference (+23 degrees Celsius, ±5° [+73.4 degrees Fahrenheit, ±5°]) temperatures, and were subsequently evaluated for accuracy with a calibrated test standard. The meters were placed into the environmental chamber for 24 hours and allowed to reach "equilibrium" at the test temperature. The temperature was then adjusted, and the test performed.

The equipment used in the environmental testing included:

- TransData SER - 2100 Watthour Meter Test Set
  - The standard test set that was used for the Environmental testing was the TransData SER2130, serial number 401151. Unit was calibrated on 3/9/2010.
  - Correction factors for Full Load = 1.0000, Power Factor = 1.00010, Light load = 1.0000.
- TestEquity Model 115 Temperature Chamber

The profiles of the meters subjected to environmental testing were:

- General Electric, Form 2S, I-210+, with Silver Spring NIC.
- Landis+Gyr, Form 2S, Focus AXR – SD, with Silver Spring NIC.

Three environmental tests were conducted to establish a baseline and to test the meters at extreme high and low temperatures as specified in ANSI Standard C12.20, and simulating proximal high and low temperature ranges of the climate zones selected for testing. The temperatures tested at were:

- Reference Test at +23 degrees Celsius, ±5° (+73.4 degrees Fahrenheit, ±5°)
- +50 degrees Celsius (+122 degrees Fahrenheit) Test
- -20 degrees Celsius (-4 degrees Fahrenheit) Test

Each scenario was executed using a full load (FL), light load (LL), and a power factor (PF) test. The maximum deviation for the FL and LL tests was no greater than 0.3% from the reference performance at nominal temperature difference, and no greater than 0.5% for the PF test. Conditions, temperatures, and performance were used as specified in ANSI C12.20.

The following figures documented the types of environmental tests conducted in Structure's laboratory, and the procedural steps taken for each test.

Structure's Environmental Reference Test +23 degrees Celsius, ±5° (+73.4 degrees Fahrenheit, ±5°)	
Type of Test	Procedural Steps

Structure's Environmental Reference Test +23 degrees Celsius, ±5° (+73.4 degrees Fahrenheit, ±5°)	
Type of Test	Procedural Steps
Full Load (FL)	The first step in the environmental testing was to establish a reference performance test as a benchmark. The benchmark was established by placing a meter in a temperature chamber set at +23°C ±5° with the rated voltage (in this case, 240VAC) applied for a minimum of 2 hours. Rated test current was applied to the meter for no less than 1 hour prior to conducting the reference test. An accuracy test was conducted at rated current and unity power factor. The accuracy test result was recorded on the reference performance test page.
Power Factor (PF)	The loading device (meter test set) was switched to 50% PF at rated current. An accuracy test was conducted at rated current and 50% power factor. The accuracy test result was recorded on the reference performance test page.
Light Load (LL)	The test current was adjusted to 10% of the meter's rated test current for no less than 1 hour prior to conducting the reference test. An accuracy test was conducted, and the accuracy test result was recorded on the reference performance test page.

Figure 14: Structure's Environmental Laboratory Reference Test

Structure's Environmental Test +50° Celsius (+122° Fahrenheit)	
Type of Test	Procedural Steps
Full Load (FL)	The temperature chamber was set to +50°C ±5° and stabilized for 24 hours. The rated voltage was applied for a minimum of 2 hours, and the rated test current was applied for no less than 1 hour prior to conducting accuracy tests. An accuracy test was conducted at the rated current and unity power factor. The results of the accuracy test were recorded.
Power Factor (PF)	The loading device (meter test set) was switched to 50% PF at rated current. An accuracy test was conducted at the rated current and 50% power factor. The results of the accuracy test were recorded.
Light Load (LL)	The test current was adjusted to 10% of the meter's rated test current for no less than 1 hour prior to conducting the reference test. The accuracy test was conducted, and the results of the accuracy test were recorded.

Figure 15: Structure's Environmental Laboratory Test: +50° Celsius (+122° Fahrenheit)

Structure's Environmental Test -20° Celsius (-4° Fahrenheit)	
Type of Test	Procedural Steps

Structure's Environmental Test -20° Celsius (-4° Fahrenheit)	
Type of Test	Procedural Steps
Full Load (FL)	The temperature chamber was set to -20°C ±5° and allowed to stabilize for 24 hours. The rated voltage was applied for a minimum of 2 hours, and the rated test current was applied for no less than 1 hour prior to conducting accuracy tests. An accuracy test was conducted at the rated current and unity power factor. The accuracy test result was recorded.
Power Factor (PF)	The loading device (meter test set) was switched to 50% PF at rated current. An accuracy test was conducted at rated current and 50% power factor, and the accuracy test result was recorded.
Light Load (LL)	The test current was adjusted to 10% of the meter's rated test current for no less than 1 hour prior to conducting the reference test. The accuracy test was conducted, and the results of the accuracy test were recorded.

Figure 16: Structure's Environmental Laboratory Test: -20° Celsius (-4° Fahrenheit)

3.2 Field Meter Testing

3.2.1 Specific Scope of Work: Field Meter Testing

This section provides specific requirements outlined in Structure's Statement of Work as they pertain to field meter testing. As referenced in the Structure's Statement of Work, Structure's scope of work stated that field meter testing would be performed utilizing the Standards for Meter Installation, Maintenance, Testing and Calibration as set forth in the Direct Access Standards for Metering and Meter Data (DASMMD) in California in order to verify the accuracy associated with PG&E's SmartMeter system. This included:

- Site Verification
- Meter type and form factor
- Proper installation
- Meter programming and accuracy

As stated in the Statement of Work, Structure was to perform the analysis on a representative sample size, with the sample size determined using the statistical relevant sample size criteria based upon the American National Standards Institute (ANSI) Z1.4 or Z1.9 standards for testing meters with an inspection level of General II for the complaint meter testing and Special Level S-4 for the territory wide PG&E meter testing. The exact sample sizes, accuracy thresholds, and detailed testing procedures were to be developed by Structure and reviewed with the CPUC prior to the start of testing. The testing was to follow standard chain of custody procedures to ensure the integrity of the metering devices and equipment.

Per the Statement of Work, Structure was to utilize the following methodology to perform the field meter testing:

- Site Verification
    1. Metering verification
        a. Meter type meets CPUC requirements
        b. Verify correct customer and customer account
        c. Verify correct meter for service characteristics
        d. Verify physical security of meter
- Field Meter Testing Methodology
    1. Contact is made with the customer and the customer is notified that Structure is representing the CPUC in the Smart Meter assessment.
        a. CPUC/PG&E will explain that the meter tester will be onsite for about an hour testing the meter and determining that the meter is operating properly.
            i. Note: The CPUC reference here indicated CPUC's representative, where Structure was operating on behalf of the CPUC.
        b. The customer will be informed that the power will be interrupted and warned to shut down computers and any other electronic devices as necessary. It is anticipated that the testing should not interrupt the customer for more than 30 minutes.
    2. The area will be reviewed for any safety issues before proceeding.
    3. The current meter screens, meter markings and displays will be observed and recorded.
    4. The physical inspection and testing of the meter will occur.
        a. The meter will be validated as the correct meter.
        b. The meter program and all pertinent electronic data such as meter constants will be extracted.
        c. The main breaker will be opened and an observation will take place for continuous current flow.
        d. The meter seals will be cut and retained and meter removed from the socket.

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e. The meter base will be inspected and any loose or corroded connections will be documented.
f. *Voltage Test* – The voltage at the service location will be performed and recorded.
g. *Customer Load Test* - The meter will be placed into a portable test board and a calibrated load will be applied to the meter.
h. *Demand Test* - The meter will be operated with a constant load for a timed period.
i. *Register Verification* - Communications with the advanced meter operator will take place to do an on-demand read of the meter.
j. Verification will take place that the test data retrieved matches the meter reading.
k. All test results will be documented.
l. Meter will be placed back into service.

5. The customer will be notified that the test has been completed.

- Meter Replacements

  When the PG&E territory [electromechanical] sample meters were taken out of the field for lab testing, new [Smart] meters replaced them. Removal of these meters followed a chain of custody and were verified for proper operations.

  1. Note: This section of the Statement of Work was removed from Structure's scope upon further discussion with the CPUC, as moving the meters from the field to the laboratory could result in invalid test results. Testing was performed at the Customers' premises.

- Shadow Meter Testing

  Shadow meter testing was performed on 10 first generation meters (DCSI) and 10 second generation meters (SSN) included as part of the high bill complaints in order to validate meter programming and measurement accuracy in a field environment. Shadow metering was performed by installing a secondary interval recording meter in tandem to the primary residential meter and read for at least a full read cycle.

- Shadow Meter Testing Methodology

  1. Customer interface will be performed consistent with the field meter testing process developed.
  2. A site verification and field meter test will first be conducted on the [Customer's] existing smart meter.
  3. A tandem meter socket system will be installed which includes two new meter sockets installed into the customer main socket.
  4. Both the primary and shadow meters are wired such that they are electrically equivalent and measuring the same load.
  5. The smart meter and a new, lab tested, interval recording meter will be placed in service.
  6. A weekly on-site inspection will be conducted to access accuracy and security.
  7. During the period of test, approximately one calendar month, both meters will record all electricity consumption at the customer premise.
  8. At the end of the test period a meter technician will:
     a. Direct the Advanced Meter Infrastructure (AMI) operator to conduct an on-demand read of the smart meter.
     b. Interrogate the shadow meter to retrieve all recorded data.
     c. Remove the tandem meter socket system.
     d. Replace the Smart Meter to service.
  9. Once back at the meter shop, the meter technician will:
     a. Upload the meter data from their laptop to an interval data collection system.
     b. Export meter data in time-stamped format acceptable for analysis.
     c. Provide meter data to analysis team.
  10. The dates, times and activities will be recorded to daily activity log.

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11. The data collected from both the shadow meter and smart meter will be analyzed interval by interval, to determine results of testing.
12. A report will be prepared with statistics of testing.

In refining the project scope with the CPUC, the following changes were agreed to be made to the field testing specific scope:

- Reduce the number of meters tested in the laboratory, and increase the number of meters tested in the field. Additionally, the number of meters to be tested in various scenarios was revised from the original estimate. The following Figure provides the initial and revised estimates for meters to be tested as part of The Assessment. The field testing scenarios were referred to as "High Bill Complaint" and "Non-High Bill Complaint" populations. The High Bill Complaint population was derived from complaints received directly by the CPUC or PG&E and those received at the regulator-driven town hall meetings. Non-High Bill Complaint Customers refers to Customers who had not filed a high bill complaint through one of these channels.

Structure's Scope Testing Estimates		
Meters to Test	**Initial Estimate**	**Revised Estimate**
Complaint Smart Meters	100	100 (To include 20 shadow meters pre-tested in Structure's laboratory, 30 PG&E shadow meters, and 50 non-shadow complaint meters.)
Installed Smart Meters (DCSI, SSN) over whole PG&E territory	125	500
Warehouse Smart Meters	25	156 (To be both laboratory-tested and used as part of selected field testing scenarios.)
Removed Electromechanical Meters	25	0
Complaint Smart Meters in Kern and Fresno Counties	50	Included as part of the Complaint Meter population.
Non-High Bill Complaint Electromechanical Meter Field Test	0	100
Total	**325**	**856***

Figure 17: Structure's Scope Testing Estimates

*Note: The final number of meters tested was 859.

3.2.2 Field Meter Testing Approach

In conjunction with the laboratory meter testing, field meter testing was performed to verify the registration accuracy associated with PG&E's Smart Meter system utilizing the Standards for Meter Installation, Maintenance, Testing and Calibration as set forth in the Direct Access Standards for Metering and Meter Data (DASMMD) in California.

Applying the criteria and methodology outlined in the Statement of Work, field testing was conducted using six scenarios to evaluate both the registration accuracy of Customers' electromechanical and Smart Meters and

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PG&E's approach to meter installations. Each scenario was designed to simulate different processes and conditions and to analyze the in-field conditions of a representative sample of PG&E Residential Customers.

The field testing scenarios were referred to as "High Bill Complaint" and "Non-High Bill Complaint" populations. The High Bill Complaint population was derived from complaints received directly by the CPUC or PG&E and those received at the town hall meetings organized by California state senators. Non-High Bill Complaint Customers refers to Customers who had not filed a high bill complaint through one of these channels.

A summary of Structure's field meter testing scenarios is provided in the following Figure.

Summary of Structure's Field Meter Test Scenarios			
Scenario	**Description**	**Synopsis**	**Target # of Meters**
Scenario 3	Electromechanical Meter Test & Smart Meter Field Replacement	The procedure for replacing self-contained, residential electromechanical meters with new laboratory-tested warehouse Smart Meters.	50
Scenario 4	Non-High Bill Complaint Smart Meter Field Test	The procedure for field-testing currently installed non-high bill complaint Smart Meters at the Customer's premise.	500
Scenario 5	High Bill Complaint Smart Meter Field Test	The procedure for field-testing currently installed high-bill complaint Smart Meters at the Customer's premise.	50
Scenario 6	High Bill Complaint Shadow Meter Field Test	Shadow Meter testing involved comparing the reads of a Shadow Meter with the Customer's usage as recorded in the existing Smart Meter. Reads were taken in parallel over a billing period, and reflected the kWh accumulated in the shadow meter vs. the kWh accumulated in the Smart Meter over the same period of time.	20
Scenario 7	Non-High Bill Complaint Electromechanical Meter Field Test	The procedure for testing self-contained, residential electromechanical meters; and PG&E's potential replacement of them with PG&E Smart Meters.	100
Scenario 8	High Bill Complaint PG&E Installed Shadow Meter Test Verification	Structure verified the PG&E accuracy testing process and procedures according to standards and monitored the read accuracy of both the Smart Meter and the shadow meter. Structure verified, oversaw, and documented the PG&E installation process and procedures of the Shadow meters including the testing of the existing Smart Meter, testing of electromechanical meter being utilized by PG&E as the shadow meter, along with the weekly read analysis.	30

Figure 18: Summary of Structure's Field Meter Test Scenarios

Each of the field testing Scenarios 3-8 were conducted by Structure's meter technicians, accompanied by PG&E meter technicians. All meter removals and installations were performed by PG&E's meter technicians under Structure's observation. This was done as agreed upon with the CPUC in order to minimize Structure's liability and to maintain the meter installation/removal procedures that were established by PG&E. PG&E removed the meter, Structure performed the required tests, and Structure observed PG&E's reinstallation of the meter.

Testing the accuracy of PG&E Smart Meters at Customer premises (in the field) meant addressing several situations:

- An existing electromechanical meter slated for replacement with a laboratory-tested, warehouse stock, Smart Meter
- A Smart Meter that was operating on the premises of a Customer who:
  - had not filed a complaint about the bills associated with the device
  - had filed a complaint about the bills associated with the device

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- A Smart Meter that was currently operating on a Customer's premises who had filed a high bill complaint, to be augmented with a "shadow" meter installation to provide parallel measurements of load over a given period of time utilizing either a accuracy-tested third party Smart Meter or PG&E-supplied electromechanical meter.

Each of these situations required the creation of a specific test scenario. As with the laboratory testing of meters, Structure considered the procedures, personnel, logistics, inter-organizational activities, and communication tools required to field test PG&E meters. These considerations were then documented within field and reference documents to ensure that a consistent, logical, and robust testing regimen was conducted with well-designed protocols to produce reliable results.

3.2.2.1 Meter and Field Testing Site Selections

Per The Assessment's scope, Structure did not test all of PG&E's residential Customer meters. Structure selected a representative sample size of PG&E's Customer base using specific criteria. The sample size criteria and testing approach were based upon the ability to reasonably assess the sample size for the attributes being tested. Where applicable, the sample sizes selected for the meter test populations were developed using the American National Standards Institute (ANSI) sampling criteria and were approved by the California Public Utilities Commission.

The list of factors with the potential to affect meter performance or unusually high bill generation included:

- Meter manufacturer – to determine whether one of PG&E's two Smart Meter vendors was inordinately responsible for high bill complaints
- Meter form – to determine if a particular type of connection between the meter and the grid was causing inaccurate measurements and high bills
- Meter program – to facilitate evaluation of different versions of Smart Meter firmware
- Climate zone – to facilitate evaluation of meter performance in different climates
- Meter age – to determine if there was a correlation of Smart Meter high bills based upon age of electromechanical meter replaced to age of electromechanical meter

The Electromechanical Meter Test & Smart Meter Field Replacement and the Non-High Bill Complaint Electromechanical Meter Field Test (Scenarios 3 and 7) field location selections were accomplished by obtaining the Wellington two week meter exchange schedule over a four week period. The exchange schedule was then parsed to obtain only those locations with the appropriate meter form with a residential billing rate. This population of approximately 64,000 meters was then sorted by Premise ID, a random number assigned by the PG&E Customer Information System. A random number generator was then used to select the first test location and every Nth location after that, where N was the ratio of the sample population divided by the required number of test locations.

The Non-High Bill Complaint Smart Meter Field Test (Scenario 4) meter population was stratified to determine if there were statistical differences in accuracy by:

- Climate Zone
- Communication Technology (DCSI or SSN)
- Billing Rate (Residential)
- Meter Manufacturer (LG or GE)
- Meter Form (1S, 2S, 2S-320, or 12S)
- Meter Read Method (Manual or AMI Enabled)

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The climate zone map designations are found in Appendix C - California Climate Zone Map. Structure's stratification of the Scenario 4 meter population is illustrated in the following Figure.

Structure's Stratification of the Meter Population for Field Meter Test Scenario 4							
Cells	**DCSI**		**SSN**		**Manual Read**		**Totals**
	L+G	**GE**	**L+G**	**GE**	**L+G**	**GE**	
Zone 1	464	0	0	0	224	2,966	
Zone 2	2	0	20,178	11,818	32,312	43,243	**107,553**
Zone 3	17	0	199,320	281,514	94,013	131,917	**706,781**
Zone 4	145	43	14,029	18,810	54,581	87,392	**175,000**
Zone 5	124	0	0	272	0	0	
Zone 11	18	2	38,809	50,501	872	15,819	**106,021**
Zone 12	19	0	266,710	333,345	53,059	81,762	**734,895**
Zone 13	108,815	2,621	214,012	234,729	26,790	33,446	**620,413**
Zone 16	4	0	505	428	1,847	1,937	**4,721**
	109,608	2,666	753,563	931,417	263,698	398,482	**2,455,384**

Figure 19: Structure's Stratification of the Meter Population for Field Meter Test Scenario 4

The selection process involved parsing PG&E's total installed electric meter database of over 5.2 million meters to obtain those locations where a Smart Meter had been installed. The resulting 2.4 million Smart Meter population was then parsed to determine the number of Smart Meters installed in each cell. The combination of 9 climate zones, 2 communication technologies, 2 meter manufacturers, and 2 meter reading methodologies resulted in a 54 cell matrix to be utilized for statistical sample size determination. Upon further meter count evaluation, cells with fewer than 3,000 actual meter locations were excluded from the test matrix reducing the test matrix to 30 cells. Based on a statistical sample of currently installed Smart Meters as of April 1, 2010, Structure utilized the meter testing population size limit of 500 for this test scenario to further refine the resulting test matrix to 16 meters per cell. The meters were sorted by Premise ID, a random number assigned by the PG&E Customer Information System. A random number generator was utilized to select the first test location within each cell and every Nth location thereafter, where N represented the cell population ratio divided by the required test locations number.

Once Structure determined the various scenario sample sizes, the selected Customers were notified and scheduled, with coordination by Structure and PG&E. The schedule was then communicated to the Structure field meter technicians and PG&E's designated personnel. PG&E was responsible for transmitting the schedule to the PG&E field meter technicians.

3.2.2.2 Field Meter Testing Procedures

Structure determined the processes required to test meters safely, completely, and accurately at Customer premises in cooperation with but without interference from PG&E, the media, or other interested parties, while also ensuring that the Customer understood the test procedure and intent. These processes were

documented in the form of procedural documents and aids, and supplied to and reviewed with each of Structure's field testers. Additionally, the Meter Testing Scenarios procedure document was provided to and reviewed with PG&E to ensure that Structure's expectations and protocols regarding the roles, general procedure, and Customer call center interactions were understood. The document outlined the testing scenarios to be addressed, along with information related to each of the scenarios for the following areas: high-level procedure; personnel; logistics; touch points between PG&E, Structure, and CPUC; determination of call center interaction; and anticipated Customer impact. An overview of the Customer contacts, e.g., the Customer Notification Letter, and media contact preparations was also provided in the document.

The Meter Testing Scenarios document clearly delineated the personnel responsible for each scenario's procedural steps, and also noted that all field and lab procedural activities were to be performed by Structure unless specified within the procedures; e.g., the removal and replacement of meters was solely handled by PG&E under Structure's observation, with testing of the meters conducted by Structure. Additionally, the document stated that the Structure Call Center Representative would handle only those calls directly related to the PG&E AMI Assessment testing effort, as addressed in the applicable section of the document, and that a CPUC Point of Contact has been appointed to address Customer questions related to the CPUC's authorization of the evaluation, along with a Structure Technical Point of Contact to address technical questions related to the evaluation.

The Structure field meter test specialist's daily regimen was directly based on the procedure outlined in the Scope of Work, with the following exceptions:

- Cut meter seals were not retained upon removal from the sockets. Photographs were taken of the as-found and as-left meters, including any original meter seals as they were found, and the Structure and PG&E meter seals as they were left.
- Register Verification of communications with the advanced meter operator to do an on-demand read of the meter were only applicable to Scenario 6's installation of shadow meters.
- Meters were not taken out of the field for laboratory testing.
    - The exception to this scope modification was the four meters discussed in the Unauthorized Meter Swap section of this document. The four meters taken to the laboratory for this testing were the old meters, and PG&E had already replaced the old meter with a new PG&E meter not tested by Structure. The receipt of the meters taken to the laboratory for accuracy testing followed a chain of custody from PG&E to Structure.

To support field testing, Structure created field test templates, a custom database to store the field test data, customer notifications of the field testing, and media press kits. Structure developed the meter testing and meter issue documents based on input from meter technicians to determine the appropriate values to be extracted from the meter test equipment for the purpose of identifying any variances from CPUC standards for meter accuracy within the various test meter populations.

Given the volume of meters evaluated and the requirement for standardized recordkeeping by personnel working in both a laboratory and in the field, Structure recognized the need to maintain test results within an electronic database. Accordingly, the forms developed to track the meters' chain of custody and the accuracy of field meters were translated into a Microsoft Access application, created for this Assessment. The Structure Meter Testing Database was primarily used for cataloging the field meter test results. The meter technicians updated the database at each premise with the test results. The results were then uploaded to the master database, and photographs taken at each premise saved to CDs and a secure central server.

The field meter specialists' activities encompassed performing the following activities:

- Download the most recent full Meter Testing Database to the Structure specialists' laptop prior to commencing a day's route

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- Meet with PG&E technician at Customer premise
- Notify Customer of testing procedure
- Handle any Customer or media requests for comments or information, per established procedures
- Verify as-found conditions to the Meter Testing Database and document any variances within the Meter Testing Database
- Test meter and document results in the Meter Testing Database
- If necessary, complete a Meter Review-Replacement Required (MRRR) form and provide PG&E with a copy of the form
- Repeat all but the first step in the daily test regimen until the day's route has been completed
- At the end of the day:
    - Export a copy of all photos with encoded GPS coordinates taken during the day from the camera to a secure thumb drive.
    - Export test results from laptop to the secure FTP site, for incorporation in the master Meter Testing Database.

Additionally, Structure project leads conducted regular calls with the Structure field meter technicians to facilitate communications and address issues related to the field work.

3.2.2.3 Communications with Customers

Structure had four primary channels of communication with Customers:

1. Advance Notifications of Field Testing
2. On-Site Notification of Field Testing
3. On-Request Information Regarding Field Testing
4. Customer Call Center

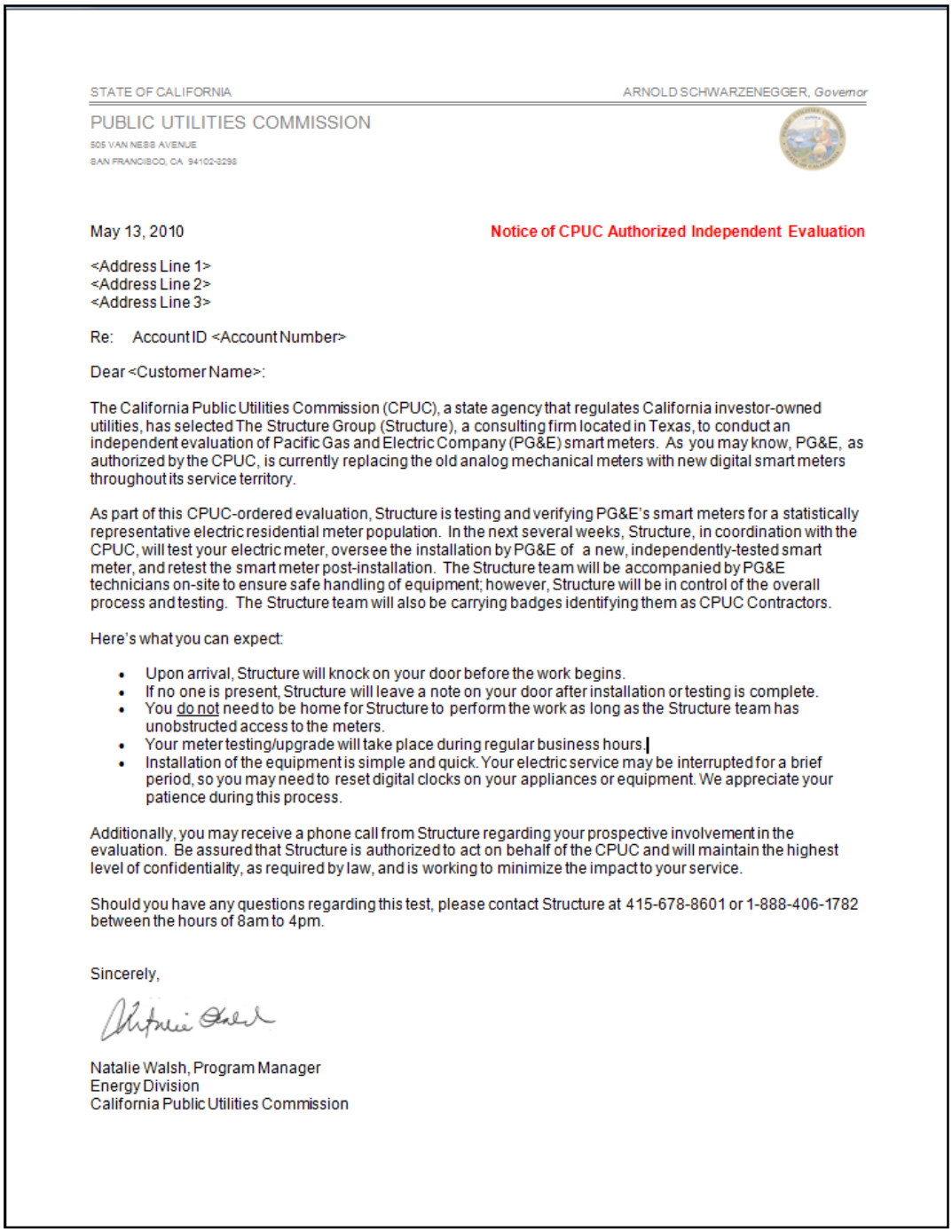
Customers selected for potential testing received advance Customer notifications of the CPUC-ordered independent assessment through a Customer Notification Letter and a Customer Call. A door hanger was left at each Customer's premise as an on-site notification that field testing had been performed. If a Customer requested additional information, the field meter technicians followed the documented communications guidelines, and provided Smart Meter FAQs and/or an outline of the field meter testing procedures as applicable. The Structure Customer Call Center was included as part of all Customer communications, and served as the point of contact for Customers during this Assessment.

3.2.2.3.1 Advance Notifications of Field Testing

The Customer Notification letter was the first notification sent by Structure on behalf of the California Public Utilities Commission. The letter provided an overview of the upcoming evaluation, a summary note regarding the specific test that was to be performed, an outline of what the Customers could expect during the testing, and Structure Call Center contact numbers for questions regarding the test. Each letter was customized for the specific scenario to be tested.

A sample of the Customer Notification Letter sent by Structure on behalf of the CPUC is illustrated in the following Figure, as applicable to Scenario 3, "Replace an Electromechanical Meter with a Smart Meter".

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STATE OF CALIFORNIA — ARNOLD SCHWARZENEGGER, *Governor*

PUBLIC UTILITIES COMMISSION
505 VAN NESS AVENUE
SAN FRANCISCO, CA 94102-3298

May 13, 2010 — **Notice of CPUC Authorized Independent Evaluation**

<Address Line 1>
<Address Line 2>
<Address Line 3>

Re: Account ID <Account Number>

Dear <Customer Name>:

The California Public Utilities Commission (CPUC), a state agency that regulates California investor-owned utilities, has selected The Structure Group (Structure), a consulting firm located in Texas, to conduct an independent evaluation of Pacific Gas and Electric Company (PG&E) smart meters. As you may know, PG&E, as authorized by the CPUC, is currently replacing the old analog mechanical meters with new digital smart meters throughout its service territory.

As part of this CPUC-ordered evaluation, Structure is testing and verifying PG&E's smart meters for a statistically representative electric residential meter population. In the next several weeks, Structure, in coordination with the CPUC, will test your electric meter, oversee the installation by PG&E of a new, independently-tested smart meter, and retest the smart meter post-installation. The Structure team will be accompanied by PG&E technicians on-site to ensure safe handling of equipment; however, Structure will be in control of the overall process and testing. The Structure team will also be carrying badges identifying them as CPUC Contractors.

Here's what you can expect:

- Upon arrival, Structure will knock on your door before the work begins.
- If no one is present, Structure will leave a note on your door after installation or testing is complete.
- You do not need to be home for Structure to perform the work as long as the Structure team has unobstructed access to the meters.
- Your meter testing/upgrade will take place during regular business hours.
- Installation of the equipment is simple and quick. Your electric service may be interrupted for a brief period, so you may need to reset digital clocks on your appliances or equipment. We appreciate your patience during this process.

Additionally, you may receive a phone call from Structure regarding your prospective involvement in the evaluation. Be assured that Structure is authorized to act on behalf of the CPUC and will maintain the highest level of confidentiality, as required by law, and is working to minimize the impact to your service.

Should you have any questions regarding this test, please contact Structure at 415-678-8601 or 1-888-406-1782 between the hours of 8am to 4pm.

Sincerely,

Natalie Walsh, Program Manager
Energy Division
California Public Utilities Commission

Figure 20: Structure's First Issue of Customer Notification Letter for Scenario 3: Electromechanical Meter Test & Smart Meter Field Replacement

The CPUC received a number of returned Customer Notification Letters labeled by the US Post Office as undeliverable due to unknown address. Structure investigated these returns and found that PG&E had provided only the premise address to Structure and had not provided the billing address for the customer. Customers that did not receive a letter due to a returned-mail notification were not removed from the premise testing as Customers received notification of the testing through other channels, such as letters, calls, and on-site door notifications.

Following meter testing notification through the Customer Notification Letter, a corollary courtesy call was made to each Customer. A call script was developed and customized for each field test scenario. These call scripts were recorded and used to contact Customers prior to the field testing. The call scripts used for each scenario are included in the Customer Communications Procedure.

A sample of Structure's call script is provided in the following Figure, as applicable to Scenario 3, "Replace an Electromechanical Meter with a Smart Meter".

> "This is a courtesy call from The Structure Group on behalf of the California Public Utilities Commission to let you know that the electric meter installed at your location may be selected for testing within the next 30 days. If selected, we will test your electric meter, oversee the installation by PG&E of a new, independently-tested Smart Meter, and retest the Smart Meter post-installation. We have no reason to believe your meter is experiencing a problem. You do not need to be present for this work, and we will leave a note on your door to let you know when the test is complete. If you would like to speak with someone about this test, please call 415-678-8601 or 1-888-406-1782 from Monday through Friday, between the hours of 8am to 4pm PST."

Figure 21: Structure's Sample Customer Call Script

Customer requests for testing or removal from the Structure testing population were documented, communicated to PG&E, and accommodated whenever possible.

3.2.2.3.2 On-Site and On-Request Notification of Field Testing

Structure left door notices on the Customer's door following completion of their meter being tested. The door notices included the logos for both the CPUC and Structure, accompanied by the notification detailed in the Figure below.

> "Your meter was tested today by The Structure Group on behalf of the California Public Utility Commission as part of an independent evaluation of the Pacific Gas and Electric Company Smart Meters.
>
> Should you have questions regarding this test, call 1-415-678-8601 or 1-888-406-1782 Monday-Friday between 8am-4pm.
>
> During your meter test, there may have been a brief power outage. Please check your electronic equipment, appliances, and sprinkler system to reset timers and clocks. We thank you for your patience."

Figure 22: Structure's Field Testing Door Notice Verbiage

Frequently Asked Questions (FAQs) regarding the Smart Meter evaluation process and a high-level outline of the meter testing procedures was available to Customers at the Customer's test time. The documents were provided only upon request by the Customer.

Additionally, Structure developed a media/press kit for the field meter technicians to provide to any media personnel encountered at a Customer's premise during the field testing. When the field meter technicians encountered media personnel, they followed specified documentation and communication procedures. Per the procedures, media were referred to the CPUC's media contact, signed a media log sheet, and been provided with the press kit. The Cover Letter for Structure's Press Kit is found in the following Figure.

The California Public Utilities Commission (CPUC), a state agency that regulates California investor-owned utilities, has selected The Structure Group (Structure), a consulting firm located in Texas, to conduct an independent evaluation of Pacific Gas and Electric Company (PG&E) Smart Meters. PG&E, as authorized by the CPUC, is currently replacing the old analog electromechanical meters with new digital Smart Meters throughout its service territory.

This Press Kit includes the following information related to the California Public Utility Commission-mandated evaluation of Pacific Gas and Electric's Smart Meters:

1. Cover Letter
2. CPUC Initial Press Release
    a. October 14, 2009
3. CPUC-Structure Press Releases
    a. March 30, 2010
    b. May 13, 2010
4. Smart Meter FAQs
    a. March 30, 2010
    b. May 13, 2010
5. Outline of Meter Testing Procedures
6. OSHA Standard 1910

All Structure and PG&E personnel involved in field testing are required to wear appropriate personal protective equipment (PPE), as required in OSHA standard 1910. To ensure safety for all involved, personnel not authorized by CPUC or PG&E are not permitted to interact with the meter technicians, and will be required to maintain the distance mandated by OSHA's ground fault current standard, as established by the on-premise security perimeter.

All questions regarding this evaluation should be directed to:

CPUC: Terrie Prosper, 415.703-1366, news@cpuc.ca.gov

Structure: Phyllis Goodson, 910.616-9160, phyllis.goodson@thestructuregroup.com

Figure 23: Structure's Press Kit Cover Letter

Structure did not encounter the need to use or distribute the Press Kit during field meter testing.

3.2.2.3.3 Structure Customer Call Center

As identified in the Customer Notification Letter, the Customer Call, and on the door hanger left at the Customer's premise, the Structure Customer Call Center was the first point of contact for all those Customers

selected for field meter testing related to the PG&E AMI Assessment. The Structure Customer Call Center was staffed by a member of Structure's team, using a dedicated phone line with a California number. Customers with general questions or complaints were referred to the CPUC. Normal billing and any PG&E-specific questions were directed to the PG&E Customer Call Center.

The Structure Customer Call Center Representative logged and answered questions related to the PG&E AMI Assessment. If the questions required additional clarifications, the Structure Customer Call Center Representative routed the call to the appropriate CPUC, PG&E, Structure, or Media point of contact, as established in the Communications procedure. The Structure Call Center Call Log was used to track all inbound and outbound calls from the 415-678-8601 or 888-406-1782 phone numbers. The phone lines were disconnected at the conclusion of the project.

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3.3 End-to-End System Testing

"End-to-End" testing in this report refers to the flow of meter usage and event data from the Customer premise, through the PG&E AMI and Billing systems, including the application of the appropriate tariff rates on the bill, to the Customer's receipt of the printed bill. In addition to meter data and bill analysis, the end-to-end system test involved side-by-side "shadow metering." All end-to-end test cases involved installation of a dual-meter socket, and were "shadowed" by a laboratory-tested and calibrated solid-state, or "electronic", meter in the other socket. Details on Structure's shadow metering procedure and individual shadow meter configurations were documented for each of the end-to-end test cases.

End-to-end test cases were broken into 9 separate cases: 5 laboratory cases and 4 field cases. All test cases used a PG&E Smart Meter. The laboratory test cases included Silver Spring (SSN) network interface card (NIC) technology. Field test cases were divided between 2 Aclara/TWACS Net Server (TNS) NIC meters and 2 SSN NIC meters that were deployed by PG&E prior to this Assessment.

Structure utilized Customer's meters from the Shadow Meter Field Testing scenario (Scenario 6) and a subset of laboratory-tested meters to verify end-to-end processing of meter usage to the Customers' bill, including the application of the appropriate tariff rates on the bill. The end-to-end testing was performed during the same test period and time period as the Shadow Meter Testing and included one billing cycle.

3.3.1 Laboratory End-to-End System Testing Approach

Structure's objective for the end-to-end laboratory test was to replicate PG&E's standard process for collecting and handling Smart Meter data with Smart Meters subjected to controlled, varying, and known load conditions, as well as simulated exception conditions designed to stress PG&Es systems. To achieve this objective, Structure requested that PG&E create "proxy accounts" for each laboratory test case. Five proxy accounts were created in PG&E's live Customer billing system. Each account was bound to the same system configuration guidelines and Validation Editing and Estimation (VEE) rules as the typical residential PG&E Smart Meter Customer. The referenced VEE standard was California Interval Data VEE Rules Revision 2.0.

End-to-end laboratory testing scenarios were driven by simulating specific metering conditions and tracking the results over a complete billing period. Laboratory testing was designed to test how PG&E's AMI system collected, validated, estimated, stored, and billed meter usage and event data under adverse conditions.

Five meters were used in the end-to-end laboratory test. After preliminary benchmark testing of the five end-to-end sets of Smart Meters had been completed, the selected devices were connected to a like form and class, electronic, certified accurate "shadow" meter. Each of these pairs of meters was subjected to a different amount of load, reflecting measurement at various rate tiers over the test period. Deviation between the amount of load seen at each Smart Meter and the respective "shadow" meter were identified as exceptions.

A SSN/Access Point unit was also installed in the proximity of the test laboratory to allow the end-to-end meters to communicate with the head-end of PG&E's billing system. This allowed Structure to test network availability and to verify the integrity of data exported from the meter. In addition, measures were taken at the laboratory to restrict or eliminate wireless access to the PG&E network by the meters, providing Structure with the opportunity to study the impact of missing data upon the generation of Customer bills. To further ensure independence from PG&E, the actual load, exception conditions, and duration of the test were not known to PG&E or the CPUC.

The end-to-end shadow meter pairs were subjected to the introduction of common exceptions to normal conditions including power outages, voltage swells, Radio Frequency outages, and voltage sags. The common exception inclusion facilitated testing PG&E's capability to handle commonly occurring problems in

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the field and perform validation, editing, and estimation (VEE) processes in compliance with CPUC rules, under these conditions and without introducing errors into Customer bills.

"Proxy" Customer accounts were created within PG&E's billing system for each of the end-to-end meters, giving Structure the ability to determine the adequacy of PG&E's application of billing determinants and rate assignments and the timeliness of physical bill issuance when charging Customers. The end-to-end test process was designed for completion over the course of one PG&E billing cycles.

The following equipment was used in the end-to-end test:

- Marwell Products A-Base adaptors
- Powerstat, 240 volt Variable autotransformer
- TESCO Phantom Load
- Staco Energy, 240 volt Variable autotransformer
- Dayton 5kW, 240 volt, resistive heater
- Marley Engineering 1.5 kW, 120 volt resistive heater
- Elster, Form 2S, A3TL Watthour meters (four meters)
- Elster, Form 1S, A3TL Watthour meter (one meter)

The meter specifications used in this test were:

- General Electric, Form 2S, I-210+, with Silver Spring NIC (two meters)
- Landis+Gyr, Form 2S, Focus AXR – SD, with Silver Spring NIC (two meters)
- General Electric, Form 1S, I-210+, with Silver Spring NIC (one meter)

Each of the five meters under test (MUT) were shadowed with an Elster A3TL of like electrical characteristics programmed to display total kWh delivered and maximum kW demand, and to perform a self-reading performed daily at midnight. The Elster meters also had internal mass-memory programmed to record kWh delivered hourly.

The end-to-end test Smart Meters were also referred to as "meters under test" (MUT) to distinguish them from the shadow meters. The following test cases were performed on the MUTs.

- Test Case 1 used 240 volt Form 2S meters with a variable voltage source (0 – 280 V) and a variable load current (0 – 50 A). Testing consisted of comparing MUT meter register readings and shadow meter, comparison of shadow meter interval data and Meter Data Management system (MDM) interval data, and blocking LAN communications of a meter with varying source voltage and varying load current.

- Test Cases 2 through 4 used 240 volt Form 2S meters with a fixed source voltage (240 V) and a variable load current (0 – 30 A). Testing consisted of comparing meter register readings of the MUT and shadow meters, comparison of interval data of the shadow meter and interval data of the MDM, and blocking LAN communications of meters with a stable source voltage and varying load current.

- Test Case 5 used 120 volt Form 1S meters with a fixed source voltage (120 V) and a fixed load current (12.5 A). Testing consisted of comparing meter register readings of the MUT and shadow meter and comparison of interval data of the shadow meter and interval data of the MDM of a meter with a stable source voltage and stable load current.

In accordance with Structure's End-to-End Test Plan, two of the Landis+Gyr meters were reprogrammed, the internal mass memory switched on, energized at varying loads, and shadowed by two Elster A3TL meters. The load profile data from these meters was compared and used to validate the output of the Silver Spring NIC.

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As part of the End-to-End testing, Structure had PG&E remove the password to the optical port of two of the laboratory meters to verify the metrology of the meter independent of the SSN NIC card. The meter reads obtained directly from the meter, independent of the NIC, were compared to shadow Elster meters with the same load applied in the laboratory. This test was conducted for 11 days. The result of the comparisons is provided in the Figure below.

Structure's Laboratory Meter Optical Port Comparisons			
Shadow Meter	**PG&E Badge #**	**Average Difference**	**Standard Deviation**
TSG-002	1006334261	0.000425	0.028249
TSG-004	1006327586	-0.017475	0.017187

Figure 24: Structure's Laboratory Meter Optical Port Comparisons

3.3.2 Field End-to-End System Testing Approach

The goal of end-to-end field testing was to track Customer usage and events for a complete billing period and analyze billing accuracy under actual field conditions. Moreover, this effort took a detailed look at the historical usage patterns of a PG&E high-bill-complaint Customer to identify consistencies and/or anomalies surrounding the Customer's complaint.

Customers chosen for end-to-end field testing were selected from a subset of 20 high-bill-complaint accounts for Shadow Meter Field Testing. All end-to-end Customer accounts were configured as non-time-of-use accounts. In addition to collecting cumulative anchor reads, each meter was configured to store 60-minute interval usage, collected daily by the AMI system for VEE and storage.

3.3.3 End-to-End System Testing Evaluation of Results

End-to-end testing was designed to test "Meter-to-Bill" PG&E processes for non time-of-use PG&E accounts, for a subset of both laboratory-based and field-based meters. To verify meter usage data's end-to-end processing from the meter to the Customers' printed bill, Structure performed in-depth data analysis on each PG&E system interface that handles Smart Meter data. Structure submitted a data request to acquire meter usage and diagnostic data elements necessary to complete the assessment. The data request was developed to provide complete visibility into how meter usage and meter event data were processed by PG&E's AMI systems, and to specify a comprehensive list of AMI and Billing exception reports with a defined weekly schedule by which extracts were to be delivered to Structure.

Upon receipt of the defined extracts, Structure performed a three-part meter data analysis:

- Part 1 targeted meter reading and VEE accuracy. Usage data from 9 PG&E AMI meters was compared against usage data collected from 9 shadow meters. Comparison involved line-by-line, anchor, and interval-read examination.
- Part 2 focused on PG&E AMI exception reporting. Analysis compared three primary data-points:
    - Meter events from the PG&E AMI meter
    - Exception reports extracted from the PG&E AMI systems:
        - Aclara Head-End
        - Silver Spring Network (SSN) Head-End

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        - Ecologic Analytics' (EA) Meter Data Management System (MDMS)
        - Customer Care & Billing (CC&B)
    - Results from the application of Structure's Laboratory Test Calendar, which detailed the defined the timeline for laboratory meter test simulations and anticipated meter exception outcomes.
- Part 3 focused on bill-print accuracy: inspection of tier baseline Average Daily Usage (ADU) allocation, use of appropriate billing tariffs, KWH calculation, and timeliness of delivery to the Customer billing address.

3.4 High Bill Complaint Analysis

3.4.1 Specific Scope of Work: High Bill Complaint Analysis

This section provides specific requirements outlined in Structure's Statement of Work, as they pertain to high bill analysis. As referenced in the Structure's Statement of Work, Structure's scope of work included performing the following tasks:

Structure was to cross check complaints to narrow 300 customer complaints to actual AMI-related concerns by identifying type of customers, complaint category, determination of cause, etc. To accomplish this Structure was to:

1. Perform historical customer complaint review utilizing Customer Information System (CIS) for analysis and trending for 6 months prior to smart meter installation to end of 2009.
    a. Review all changes made to the customer's account including rate tariff change history.
    b. Review Meter Exchange orders to verify proper installation of billing determinants such as meter exchange readings, billing constants, meter form factor, etc.
    c. Review exception logs and data repair history for these accounts.
2. For those accounts that do show causation from rate tariff changes or meter exchange errors Structure was to:
    a. Correlate usage to weather data to identify anomalies in weather adjusted usage patterns including historical analysis of meter data.
    b. Develop report on results of statistical analysis and correlations.
    c. Develop customer complaint model correlated to weather and prior energy usage patterns.
3. For those accounts that did not show causation due to rate tariff changes, meter exchange errors, or weather related factors Structure was to:
    a. Prepare interview questions and conduct interview to determine if customer usage patterns had changed due to customer behavior, installation of new equipment/appliances, or faulty equipment/appliances.
    b. Develop report on results of interview process.
4. For those accounts that had not had causation determined from the previous reviews, Structure was to:
    a. Structure was to perform the above defined field test on the customer meter.
5. Analyze actual bills (provided by CPUC staff) received by PG&E's customers who had filed complaints to determine if there is a pattern of anomalies that indicate a systematic or intermittent problem in the AMI, MDM or billing systems.
6. Identify any trends that require additional applicable testing to confirm process/system modifications initiated.
7. Develop report of customer complaints and trend analysis.
8. Develop test plan and sample selection for reconciliation across systems and printed/automated bill print based on:
    a. reference ID,
    b. time period,
    c. meter read date and cycle,
    d. rates,
    e. volumes (estimated or actual),
    f. adjustment factors,
    g. total dollars,
    h. premise,
    i. customer ID,
    j. time period,
    k. automated adjustments,

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l. manual adjustments,
m. payments,
n. field orders,
o. settlements,
p. fees,
q. deposits,
r. re-bills.

9. Perform billing component validation testing utilizing defined test plan on statistically relevant sample size along with historical customer complaints.
10. Review applicable system upgrades objectives (release plans) and implementation timing for billing elements systems of record, bill calculation engines, data repositories along with printing engines.
11. Develop report on testing.

3.4.2 High Bill Complaint Analysis Approach

Structure conducted an analysis of the 1,360 electric Customer complaints filed by PG&E Customers from September 2007 through April 2010, which included the original 300 identified complaints from the Bakersfield and Fresno town hall meetings. In many cases, Customer complaints were filed with both the CPUC and PG&E; as such, the electric Customer complaint population actually reflected 1,378 electric residential Smart Meter unique accounts of high-bill complaint Customers, including the 231 Town Hall Complaints, during the specified period.

Structure compared the average daily kilowatt hour (kWh) usage history, bill cycle length, cancel/re-bills, duplicate billings, estimated meter reads, and average cost per kWh for each Customer's account. The objective of the high bill analysis was to determine if the high bill complaint customers experienced increased kilowatt hour (kWh) usage after installation of Smart Meters, and if the Customer bill was accurately represented.

In order to perform a more in-depth analysis of Customer complaints, Structure requested that PG&E provide additional information regarding a subset of 73 Customer complaints that included usage profiles, resolution codes and complaint resolution timeframes that required further research and supporting documentation. The 73 Customer complaints were a biased selection from the high bill complaints register based upon the propensity to identify system issues within the complaint population, Structure was provided with the 73 Customer complaint details, including PG&E Customer Management notes, usage profiles, resolution analysis, and detail for additional analysis. The 73 complaints were evaluated for completeness and reasonableness of explanation, and included as a source of the Customer interviews.

3.4.2.1 Test Data Selection Criteria

Structure developed selection criteria for testing customer accounts with Smart Meter High Bill Complaints based upon the availability of data for the Customer complaint population including:

- Method by which Customer complaint was registered (PG&E Customer Service High Bill Complaint Group, CPUC Customer Advocacy Board or Senator Flores' Bakersfield and Kern town hall meetings)
- Compliant resolution time
- Complaint classification (High Bill, Meter Issue, Smart Meter not wanted, Communication issues, Rate Issues, Other)
- Commodity type (Electric, Electric and Gas, Gas Only)
- Customer specific data

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- Meter set date
- Meter removal date (if applicable)
- Meter specification (meter manufacture, meter model type, meter form, meter configuration, meter firmware, AMI- enabled, Network Information Card (NIC), NIC model , NIC firmware
- Rate schedule
- PG&E territory location

Structure also requested and received the Customer usage history, including historical kWh monthly usage data by Customer premise in a separate file from the Customer complaint details. Structure had requested 5 years of historical monthly kWh usage data if available, and was provided historical data on each account available for the past 9 years. Structure reviewed all available data provided by PG&E for each account. The Customer monthly data included:

- Average Daily Usage
- Billing period
- Cancel/re-bill designation
- Rate structure
- Electric monthly total
- Bill total

Structure correlated the Customer premise-related data with the premise usage history to develop findings for this Assessment.

3.4.3 Customer Interviews

Structure performed Customer interviews as part of our analysis of PG&E's handling of Customer's complaints. Customer interviews participants were selected based on the following criteria:

- Customers who submitted a high bill complaint through the CPUC CAB or PG&E Customer Management process during the period from June 1, 2009, to June 10, 2010. Structure also included Town Hall participants in the initial selection criteria.
- Customer willingness to participate.

Structure selected 100 high bill complaint Customers to contact, which include the 73 Customer complaints identified from the list that Structure was provided, and an additional 27 complaints with usage patterns and complaint resolution status that appeared to be misaligned. Structure completed 20 Customer phone interviews regarding the complaint resolution process and overall satisfaction with the PG&E resolution process. Structure facilitated each call with the PG&E high bill complaint Customer. The CPUC was also present during several Customer interviews. During the interviews, Customers were asked to describe their situation around their high bill complaint as well as questions related to processes and resolution procedures followed by PG&E. With the Customers' permission, Structure followed up on each Customer interview with PG&E's Customer Relations-Escalation Management team to further review the complaint and resolution on behalf of the Customer.

Structure performed an independent test of PG&E's call center utilizing the information from Structure's proxy Customer shadow testing account, focusing on the call center complaint handling and a Smart Meter test request to obtain direct experience with the Customer call center.

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3.5 Best Practices Associated with Smart Meters

3.5.1 Specific Scope of Work: Best Practices Associated with Smart Meters

This section provides specific requirements outlined in Structure's Statement of Work, as they pertain to the best practices associated with Smart Meters. As referenced in the Structure's Statement of Work, Structure's scope of included performing the following tasks:

Structure was to perform the activities around best practices including:

- Confirm that PG&E followed established practices in place for the following areas:
  a. Meter manufacturing quality control.
  b. Meter installation standards.
  c. Meter equipment safety.
  d. Meter Deployment.
  e. Meter Data Management Interfaces.
  f. Validating, Estimating and Editing for monthly and interval data.
  g. Account billing.
  h. High Bill complaint troubleshooting.
- Structure was to determine best practices around the areas reviewed above by performing the following activities:
  a. Utilize a base set of industry leading practices as standards for performance.
  b. Confirm with (3) utilities who have deployed similar technologies that the practices undertaken are best in class.
  c. Confirm with (3) industry experts that the practices are best in class across the industry.
  d. Develop report of Best Practices.
- Structure was to develop a report that compares the validated best practices to the actual practices performed in Kern and Fresno counties and current practices by PG&E and identify variances.

Structure performed the following activities around best practices:

- Assess how PG&E's practices compared with industry best practices in the following areas:
  - Meter manufacturing quality control.
  - Meter installation standards.
  - Meter equipment safety.
  - Meter Deployment.
  - Meter Data Management Interfaces.
  - Validating, Estimating and Editing for monthly and interval data.
  - Account billing.
  - High Bill complaint troubleshooting.

Structure also compared the validated best practices to the actual practices performed in Kern and Fresno counties and current practices by PG&E.

The following sections present the methodology and criteria used to assess best practices associated with Smart Meters.

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3.5.2 Best Practices Associated with Smart Meters Evaluation Approach

The following sections present the approach and methodology used in the evaluation of PG&E's practices compared to industry standards. The areas evaluated assessed were:

- Meter Manufacturing Quality Control
- Meter Installation Standards
- Meter Equipment Safety
- Meter Deployment
- Meter Data Management Interfaces
- Validating, Estimating, and Editing for Monthly and Interval Data
- Account Billing
- High Bill Complaint Troubleshooting

3.5.2.1 Meter Manufacturing Quality Control

To ensure that meters used for an Advanced Metering Infrastructure (AMI) implementation comply with meter manufacturing Quality Control, the utility should only purchase metering from manufacturers that have implemented the ISO 9001 Quality Control System. The Utility's responsibility will be to ensure that the manufacturer has indeed implemented the processes by requesting the ISO 9001 certification documents, and that they continue to adhere to ISO processes and standards. This is best accomplished though on-site review and auditing at the meter manufacturing location or locations. Specifically related to meter manufacturing, the following standards and process should be followed.

- ANSI certification: ANSI C-12 testing that is required for any meter product to demonstrate metrology accuracy, electric integrity and safety. This should be done at an independent third party
- FCC certification: The meter with AMI module must be certified per the FCC requirements for transmission power, interference/interoperability, etc.
- First Article Testing: This is the testing that occurs on the first article of a first design, or major design changes.
- Manufacturing Quality: The circuit boards should be wave soldered and processed according to mass volume quality standards. There should be adequate testing of each board during the manufacturing process to identify manufacturing defects.
- Calibration Testing: Each meter should be tested and calibrated as it leaves the manufacturing process. The calibration results should be captured electronically and provided with the NOS file. The calibration equipment should be maintained against a Radian standard and calibrated/checked at least once each shift.
- Sample Testing: Each lot of meters should be sample tested according to AQL standards. This testing should be conducted either on-site (just in time sample testing) or at the utility facilities (typical batch sample testing).
- Change management: Need to validate and ensure that there are proper documentation and procedures whenever a manufacturing, firmware or design change occurs. This may include ANSI and FCC certification. This should be covered in ISO 9001, but doesn't hurt to look at this explicitly.
- Configuration Management: Need to validate that the supplier is managing the configuration information to know exactly what was shipped and what the configuration is (including the numbering). This should be reflected in the NOS, but need to know that they have a system in place to manage this and resolve discrepancies.

Areas to be audited include:

3.5.2.1.1 Customer Related Processes

3.5.2.1.1.1 Determination of Requirements Related to the Product

Meter Manufacturer determines:

- Requirements specified by the Utility, including the requirements for delivery and post-delivery activities

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- Requirements not stated by the Utility but necessary for specified or intended use, where known
- Federal, Statutory and regulatory requirements applicable to the product, and
- Any additional requirements considered necessary by the Meter Manufacturer.

3.5.2.1.1.2 Review of Requirements Related to the Product

Meter Manufacturer should review the requirements and specifications related to the product as requested in the utility purchasing process. This review is conducted prior to Meter Manufacturer's commitment to supply a product to the Utility (e.g. submission of tenders, acceptance of contracts or orders, acceptance of changes to contracts or orders) and ensures that:

- Product requirements are defined
- Contract or order requirements differing from those previously expressed are resolved
- Meter Manufacturer has the ability to meet the defined requirements.

Records of the results of the review and actions arising from the review are maintained. Where the Utility provides no documented statement of requirement, the Utility requirements are confirmed by Meter Manufacturer before acceptance. Where product requirements are changed, Meter Manufacturer ensures that relevant documents are amended and that relevant personnel are made aware of the changed requirements.

NOTE: In some situations, a formal review is impractical for each order. In those cases, the review can cover relevant product information such as catalogues or advertising material.

3.5.2.1.1.3 Utility Communication

Meter Manufacturer determines and implements effective arrangements for communicating with Utility in relation to:

- Product information,
- Product roadmap and impending changes or enhancements,
- Manufacturing issues and delays during the project period
- Enquiries, contracts or order handling, including amendments, and
- Utility feedback, including customer complaints.

3.5.2.1.2 Design and Development

3.5.2.1.2.1 Design and Development Planning

Meter Manufacturer plans and controls the design and development of product. During the design and development planning, Meter Manufacturer determines:

- The design and development stages.
- The review, verification and validation that are appropriate to each design and development stage, and
- The responsibilities and authorities for design and development.

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3.5.2.1.2.2 Design and Development Inputs

Inputs relating to product requirements shall be determined and records maintained. These inputs shall include:

- Functional and performance requirements.
- Applicable statutory and regulatory requirements.
- Where applicable information derived from previous similar designs, and
- Other requirements essential for design and development.

The inputs shall be reviewed for adequacy, requirements shall be complete, unambiguous and not in conflict with each other.

3.5.2.1.3 Purchasing

During the Purchasing process, the Meter Manufacturer ensures that purchased product conforms to specified purchase requirements. The type and extent of control applied to the supplier and the purchased product is dependent upon the effect of the purchased product on subsequent product realization or the final product.

3.5.2.1.3.1 Purchasing Information

Purchasing information describes the product to be purchased, including where appropriate:

- Requirements for approval of product, procedures, processes and equipment,
- Requirements for qualification of personnel
- Quality management system requirements.

Meter Manufacturer ensures the adequacy of specified purchase requirements prior to their communication to the supplier.

3.5.2.1.3.2 Verification of Purchased Product

Meter Manufacturer establishes and implements the inspection or other activities necessary for ensuring that purchased product meets specified purchase requirements. Where Meter Manufacturer or the Utility intends to perform verification at the supplier's premises, Meter Manufacturer states the intended verification arrangements and method of product release in the purchasing information.

3.5.2.1.4 Production and Service Provision

3.5.2.1.4.1 Control of Production and Service Provision

As applicable, Meter Manufacturer plans and carries out production and service provisions under controlled conditions. Controlled conditions include:

- The availability of information that describes the characteristics of the product,
- The availability of work instructions, as necessary,
- The use of suitable equipment,
- The availability and use of monitoring and measuring equipment,

- The implementation of monitoring and measurement activities, and
- The implementation of product release, delivery and post-delivery activities.

3.5.2.1.4.2 Validation of Processes for Production and Service Provision

Meter Manufacturer validates any processes for production and service provisions where the resulting output cannot be verified by subsequent monitoring or measurement and, as a consequence, deficiencies become apparent only after the product is in use or the service has been delivered. Validation demonstrates the ability of these processes to achieve planned results. As applicable, Meter Manufacturer establishes arrangements for these processes including:

- Defined criteria for review and approval of the processes,
- Approval of equipment and qualification of personnel,
- Use of specific methods and procedures,
- Requirements for records
- Revalidation.

3.5.2.1.4.3 Identification and Traceability

Where appropriate, Meter Manufacturer identifies the product by suitable means throughout product realization. Meter Manufacturer identifies the product status with respect to monitoring and measurement requirements throughout product realization. Where traceability is a requirement, Meter Manufacturer controls the unique identification of the product and maintains record.

3.5.2.1.4.4 Preservation of Product

Meter Manufacturer preserves the product during internal processing and delivery to the intended destination in order to maintain conformity to requirements. As applicable, preservation includes identification, handling, packaging, storage and protection. Preservation also applies to the constituent parts of a product.

3.5.2.1.4.5 Control of Monitoring and Measuring Equipment

Meter Manufacturer determines the monitoring and measurement to be undertaken and the monitoring and measuring equipment needed to provide evidence of conformity of product to determined requirements. Meter Manufacturer establishes processes to ensure that monitoring and measurement can be carried out, and is carried out in a manner that is consistent with the monitoring and measurement requirements. Where necessary to ensure valid results measuring equipment is:

- Calibrated, verified or both at specified intervals, or prior to use, against measurement standards traceable to international or national measurement standards; where no such standards exist, the basis used for calibration or verification shall be recorded,
- Adjusted or re-adjusted as necessary,
- Have identification in place to determine the individual meter calibration status,
- Safeguarded from handling practices and tampering that would invalidate the measurement result, and

- Protected from damage and deterioration during handling, maintenance and storage.

In addition, Meter Manufacturer assesses and records the validity of the previous measuring results when the equipment is found not to conform to requirements. Meter Manufacturer takes appropriate action on the equipment and any product affected. Records of the results of calibration and verification are maintained.

Note: Confirmation of the ability of computer software to satisfy the intended application will typically include its verification and configuration management to maintain its suitability for use.

3.5.2.1.5 Measurement, Analysis, and Improvement

To ensure that the Meter Manufacturer plans and implements the monitoring, measurement, analysis and improvement processes needed to:

- Demonstrate conformity to product requirements,
- Ensure conformity of the quality management system, and
- Continually improve the effectiveness of the quality management system.

This includes determination of applicable methods, including statistical techniques, and the extent of their use.

3.5.2.1.5.1 Monitoring and Measurement

Customer satisfaction is one of the measurements of the performance of the quality management system. Meter Manufacturer monitors information relating to customer perception as to whether the Meter Manufacturer has met customer requirements. The methods for obtaining and using this information are determined by reviewing.

3.5.2.1.5.2 Internal Audits

Meter Manufacturer conducts internal audits at planned intervals to determine whether the quality management system:

- Conforms to the planned arrangement to the requirements of ISO 9000 and to the quality management system requirements established by the Meter Manufacturer, and is effectively implemented and maintained.

An audit program is developed by taking into consideration the status and importance of the processes and areas to be audited, as well as the results of previous audits.

The audit criteria, scope, frequency and methods are defined. The selection of auditors and conduct of audits ensure objectivity and impartiality of the audit process. Auditors do not audit their own work. The responsibilities and requirements for planning and conducting audits, and for reporting results and maintaining records are defined in a documented procedure. The management responsible for the area being audited ensures that any necessary correction and corrective actions are taken without undue delay to eliminate detected nonconformities and their causes. Follow-up activities include the verification of the actions taken and the reporting of verification results.

3.5.2.1.5.3 Monitoring and Measurement of Processes

Meter Manufacturer applies suitable methods for monitoring and where applicable, measurement of the quality management system processes. These methods demonstrate the ability of the processes to achieve planned results. When planned results are not achieved, correction and corrective action is taken, as appropriate.

3.5.2.1.5.4 Monitoring and Measurement of Product

Meter Manufacturer monitors and measures the characteristics of the product to verify that product requirements have been met. This is carried out at appropriate stages of the product realization process in accordance with the planned arrangement. Evidence of conformity with the acceptance criteria is maintained. Records indicate the person(s) authorizing release of product for delivery to the customer. The release of product and delivery of service to the customer does not proceed until the planned arrangements have been satisfactorily completed, unless otherwise approved by a relevant authority and where applicable, by the customer.

3.5.2.1.5.5 Control of Nonconforming Product

Meter Manufacturer ensures that product which does not conform to product requirements is identified and controlled to prevent its unintended use or delivery. A documented procedure is established to define the controls and related responsibilities for dealing with nonconforming products. Where applicable Meter Manufacturer deals with nonconforming product by one or more of the following ways:

- By taking action to eliminate the detected nonconformity,
- By authorizing its use, release or acceptance under concession by a relevant authority and, where applicable, by the customer, and
- By taking action to preclude its original intended use or application.
- By taking action appropriate to the effects, or potential effects, of the nonconformity when nonconforming product is detected after delivery or use has started.

When nonconforming product is corrected, the product is subject to re-verification to demonstrate conformity to the requirements. When nonconforming product is detected after delivery or use has started, Meter Manufacturer takes action appropriate to the effects, or potential effects, of the nonconformity such as recalls, bulletins, etc. Records of the nature of nonconformities and any subsequent actions taken, including concessions obtained, are maintained.

3.5.2.1.5.6 Analysis of Data

Meter Manufacturer collects and analyzes appropriate data to demonstrate the suitability and effectiveness of the quality management system and to evaluate where continual improvement of the effectiveness of the quality management system can be made. This includes data generated as a result of monitoring and measurement and from other relevant sources. The analysis of data provides information relating to:

- Customer satisfaction
- Conformity to product requirements
- Characteristics and trends of processes and products including opportunities for preventive action
- Suppliers

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3.5.2.1.6 Acceptance Testing

Acceptance testing of delivered meters and modules should be conducted in conjunction with ANSI/ASQC Z1.4. Sample lots should be randomly drawn from delivered truck loads and tested for acceptance purposes. Should the sample fail the initial acceptance test the lot may be retested using more stringent acceptance levels. Should the second sample fail, the entire shipment should be returned to the Meter Manufacturer as non compliant and root cause analysis should be instituted to determine the reason or failure.

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3.5.2.2 Meter Installation Standards

3.5.2.2.1 Detailed Approach and Methodology

The utility must develop a detailed approach, methodology, and standards for AMI meter installations. These requirements will serve as the key drivers in the AMI installation process and ultimately will serve as a major component of the success of the overall project.

A detailed work plan should be developed that includes the specific tasks, milestones, deliverables, and timing. The plan should also include resource ramp up and down and the corresponding equipment delivery schedule that will be needed to match the resource availability for the implementation.

3.5.2.2.2 Detailed Project Management Plan

A detailed project management plan should include the following:

- The details of the project team that will be utilized to support the project, and the roles and responsibilities of all of the proposed project members. An organizational chart of the project staff, identifying the number and type of resources needed from both the utility and contractors, along with their roles and responsibilities. Installation Call Center and Field Service support requirements should be included.
- The number of full time, part time and contract employees that will be utilized on the project.
- If the contractor is involved in multiple contracts simultaneously they should define the ability to support multiple concurrent installation contracts with multiple utilities.
- Determine how staff is recruited, including pre-employment screening and background checks from any contractors.
- Determine how new staff will be trained and include sufficient knowledge transfer and monitoring
- Identified risks and mitigation plan, issues tracking, communication plan (both internal and external)
- Detailed Project plan identifying tasks and dependencies
- Change management plan should include both impacts to internal resources and external customers
- Testing Plan and ongoing quality assurance monitoring/auditing
- Equipment handling policy for new and retired assets

3.5.2.2.3 Staffing Plan

Within thirty (30) days of contract signing, contractors should provide a staffing plan to the utility that demonstrates adequate staffing that will be available throughout the project. Potential contract employees should undergo background checks including driving records and drug and alcohol checks at the expense of the Contractor. This recruitment and retention plan should include details including; staffing requirements throughout the project, management and oversight personnel, external contactors to be utilized, recruitment literature and sources, training for multiple areas, training evaluation, field training etc.

3.5.2.2.4 Tools

The contractor is generally expected to provide:

- Signage for installation of AMI meters and AMI communication network
    - Some contractors will supply vehicles. Where vehicles are not supplied by the Contractor, the Contractor must ensure that employee supplied vehicles are safe and presentable.

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- Fire rated safety equipment and safety face shields
- Personal Protective Equipment (PPE) and supplies
- Tools and supplies for installing AMI meters and AMI communication network
- Installer uniforms

In addition to the previous expectations the Contractor should provide a handheld field tool that supports the following functionality:

- Field tool shall have ability to read the barcodes on new meters.
- Installation tool shall have ability to test network and meter communication.
- Field tool should have GPS recording capabilities, although this is not required.
    - The accuracy of the GPS should be 3-5 meters under normal conditions. The accuracy of the Contractor's GPS reading should be verified prior to deployment
- Field tool shall have ability to capture and communicate to the Installation Contractor's Meter Management System the meters physical location (GPS coordinates), device location, removed meter number, and removed meter final read, and any field notes and flags/discrepancies.
- Installation tool shall interface with the utility's Customer Information and /or Field Order System .
- The field tool shall be capable of communicating through either the public communications network (e.g. GSM) or be uploaded or downloaded through a docking station.
- A field tool shall be configured to support the installation and communication testing of Smart Meters and support the close out of work orders through Work Management System (WMS).
- The field tool shall be capable of initiating a new work order in the field if one is unavailable for the work.
- The field tool shall be capable of verifying that the Smart Meter is working properly.
- The field tool shall be able to initiate a meter self-test and support the trouble shooting of the meter through a display of meter diagnostics.
- The field tool shall be capable of capturing manual field notes and attaching these notes to the work order.
- The field tool shall identify if there is a discrepancy between a meter ID and associated address.
- The field tool shall be able to communicate with the Smart Meter through an optical port or through RF communications.
- The field tool shall perform all "normal" meter check functions e.g. validates read and notifies installer if read is outside specified variance, etc.

3.5.2.2.5 Installer Training

Meter Installation training should be provided to all meter Installers. Training should include but is not limited to the following subjects:

- Customer interaction rules and guidelines
- Utility meter replacement safety rules
- Field safety
- Identifying hazardous conditions
- Meter reading accuracy
- Field work practices
- Defensive driving
- Identifying potential meter tampering and energy diversion

Contractor should provide revenue protection training to all AMI meter installation technicians. This training should include how to spot meter tampering and energy diversion when replacing meters, safety concerns of

revenue protection, procedures and policies dealing with revenue protection, safely handling customers who are not in compliance with the law, etc.

3.5.2.2.6 Identification

All Contractor employees and sub-contractors should be clearly identifiable as Contractors. Identification badges should be utilized to enforce contractor identification and must be worn at all times while in the field. All vehicles should clearly display company logo and information.

3.5.2.2.7 Communication

The Utility should be responsible for all communications to the public relating to the installation of the new AMI meters. A joint communication plan should be developed by the Contractor and utility for deployment of meters. All Contractor employees should be provided with communication materials and background information on the project and the AMI meters. All Contractor employees should be provided with phone numbers and contact information should customers request additional information.

An attempt should be made to advise customers that their meter is being changed and that there will be a short interruption to service. The Contractor employee should ensure that the customer representative is of sufficient age and capability to understand the impending activity. In the event the customer is not available at the time of the installation and the Contractor can safely access the meter without interference, a door hanger or flyer should be left at the premise following the successful installation advising the customer of the installation or, in the case of inadequate access or safety, advising the customer to contact the Utility or call center.

3.5.2.2.8 Installation Plan

Contractors should work with the utility to develop a plan for the installation of the AMI meters that includes any pilot implementations and the full meter rollout. The installation plan should detail the hiring procedures for employees, the training methodology/content, detailed billing blackout days (days before and after billing cycle where meter should not be replaced), meter delivery schedules, AMI communication network deployment and target installation levels. The installation plan should ensure that the AMI communication network is in place and operational prior to the installation of any AMI meters within the coverage of the AMI communication network.

The Installation Plan should include the guidelines for when the Contractor has exhausted efforts for installing a meter and turns the work over to the utility. The process for the Utility to resolve UTC (unable to complete) cases should be included in this Installation Plan.

This plan should be jointly developed as early as possible and continuously updated and reviewed by both parties at an agreed upon interval.

3.5.2.2.9 Key Performance Indicators (KPI)

Key Performance Indicators (KPI) should be jointly developed by the Contractor and utility to provide a consistent objective measure of installation processes' performance. Daily reports should be generated and distributed by the Contractor to keep utility informed as to the installation progress. A standard set of KPI's typically used to ensure the project is meeting the defined objectives should include:

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- Project Schedule Compliance (Meters planned vs. Meters installed, AMI communication network devices planned vs. installed)
- Meter and equipment failure (as a % of all devices)
- Meter access failures (as a % of all attempts)
- Unable to Complete (as a % of all planned installs)
- Customer Complaints (response and resolution times)
- Meter socket/panel unfit for installation (as a % of all attempts)
- Safety breaches and employee accidents
- Quality of workmanship
- Route Saturation (% of meters installed on a route within the first billing cycle)

The Contractor should continually monitor the process to ensure the identification and resolution of commissioning and provisioning process issues. All installation data supplied back to utility should be validated through the appropriate validation criteria (Hi/Low, Missing, meter/service point relationship, etc.). Exceptions should be flagged and corrected (where possible) prior to upload to utility. All completed, and failed, installation work orders should be uploaded to the utility by midnight of the installation day to ensure all data can be properly processed and validated within one day of the installation.

3.5.2.2.10 Exchange Meter

Contractor's installers should complete the following steps to physically install a meter:

- Attempt to contact each customer at the time of installation. If unable to directly advise the customer, a door hanger should be left at the premise advising the customer of the installation.
- Ensure service is not interrupted without customer notice on accounts with medically essential equipment (identified on deployment file). If the customer cannot be directly advised, alternate arrangements (e.g., appointment) should be made with the customer. Where a medical condition is flagged, the Installer must ensure that the person answering the door is of adequate age and capability to understand that electric service will be interrupted. If such person is not available, the installer should skip the installation and arrange for a follow up.
- Assess overhead / underground feed to the meter for damage and suitability of installation.
- Assess the meter enclosure and lid for damage and suitability of installation.
- Remove the existing meter seal, seal ring and meter enclosure lid.
- Visually examine the meter enclosure and meter jaws for damage and suitability of installation.
- Refer any damaged meter enclosures / facilities that preclude safe installation to their Field Supervisor for documentation / repair (see Customer Repair section below).
- Identify and report current diversion condition found. (See Digital Imaging - Current Diversion section).
- Capture removal reading and remove the existing meter. All readings that fail high/low validations should require that the meter be re-read and the reading be re-entered in the handheld.
- Re-examine the meter enclosure and meter jaws for damage and suitability of installation.
- If a meter is currently disconnected, the new AMI meter should be set in a disconnected state. The AMI meter should be set to the disconnected state before installation of the meter.

- Install meter and capture meter readings from the set meter. Verify there is no service caution flag evident on bottom of display. If meter display is blank, displaying 88888, presenting a service caution flag, or is otherwise not functioning properly, verify voltage is correct at socket.
- If socket is dead and account is inactive, installer should install meter disconnect blank.
- If voltage is correct, apply Unsatisfactory Performance Report (UPR) label to defective meter with applicable comments and set another AMI meter.
- Capture new meter and module data from device bar codes. Meters whose meter-module serial number combinations fail validation against the meter-module relationship table provided by utility should not be installed. These meters should be tagged separately and returned to utility for investigation / correction.
- New meters should be set as the existing meter was found (e.g., on, off) and their installed disposition communicated via the installation file.
- New meters set “off” should have the Meter disconnect status set to disconnected..
- Replace meter enclosure lid, replace lock (if present).
- Re-seal the meter enclosure lid and seal ring with a new seal.

3.5.2.2.11 Premise Access

In instances where the installation cannot be completed due to access (a skip), the installer should leave a door hanger explaining the installation was attempted and instructing the homeowner to call the appropriate call center (either Contractor or Utility) to set a convenient time for the installation to be completed. Call Center contact number should be listed on the door hanger.

All skips should receive up to three calls from Call Center requesting an appointment. These calls should span out at least over a one week period, with at least one attempted after normal working hours.

If after an agreed upon (typically three) in-person attempts and an agreed upon (typically three) telephone attempts, the installation has not been completed, the customer should be returned to utility as UTC (unable to complete) and the Utility is responsible for utilizing its standard processes for obtaining access to the customer premises for meter exchange.

3.5.2.2.12 Access to System Data

Contractor should work with utility to provide online access to meter installation and inventory data. Contractor should provide daily reports from their WMS (work management system) and inventory management system that contains all of the data relating to the meter exchanges. Digital photographs of the meter prior to removal should be made available to utility. Contractor should identify all exceptions and identify accounts where premise access is still pending.

3.5.2.2.13 Reporting Framework

Contractor should provide daily and weekly reports to utility that details project activity and provides status as defined by utility and the Contractor.

A reporting framework should be developed by the Contractor for use by the Contractor and the Utility. Reports should be automated and include items such as:

- Planned vs. installed AMI meters

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- Planned vs. installed AMI communication network devices
- UTC instances
- Inventory levels (by meter base and form)
- KPI's
- Status reports
- Tampering and Diversion cases
- Customer complaint cases
- Employee accident cases
- Staffing levels
- Other reports as defined in planning phase by Contractor & Utility

The ability for the utility to run ad hoc reports at any time should be provided by the Contractor. The Utility should be provided access to the Suppliers databases for access to service orders, new installation information and meter exchange information. Access to revenue protection information and site access information should also be provided from the Suppliers database. Daily and Weekly progress meetings should be held to address issues and concerns.

3.5.2.2.14 Customer Service/Complaints

Contractor should employ a work force management and customer service system to track and resolve customer complaints. The customer service procedure should document the process employed by Contractor field technicians and Contractor call center personnel when responding to customer service requests. This procedure should outline the data requirements and tracking process to complete service calls.

- Contractor should contact customer within the two business days of receiving the complaint.
- Contractor should forward an email to Utility the same day contact is made outlining arrangements made with customer.
- Contractor should forward an email to the Utility outlining the actions taken and/or the results of their investigation
- Contractor should forward customer complaints to the appropriate utility group, where the customer complaint is outside of the guidelines and responsibility of the Utility.

A summary of the customer complaints should be included in the weekly project summary, with details made available upon utility request.

3.5.2.2.15 Inventory Management

3.5.2.2.15.1 Tracking

The Contractor or the Utility should supply an inventory tracking application and associated business processes for the receipt and tracking of the AMI meters and AMI communication network equipment. This application should track meters and equipment through the meter lifecycle, from the receipt of the meter, sample testing, in route, received in warehouse, in inventory, assigned, on truck, installed, retired/scrapped etc. Tracking should be provided to the warehouse site location(s) and be made accessible to utility personnel.

The Contractor or Utility should utilize an inventory management application to manage the depletion and replenishment of meters, equipment, parts, and supplies. Material shortages should be known in advance of a deployment and this information should be provided to utility. The inventory management application should

be able to track small inventory items such as meter seals, tamper tools, miscellaneous hardware etc. Daily inventory reconciliation should be generated to ensure adequate staffing levels of materials and supplies. Any discrepancies in inventory should be investigated and remedied in an expedient manner.

3.5.2.2.15.2 Security

Contractor or Utility should maintain security at each of the installation warehouses to ensure the security of the inventory. The Contractor is responsible for the security of Contractor held inventories. The warehouse employees should have adequate training on warehouse equipment including forklift training and safety procedures.

3.5.2.2.15.3 Material and Equipment Liability

All equipment that is provided by Utility such as the meters and miscellaneous equipment are the property of Utility and must be returned at the completion of the project. The Contractor, if appropriate, should assume responsibility for any damage to or loss of equipment from the Utility including; meters, hardware, property or other supporting equipment.

3.5.2.2.15.4 Tools

The contractor should furnish all necessary tools, test equipment and communication equipment necessary to complete the meter installations. It should be the responsibility of the Contractor to supply the technicians with these tools.

3.5.2.2.16 Diversion Detection and Resolution

If a Contractor identifies a situation where tamper or energy diversion is suspected, the Contractor should contact a designated Utility representative or Contractor supervisor and skip the installation so that Utility personnel can investigate the diversion condition. This is the best practice as Contractor personnel are not adequately trained to investigate and resolve diversion situations and should not be put into the position of dealing with these situations.

3.5.2.2.17 New Meters

Notice of Shipment files (NOS) should be received electronically from the meter manufacturer and not handled manually. This file contains the type of meter, meter serial number, communication module and communication ID. This information should be updated in the Utility's meter tracking system and inventory system. Meters are received by the Contractor at the individual warehouses, and appropriate inventory systems are updated.

The Contractor should work with the Utility, and the meter vendor to develop a project delivery plan. The plan should include the quantities of meters needed, meter types, needed delivery locations and dates. The plan should be updated on a regular basis throughout the project. The Contractor may also utilize a dedicated system to accomplish the deployment and provisioning of the AMI meters.

Contractor may receive pallets of meters directly from the meter manufacturer. The Contractor should send the utility a statistically valid sample of meters for testing. Alternatively, the Utility may arrange for Source Inspection of the meters such that sample testing is performed as meters complete the manufacturing process

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and prior to the shipment of the meter. The Contractor should verify that the shipment quantity received matched expected quantity, inspect shipment for damage, and should enter all meter update information into the meter inventory system. The Contractor should also provide utility delivery receipt for the shipment.

Meter acceptance testing is performed on a statistically valid sample batch of meters and if the batch is accepted the inventory status is updated. If any meters are damaged or do not pass initial acceptance testing, this information is updated in the inventory status and relayed to the Utility. The Utility should have access to the inventory system.

3.5.2.2.18 Customer Repairs

Contractor or Utility should repair minor meter socket damage as they are identified or occur during the implementation of the project. An installer should notify their field supervisor when a potential site is identified as damaged during the course of meter exchange. The field supervisor should inspect the site, document the damage with a digital camera, and determine the level of repairs needed.

- Premises that require electrical repairs before meter exchange can be completed should scheduled for repair with an utility preferred electrical contractor. Contractor and/or their designated electrical contractor should be responsible for obtaining any permitting or licensing required for performing repairs.
- Where damage is identified which would result in unsafe meter exchange and where the damage is greater than within the scope of the utility contractor repair, the Contractor should immediately notify a Utility field supervisor and remain at the site until the supervisor arrives. The Utility field supervisor will work with the customer to resolve the unsafe condition.
- Field supervisor should pull the existing meter, blank the socket and hang a yellow caution tag for any extreme wiring problem that is deemed unsafe and hazardous. Customer should be notified of the needed repairs.
- Contractor should notify utility in the event utility crew assistance is required for repairs (e.g., service disconnect/reconnect) or service is terminated for an unsafe/hazardous condition.
- All repairs need to meet NESC standards and comply with applicable local, county or city ordinances.
- Repairs should be completed within the same day unless necessary parts are not available.

3.5.2.2.19 Defective Meters

Meters that are installed and deemed as defective should be labeled and returned to the warehouse. The Utility should be informed of all defective meters at least on a weekly basis.

The Contractor's technicians should verify voltage and service conditions prior to replacement with another meter. If there are any issues with the installation, or there are issues with the enclosure, the Contractor should be responsible for correction of the issue. If any substandard service conditions are encountered, a qualified electrical contractor should be contacted by the Contractor and the Contractor or Utility should coordinate all work involved in repairing the condition.

New serial numbers for the meter and communication module should be recorded in the handheld device and this information uploaded to utility. Metrics should be maintained by the contractor on all defective devices.

3.5.2.2.20 Data Exchange

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The Utility and Contractor should exchange data in a mutually agreed upon format daily. The mode of transfer should be determined by the Contractor and utility.

Contractor should hold select installation records for the purposes of obtaining digital imaging, verifying out reads and remedying potentially erroneous data. Contractor should, however, in all cases send all completion data to utility by midnight after installation.

The Contractor should provide for a verification of the closing read of the removed meter. The first verification of the read should occur as part of the meter exchange process and is part of the validation algorithms in the handheld field tool to compare the closing read against a high/low check. A second verification should occur in the Contractors meter handling facilities. This second verification can be a second reading of the meter and comparison against the reported closing read or a digital image of the closing meter read.

The following files should be shared with the Contractor through a secure site on a daily basis:

- Deployment File – Extract from Customer Information System containing customer information, meter type, form, and class data, and meter reads
- Installation File – Listing of sites to be installed
- AMI Meter Marriage File – File of Meter/Communication module relationships
- UTC File - File of dates when a meter cannot be changed out.

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3.5.2.3 Meter Equipment Safety

Meter Equipment and Installation Safety training should be provided to all meter Installers and technicians. Training should include but is not limited to the following subjects:

- Utility meter replacement safety rules
- Meter testing rules and procedures
- Field safety
- Identifying hazardous conditions
- Identifying potential meter tampering and theft
- Field work practices
- Defensive driving

Safety meetings should be conducted on a weekly basis. The content and dialog of these safety meetings should be recorded and included in the monthly reports to the utility. Contractors should provide a written Code of Safety Practices for review and approval by the utility.

Standards, regulations, and specifications related to Meter Equipment Safety include:

- OSHA Standard 1910-269 Electric Power Generation, Transmission, and Distribution, Appendices A & B
- ANSI C2-1993, National Electrical Safety Code.
- ANSI/IEEE Std. 100-1988, IEEE Standard Dictionary of Electrical and Electronic Terms.
- ANSI/IEEE Std. 516-1987, IEEE Guide for Maintenance Methods on Energized Power-Lines.
- ASTM D 120-87, Specification for Rubber Insulating Gloves.
- ASTM F 496-93B, Specification for In-Service Care of Insulating Gloves and Sleeves.
- ASTM F 1236-89, Guide for Visual Inspection of Electrical Protective Rubber Products.
- ASTM F 1505-94, Standard Specification for Insulated and Insulating Hand Tools.
- ASTM F 1506-94, Standard Performance Specification for Textile Materials for Wearing Apparel for Use by Electrical Workers Exposed to Momentary Electric Arc and Related Thermal Hazards.

Personal Protective Equipment (PPE) required for to safely remove and replace residential meters include:

- Flame retardant shirt meeting ASTM F 1506-94
- Leather gloves for non energized work
- Rubber gloves rated at 1000 volts with leather gauntlets meeting ASTM D 120-87 for work on energized equipment
- Safety glasses for work on non energized equipment
- Full face protection while inserting or removing residential meters

Steps required to safely remove and replace a residential meter installation include:

- The installer will visually inspect the weatherhead and meter panel for signs of tamper, damage or excessive wear. The installer should verify adequate and safe access to the meter panel.
- The Installer will remove the meter or circuit panel door slowly.
- If there is a bypass or a main breaker present at the meter, the Installer will operate the bypass or main breaker before removing the meter.

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- The Installer should examine the inside of the meter box for danger, theft, animal or insect infestation or other irregularities.
- The Installer should take a voltage reading, checking for proper voltage and back feed, with an approved device.
- The Installer will place both gloved hands on the meter. One hand will be placed on the bottom of the meter and will be used to steady the meter. The other hand will be placed on the top of the meter. The top hand will be used to unseat the meter by applying slow and steady downward force until the meter is released from the top meter jaws and rocks back into the bottom hand. The Installer will then pull the meter away from the meter base removing it from the bottom meter jaws.
- The Installer will examine the inside of the meter panel for danger or irregularity. The Installer will examine wiring, connections, lugs, blade receivers and the meter block.
- If the meter socket, block and contents appear to be in good condition, the Installer will approach the meter base with the new meter, confirming the new meter is the proper voltage, form and class for the installation
- The Installer will place the meter in the front of the meter base slowly. The Installer will look around the side of the meter in an effort to properly align the bottom two blades of the meter with the blade receivers. The Installer will apply even pressure until the bottom two blades are inserted into the blade receivers. Once the bottom blades are in place the Installer will apply even pressure both inward and upward until the two top blades are secure. The Installer should not hit or strike the meter with any tool.
- If a bypass or main breaker was opened during installation, the Installer will close them to energize the meter.
- The Installer will then replace the meter cover and seal the installation with utility provided meter seals.

3.5.2.4 Meter Deployment

Meter deployment for an AMI system should take into account the customer types, meter types and geographic areas where the Business Case benefits are the greatest. For instance, one utility may find significant pay backs by deploying its system first to transient customer accounts such as, apartments, college areas, and trailer parks to eliminate field service work involved with turn on and turn offs. Another utility may find that the largest benefit is to implement time of use and critical peak pricing rates to Commercial and Industrial customers. Either scenario is may be valid and drive the meter deployment strategy in different directions.

Meter Deployment strategy is generally broken down into the AMI Communication Network Deployment and Meter Deployment. In all cases, the AMI Communication Network should be deployed ahead of the AMI Meters to ensure that as soon as an AMI meter is installed it can communicate with the AMI network and complete the provisioning process.

3.5.2.4.1 Communication Network Deployment

3.5.2.4.1.1 AMI Communication Plan

The AMI Supplier should create a network plan leveraging topology maps, density figures and RF propagation characteristics to determine the ideal location for the AMI Communication Network devices for optimal coverage of the meters. This plan will guide the deployment of network and metering devices. This network plan should be updated regularly as device installations are completed.

Wherever possible, the AMI network plan should provide for redundancy between collectors such that multiple collectors or concentrators will support any single AMI meter. The level of redundancy will depend on the meter density in the area, the priority of the customer base in the area, and the maximum number of possible hops, if employing a mesh network AMI system.

3.5.2.4.1.2 Deploy WAN/LAN Collectors Prior to Meter Deployment

By installing the communication backbone prior to meter deployment the majority of the Smart Meters will have immediate communication with the AMI Head End. This methodology ensures that meters can complete the provisioning process as quickly as possible and eliminates additional visits to the customer premises for manual meter reading. This methodology also allows for rapid discovery of communication holes where repeaters or additional collectors may need to be installed and allows for the quick transition of meter reading personnel.

3.5.2.4.1.3 Develop Methods and Procedures for Collector Site Selection

Develop a comprehensive Methods and Procedures (M&P) document for site survey and selection process to standardize the field team activities. This M&P will help vendors and sub-contractors adhere to the policies and best practices outlined by the utility.

3.5.2.4.1.4 Provide Redundancy

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Wherever possible design the network to provide for layer of redundancy between collectors. The level of redundancy will depend on the meter density in the area, the priority of the customer base in the area, and the maximum number of possible hops if employing a mesh network AMI system.

3.5.2.4.1.5 Use Pole Mounted Equipment

AMI Communication Network devices for an RF network should be mounted between 15 and 20 feet above the ground to provide for optimal coverage as well as guard against unauthorized access. External antennas can be utilities to address locations with marginal coverage. External antenna options can help improve received signal strength and increase the range of AMI coverage.

3.5.2.4.1.6 Site Surveys

Installation sites for AMI Network Devices, as determined from the Network Plan, should be surveyed prior to scheduling the installation. The survey of the candidate site will determined whether the device can be safely and securely installed at the desired location (some distribution poles may be cluttered and provide for insufficient climbing space) and will identify any special permitting or access requirements. Depending upon the communication technology and AMI provider recommendations, wireless coverage measurements may be required to validate the communication potential of the site against the RF propagation predictions. Fade margins, signal strength requirements, etc. should be provided by the AMI vendor and utilized in these surveys. Ensure no possibility of physical obstruction and analyze foliage growth.

3.5.2.4.2 Meter Deployment

In addition to following the practices delineated in the Meter Installation Standards document meter deployment practices should include the following:

3.5.2.4.2.1 Develop Meter Deployment Schedule

Develop a meter deployment schedule that takes into consideration the billing cycles of the meters in the geographic area to be deployed as well as the AMI Communication Network deployment plan. Exchanging meters close to the bill date can create errors in billing. Ensure that the exchange schedule allows sufficient time for the meter exchanges to be processed into the customer billing system prior to billing and do not start until billing has completed for that route.

3.5.2.4.2.2 Develop Meter Deployment Communication Plan

A Meter Deployment Communication Plan should be developed to ensure that all stakeholders are informed of the deployment schedule and activities. The Communication Plan should include the use of letters, bill inserts, door hangers, post cards, and mass print and communications media. Stakeholders should include regulatory agencies, local government, business associations and civic groups, customers impacted, and internal communications with employees and contractors. The Communication Plan should also include regular communications to the local police and fire departments.

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3.5.2.4.2.3 Provide Meter Rerouting Software

As the meter exchange process increases across the utility a Meter Rerouting Software package is generally needed to properly transition meter reading resources and create new meter routes that ensure that skipped or delayed meter exchanges are read on the normal billing cycle.

3.5.2.4.2.4 Distribute Meter Warehouses and Exchange Centers across the Service Territory

Locate the meter inventory warehouses and installation centers across the service territory to minimize installation crew travel time.

3.5.2.4.2.5 Perform Parallel Reads during Initial Implementation

Performing manual meter reading on the communicating Smart Meters during the initial implementation or pilot phase provides verification that the AMI system is tracking with the manual reading system. This should be done for no more than one or two months to gain confidence in the AMI System and only on a small representative population of the customer base. The MDMS should be able to capture both the manual read and the AMI reads and automatically verify the data is consistent from both sources. When discrepancies are found the MDMS should automatically open a work order for an analyst to resolve the discrepancies.

3.5.2.4.2.6 Develop Route Acceptance Procedure

A process map that defines the route closeout / acceptance procedures and clearly identifies the key steps that should lead to utility's acceptance at the route level should be jointly developed by the Utility and Contractor. Routes or areas that meet the agreed upon saturation, quality and readability threshold should be delivered to Utility for inspection and acceptance. The MDMS should track the process through to complete route acceptance and generate a notice to the CIS that manual meter reading of the route is no longer required. The MDMS should orchestrate the process of route acceptance as part of the AMI meter provisioning.

3.5.2.4.2.7 Automate Provisioning Process

A process map that defines the meter installation lifecycle including the provisioning process should be documented along with process monitoring tools that provide a view into the work-in-process at each stage of the lifecycle. The installation life cycle should include planning, scheduled, installation in process, installed, communicating, first readings validated, manual reads verified, route accepted and billing cut-over completed. The status should be tracked both by individual meter and by route. The MDMS should orchestrate this process and track the status of each meter through the process. The MDMS should automate the provision of meter configurations related to tariff or data to be collected. Any exceptions identified during the processing should trigger a work order for resolution. Comprehensive reporting of the numbers of exceptions and issues with the installation lifecycle should be used to ensure that issue and exception management processes are working and that the installation process is meeting quality and agreed service levels.

3.5.2.4.2.8 Installation Audit Process

The installation process should be audited with a manual read at some point after the route acceptance and cutover to AMI billing. This process should verify that the meters inspected are at the right premise, that the

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AMI readings are consistent with the meter display and that no error codes or meter exceptions are displayed. Audit inspection should also check for signs of diversion.

3.5.2.5 Meter Data Management Interfaces

Meter Data Management System (MDMS) interfaces and integration are keys to a successful AMI implementation. Consideration should be given to the following:

- Data Strategy: Identify all the sources of data into the MDMS and all potential users of the data maintained within the MDMS. For each data user, identify the frequency and latency of the data request.

- Users: Identify the users of the MDMS who will require direct interface via the user interface or ad hoc query.

- Plan the technical architecture and application solutions with flexibility and adaptability in mind to choose a best-in-class architecture to accommodate inevitable changes.

- Establish an integration standard to be followed whenever possible. Best practices recommend that this should be compliant with the IEC 61968-9 interoperability standards. Best practices recommend that this should be web services.

- Deploy a service-oriented architecture (SOA) to deal with integration challenges and provide a highly-adaptive architecture. If consistent with the overall IT standards and architecture, this should be consistent with a three-tier Enterprise Service Bus (ESB) architecture with appropriate firewall and DMZ security features dictated by system access requirements. Batch integrations should be minimized in consideration for real-time interfaces and integrations.

- The MDMS should provide standard adapters to each AMI head end system, MV-90, and the Utility's manual meter reading system to ensure that the MDMS is receiving all meter data from all sources and can be the central repository for all meter data. Identify all non-billing sources of meter data, all unmetered service points, and other meter data sources to ensure that all meter data can be centralized in the MDMS.

- MDM needs to support load balancing and leverage multi-threading capabilities in order to effectively take advantage of scalability provided by the inexpensive addition of application servers.

- The system should be designed with the use of a meta-data layer, to enable the business users to add new database objects and attributes and to change relationships without the need for database table or structure changes.

- Develop an Information Technology Road Map indicating the priorities and integration timing of systems with which the MDM will need to interface. As a general rule the following are systems that must be considered for interfaces with the MDM:

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- AMI
- Manual Meter Reading
- C&I Meter Reading (e.g. MV90 or equivalent)
- Meter Asset Management System (MAMS)
- Customer Information Systems and Billing
- Customer Web Portal
- Internal Meter Data Portal
- Data Warehouse
- Mobile Workforce Management, including mobility
- Outage Management
- Load Management System (Demand Response Control)
- Geospatial Information System (GIS)
- Distribution Management System (DMS)
- Settlement Systems
- Load Research
- Energy Forecasting

- Implement MDMS before the deployment of AMI. This will provide great insight, monitoring, validation, presentation, and auditing capabilities for all AMI meter technologies being deployed. If MDMS cannot be implemented prior to the start of deployment, ensure that all pre-existing AMI meters are properly migrated to the MDMS.

- To prepare for an AMI deployment, conduct a pilot program or phased implementation approach with a limited number of meters (e.g. 5,000 meters) to MDMS prove functional and operational viability and smooth integration across key systems.

- Correlate AMI meter events and alarms with VEE and CIS audits and checks for automated exception handling.

- Before the full project is commissioned, perform a full performance scalability test to prove operational functionality.

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3.5.2.6 Validating, Estimating, and Editing for Monthly and Interval Data

Processing interval data collected via AMI is much more complex than processing consumption data collected via manual or semi-manual methods. An effective MDMS should not only deal with this level of complexity, but also provide significant flexibility in how data cleansing is accomplished. The following must be considered in the design of an effective validation, estimation and editing (VEE) process.

At a minimum, VEE must be performed following the generally accepted validation tests of the California Interval Data VEE Rule Set (Revision 2) such as:

- Missing Interval Check
- Missing Intervals Due to Power Outage
- Zero Check
- Maximum Demand Check
- Negative Value Check
- Static Value Check
- Spike Check
- Sum Check
- Time Change Check

An effective MDMS needs to provide users with the ability to easily create custom validation - and estimation - rules for a variety of purposes. As a minimum the system should allow the user to create different VEE work flows for the following different groups of customers:

- Revenue Class
- Rate Class
- Utility Commodity (Electric or Gas)
- Climate Zone
- Regulatory Jurisdiction
- Competitive Suppliers
- Ad Hoc

There needs to be a simple way to group customers together for VEE, and even the ability to include customers in different groupings for different purposes. Groupings and processes that should be addressed include:

- Revenue Protection Analysis
- Customer Load Profiles (Rate Analysis and Estimation Purposes)
- Geographic Analysis (i.e., Loading on Substation, Distribution Circuit, Line Segment, Transformer, etc.)
- Settlements (Based upon different market rules)

After full implementation the MDMS should replace the existing pre-bill functions within the CIS. MDMS should handle all meter reading data validation, high/low edits, and estimation. It should provide parameter based, user defined validation and estimation rule processing. MDMS must provide an on-line method, with workflow, resolving validation errors rather than reports. MDMS will replace all pre bill edit functions. MDMS must be utilized for:

- interval data validation;
- billing cycle validation;
- estimation process including:

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  - automatically estimate meter data to fill in gaps in meter data brought in from integrated AMI systems;
  - flag estimated data as such;
  - capability to notify users and systems that meter data has been estimated;
  - estimation routines used to fill these gaps shall be customizable by the user;
  - allow the user to define and select the estimation routine needed for a particular meter or group of meters
- configurable to limit the number of intervals that can be estimated to address meter failure;
- able to display the number of meters that were estimated and the amount of estimated data for each meter;
- manual data editing;
- managing updates;
- data versioning;
- standard versus configurable flags;
- logging and tracking process for added/edited/deleted data;
- prioritization of editing rules;
- acknowledgement triggers and messaging capability;
- interval data for billing determinants (e.g. peak, off-peak, and critical peak usage quantities for a given month that the billing system can then use to calculate the bill);
- capability to manually edit interval data over a defined period of time;
- able to report on edited interval data, including original and new values, reason, process, and user.

The system should allow the utility to set up or change data validation and estimation rules, user screens, and alarm/event notifications without modifying source program code and without any proprietary language skills.

The VEE workflow must also consider the overall business process. Under certain circumstances data should be automatically estimated. These include:

- kWh only billed meters not to exceed “X” missing intervals
- Missing intervals due to power outage

Circumstances requiring manual intervention include:

- Missing intervals on KW demand billed customers
- Missing channels on poly-phase meters

The VEE process must correlate interval data with meter events and alarms and provide automated responses and exception reporting, some examples include:

- Request Meter Health Check after “X” zero intervals
- Report Failed Meter Health Checks
- Group flicker counts by Substation, Distribution Circuit, Line Segment, or Transformer

Finally, the VEE process must recognize the importance of timing. Work flows should be scheduled and/or triggered by other events, such as data loading. Data should be loaded throughout the day with VEE being

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done as it is loaded, with finalization at day's end to perform sum checks and estimations with all available data.

3.5.2.7 Account Billing

Account billing must be both accurate and timely. Accuracy is obtained through quality meter reading data that has been validated or edited, and estimated if there are interval gaps and billing is based on usage values calculated from interval reads. Where there are multiple meter reading systems in place (such as during the implementation phase of an AMI system), there should be multiple levels of audits for accuracy.

These billing audits should be performed utilizing both pre-bill and post-bill audits within the Customer Information or Billing System (CIS) or though the Validation, Editing and Estimation (VEE) process for AMI-captured reads being processed though the Meter Data Management System (MDM). During the implementation phase there should be redundant audits performed on AMI data through both MDM and CIS.

3.5.2.7.1 Pre-Bill Audits

Pre-bill audits should examine kWh usage data, and at a minimum include:

1. Use on Inactive Account: Consumption where no active contract or account exists.
2. Zero Use on Active Account: Zero consumption for the entire billing period. Where the account is a multi-commodity (e.g. gas and electric) service, zero consumption on both commodities is a valid condition and only zero consumption on one of the commodities and not the other is an exception.
3. Complete Billing Determinants: All billing determinants as required by the rate are available and represent the same billing period (end on the same date and time).
4. TOU Verification: For TOU, or dynamic rates, the peak and off-peak consumption billing determinants should total to the Total consumption for this billing period.
5. Bill Period: The billing period should not be more than Max Billing Period (typically 33 to 35 days), nor less than Min Billing Period (typically 26 to 27 days).
6. Consecutive Estimates: The billing determinants should not be estimated for more than Max Estimates (typically 2) billing periods.
7. High/Low check on meter reading (consumption for the billing period) +/- x% of monthly usage as compared to last billing period, same month last year, same month rate class profile.
8. Rated Load: The number of days in the billing period multiplied by the current rating of the meter multiplied by 24 hours per day will provide a kWh usage level at which meter or electrical service is overloaded and may create either metering or safety issues.
9. Service type and rate (gas vs. electric vs. water) mainly for multiple commodity utilities. Sometimes this is performed as screen validation.
10. Account class and rate (residential vs. commercial vs. industrial). Sometimes this is performed as screen validation.
11. Tariff Check: Verification that the rate and rider combinations are correct for this service point.
12. Billing Determinant Check: Verification that the meter supports all of the billing determinants required for the tariff.

3.5.2.7.2 Post-Bill Audits

CIS post bill audits should examine the dollar amount of the bill:

1. +/- x% of total bill ($'s) as compared to last month, same month last year, same month rate class profile.
2. +/- x% of consumption based dollars on bill (this is to remove riders, service charges, etc) as compared to last month, same month last year, same month rate class profile.

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The levels that trigger both Pre- and Post-Bill Audits should be set such that they do not cause a high level of false positives, yet low enough that the majority of billing error issues are reviewed prior to mailing an incorrect bill.

3.5.2.7.3 Timeliness

As a general rule, exceptions should be reviewed and corrected within three business days of billing to ensure an accurate bill is delivered in a timely manner. To further ensure billing timeliness the Meter Read Window (the number of days in which the meter may be read without creating proration issues for the specific bill cycle) should generally be three to five days. In the five day Meter Read Window scenario this would mean that a meter read obtained no more than two days prior to or after the scheduled bill cycle date would be acceptable. Any accounts not read by the end of the Meter Read Window should be estimated.

3.5.2.7.4 Billing Estimation

Whenever possible estimated bills should be avoided, however if they must be estimated the estimation algorithms should take into account as many variables as possible for the individual account. For those meters which are read by AMI and the usage is calculated from the interval data, the estimation should occur at the interval level (typically, in the MDM). Those variables should include:

- Weather related data
  - Climate Zone
  - Number of Heating or Cooling Degree Days
- Premise Data
  - Square Footage
  - Heating Source
  - Whether or not there is a swimming pool or hot tub (if available)
- Account historical data
  - Previous month usage
  - Same month last year usage
- Rate Class kWh usage profiles

With AMI Meters and where interval data is used for billing, the estimation of intervals must be factored into the determination of whether a bill is deemed estimated or not. While meter reading data for the billing period may be complete to the end date of the period there may be estimated intervals within the billing period. If more than x% of the intervals or y% of the energy usage for the period are estimated, those billing determinants computed from interval data should be marked as estimated. KW or KVAR Demand billing determinants should not use estimated intervals.

Account estimation should not occur more than two consecutive months or more than 6 times per year. Once these parameters are reached a field service order should be issued to investigate the causes for estimation and potential resolutions to the issue.

3.5.2.7.5 Data Traceability

The meter data used for billing must be traceable from the raw meter data collected through the AMI system to the actual billing determinant used to calculate the bill. As a best practice, this would be a single system where all meter data is retained, where any changes or edits to the data are performed and all data is versioned. If billing data is changed as part of the billing process in another system, then such data should be reflected back into the meter data repository to maintain a consistent and auditable system of record for meter data.

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3.5.2.8 High Bill Complaint Troubleshooting

High bill complaint trouble shooting should be instituted whenever a Customer complaint has been received concerning excessive consumption or an unusually high billed amount. Information must be gathered from the following sources:

- Customer
- Customer Information System/Billing System
- Field Order Service System
- Meter Installation Work Force Management System
- AMI Head End System/ Meter Data Management System

In-depth analysis of each of these sources must be performed to determine the causation of the high bill. The causation may frequently be inter-related to several factors that can be determined through these sources. A field visit must occasionally be scheduled to determine other possible causes.

Information to be ascertained and questions to be follow.

3.5.2.8.1 Customer

- How does the customer describe their issue?
- How did the issue first arise and when?
- When did the customer first contact the utility?
- When did the customer move into the current address?
- Have there been previous instances of the same issue?
- What is customers heating/cooling source?
    - What is the temperature setting?
    - Do the HVAC controls operate automatically?
    - Have there been any issues with these systems during the period in question?
- What is the connected load?
    - Are there high usage appliances such as pool pumps, spa, water heaters, space heaters, clothes dryers, etc?
    - Have any of any of these appliances exhibited any issues or problems during the billing period in question?
    - Are any of these high consumption appliances on timers?
    - Has the water bill increased during the period in question?
    - Has the customer added or removed appliances during the period in question?
- What is the daily consumption pattern?
    - What time do they sleep?
    - How many people are in the household?
    - Has that number changed?
- Does the customer mention changes in the household or home equipment that could affect consumption?
- What were the dates and times of changes in customer behavior?

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3.5.2.8.2 Customer Information System/Billing System

3.5.2.8.2.1 Usage History

- Is the usage for the period in question significantly higher or lower than the previous billing period?
- Was there a meter change before or during the billing period in question?
- Has usage pattern changed?
- If so, when did usage pattern change?
- How does usage pattern compare to same month for the past three years?
- Has usage pattern ever been that high or low as the period in question for that customer?
- Has usage pattern ever been that high or low as the period in question for that premise?
- Are there corresponding increases in gas usage/decreases in electric usage or vice versa during the period in question?
- Were there any weather events that could have affected usage?
- Does the usage pattern coincide with the installation of the new meter?
- Is the usage associated with the old meter (indication of mis-read during meter exchange process) or new meter (indication of problem with the AMI meter) suspect?

3.5.2.8.2.2 Billing History

- When were bills generated?
- Were any bills delayed?
- Is there a large difference between the number of days in the previous billing period and the billing period in question?
- Was the customer over/under billed based on an erroneous manual meter read?
    - Is that affecting the bill in question?
- Is the number of days in the billing period consistent?
- If the bill was estimated was it spread across the tiers properly?
- Have tier changes affected the bill compared to last year?

3.5.2.8.2.3 Rates

- What is the end use code?
- Does the customer have the proper baseline adjustment?
- What is the Medical Baseline history and status?
    - Was the customer recently dropped from Medical Baseline?
    - Should we send a Medical application?
- What is the CARE history and status?
    - Did the customer recently drop form CARE?
    - Does the customer qualify for CARE?
- When did rates change for the customer?
- If the rate changed, did it contribute to the customer's issue?

3.5.2.8.3 Field Order Service System

- Was there a meter exchange?

- What are the meter exchange details?
- What were the meter faceplate details?
- Is an image or verification of the removed meter read available?
- Were there alterations or modifications to the meter or service?
- Were there any additional employee observations?

3.5.2.8.4 Meter Data Management System

- What is the service point status?
- Has the Smart Meter been enabled, read, or billed?
- When did the meter start communicating?
- If meter stopped communicating, when?
- Are there meter events?
- What are the descriptions and dates?
- Which reads were validated actual as opposed to estimated?
- Are estimated reads in line with validated actual reads?
- Which estimation rules were used?
- Is there a relationship between meter event dates and usage or read status?
- Does AMI Head End data align with MDMS data?
- Does read data align with customers stated usage patterns?
- Are night time intervals higher than normal?

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3.6 Security Assessment

3.6.1 Specific Scope of Work: Security Assessment

This section provides specific requirements outlined in Structure's Statement of Work pertaining to the security assessment of PG&E's cyber security program as it relates to the Smart Grid system. As referenced in the Structure's Statement of Work, Structure's scope of work included performing the following tasks:

Structure was to supplement the Best Practices review with activities focused on security testing to identify technical control weaknesses that may have impacted the meter data or billing resulting in high customer complaints. The work was to include:

- A security risk assessment performed to identify technical control weaknesses:
    a. Review end to end data flow documentation to ascertain interfaces and information integrity requirements.
    b. Review network architecture used at each tier of communication to identify interoperability and security points of focus for additional testing Detail of Security Assessment Findings..
    c. Review the physical security of utility deployed technologies and determine risks associated with meters, BPL equipment, access points and relays.
    d. Develop report on results.
- Review AMI Network, Meters to identify interoperability and security exposure points and develop report:
    a. Access control assessment for the following elements:
        i. Meters
        ii. Network Access Points
        iii. AMI Head End
        iv. Utility Back Office
    b. Review Remote Monitoring Capabilities for Intrusions.
    c. Review Utility's North American Electric Reliability Corporation Critical Infrastructure Protection (NERC CIP) Compliance Capabilities for AMI related systems.
    d. Review AMI Network Provider's NERC CIP Compliance Capabilities.
    e. Perform diagnostic testing for system vulnerability – (Penetration testing will not be performed as this type testing is random in nature).
    f. Review network equipment for control weakness.
- Assessment and reporting of Billing & Meter Data Systems:
    a. Review data flow diagrams to determine logical interfaces to Meter Data Management System.
    b. Review access control capabilities of MDM and related interfaced systems.
    c. Review monitoring functions of MDM and related interfaced systems.
    d. Perform vulnerability scan and system testing of MDM and related interfaced systems.

As discussed and agreed upon with the CPUC, Structure performed a review of PG&E's cyber security program as it relates to the Smart Grid system. This review was done in conjunction with Structure's review of the PG&E AMI implementation. Structure's security assessment focused on the following areas:

- Corporate Cyber Security Approach
- Confidentiality and Privacy
- Integrity
- Availability
- Identification and Authentication of Users

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- Authorization of Users
- Accounting and Non-Repudiation
- Anomaly Detection Services
- Boundary Services and Interfaces
- Cryptographic Services
- Resource Management Services
- Development Rigor
- Organization Rigor
- Handling and Operating Rigor
- Accountability

Structure utilized several methods to perform the review, including interviews and documentation reviews of PG&E policies and procedures. Structure also reviewed targeted performance evidence to determine if the policies and procedures were being followed. All the information obtained through these methods was then compared against the applicable sections of the "AMI System Security Requirements" developed by the OpenSG AMI-SEC Task Force. A comparison to cyber security "best-practices" was also performed.

3.6.2 Security Assessment Evaluation Approach

The evaluation approach for each of the following Security Assessment areas is detailed in the following sections:

- Corporate Cyber Security Approach
- Confidentiality and Privacy
- Data and System Integrity
- System Availability
- Identification and Authentication of Users
- Authorization of Users
- Accounting and Non-Repudiation
- Anomaly Detection Services
- Boundary Services and Interfaces
- Cryptographic Services
- Resource Management Services
- Development Rigor
- Organization Rigor
- Handling and Operating Rigor
- Accountability

3.6.2.1 Corporate Cyber Security Approach

Structure performed interviews and documentation reviews to determine if PG&E had developed a cyber security approach that had high-level management support with defined metrics and consequences for deviation from stated policies and procedures.

3.6.2.2 Confidentiality and Privacy

Many of the systems that comprise a smart grid implementation contained confidential information about the utility's customers or sensitive company information. Therefore, the implemented policies and procedures need to address the safeguarding of this data. These safeguards should protect the data from unauthorized disclosure as the data is collected, transmitted, and stored. Structure performed interviews and documentation reviews to determine if PG&E had developed policies and procedures to address Confidentiality and Privacy.

3.6.2.3 Integrity

Maintaining system and data integrity is a key aspect of cyber security. Therefore, the implemented cyber security controls should address maintaining the integrity of the smart grid system and the data within the system. Structure performed interviews and documentation reviews to determine if PG&E has developed policies and procedures to address system Integrity.

3.6.2.4 Availability

System security controls should address the ability of the system to continue to operate under various situations such as normal operation, heavy usage, active attacks, and maintenance. Structure performed interviews and documentation reviews to determine if PG&E had developed policies and procedures to address system Availability.

3.6.2.5 Identification and Authentication of Users

Cyber security controls should provide mechanisms to validate the identity and authorize the accessing party. Structure performed interviews and documentation reviews to determine if PG&E had developed policies and procedures to address Identification and Authentication of Users.

3.6.2.6 Authorization of Users

Cyber security controls should provide mechanisms to authorize user actions and their level of access. Structure performed interviews and documentation reviews to determine if PG&E has developed policies and procedures to address Authorization of Users.

3.6.2.7 Accounting and Non-Repudiation

Cyber security controls should be implemented to track all actions back to the initiating user or system. These controls should contain provisions to record all system events related to user actions and system access. Structure performed interviews and documentation reviews to determine if PG&E had developed policies and procedures to address Accounting and Non-Repudiation.

3.6.2.8 Anomaly Detection Services

Cyber security controls should require implementation of systems to detect events that are outside the bounds of normal operations. There should also be procedures to respond to any detected anomalies. Structure performed interviews and documentation reviews to determine if PG&E had developed policies and procedures to address Anomaly Detection Services.

3.6.2.9 Boundary Services and Interfaces

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Cyber security controls should be implemented around boundary security and interfaces to external systems. Structure performed interviews and documentation reviews to determine if PG&E had developed policies and procedures to address Boundary Services and Interfaces.

3.6.2.10 Cryptographic Services

Cyber security controls requiring cryptographic services should be implemented where technically feasible. The controls should detail the level of encryption, signing mechanism, key management and key revocation. Structure performed interviews and documentation reviews to determine if PG&E had developed policies and procedures to address Cryptographic Services.

3.6.2.11 Resource Management Services

Cyber security controls should be implemented to address the management of system resources that are limited. Structure performed interviews and documentation reviews to determine if PG&E had developed policies and procedures to address Resource Management Services.

3.6.2.12 Development Rigor

Cyber security controls should be implemented in the development lifecycle of the systems including acquisition, configuration management, and development practices. Structure performed interviews and documentation reviews to determine if PG&E had developed policies and procedures to address Development Rigor.

3.6.2.13 Organization Rigor

Policies and procedures should be implemented to address organizational aspects to the smart grid system. These include user training, personnel security, and policy development. Structure performed interviews and documentation reviews to determine if PG&E had developed policies and procedures to address Organization Rigor.

3.6.2.14 Handling and Operating Rigor

Policies and procedures should be implemented to address the operational aspects of the smart grid system. These include incident response, maintenance procedures, and information protection policies. Structure performed interviews and documentation reviews to determine if PG&E had developed policies and procedures to address Handling and Operating Rigor.

3.6.2.15 Accountability

Policies should be implemented to re-affirm the entity's commitment to cyber security and the consequences for non-compliance with the approved policies. Structure performed interviews and documentation reviews to determine if PG&E had developed policies and procedures to address Accountability.

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4 Data and Assumptions

The field testing scenarios were referred to as "High Bill Complaint" and "Non-High Bill Complaint" populations. The High Bill Complaint population was derived from complaints received directly by the CPUC or PG&E and those received at the regulator-driven town hall meetings. Non-High Bill Complaint refers to Customers who had not filed a high bill complaint through one of these channels. The following Figure outlines the laboratory and field test scenarios conducted for this evaluation.

Summary of Structure's Test Scenarios		
Scenario	**Description**	**# of Meters**
Scenario 1	Environmental and End-to-End Smart Meter Laboratory Test	11
Scenario 2	Warehouse Stock Smart Meter Accuracy Laboratory Test	163
Scenario 3	Electromechanical Meter Test & Smart Meter Field Replacement – Electromechanical Meter Test	47
Scenario 3	Electromechanical Meter Test & Smart Meter Field Replacement – Smart Meter Test	45
Scenario 4	Non-High Bill Complaint Smart Meter Field Test	531
Scenario 5	High Bill Complaint Smart Meter Field Test	36
Scenario 6	High Bill Complaint Shadow Meter Field Test	19
Scenario 7	Non-High Bill Complaint Electromechanical Meter Field Test	100
Scenario 8	High Bill Complaint PG&E Installed Shadow Meter Test Verification	18

Figure 25: Summary of Structure's Test Scenarios

For the purposes of this Assessment, Structure tracked the CPUC and PG&E's acceptance testing levels, as well as the meter manufacturer's specifications. The following Figure identifies the acceptable meter accuracy percentages associated with the CPUC, PG&E, and the meter manufacturers (GE and Landys+Gyr), as applicable to electromechanical meters and Smart Meters. These percentages apply to warehouse-provisioned meters prior to installation at a Customer premise. The standard for testing once a meter is placed in the field is based on the 2% CPUC standard for both electromechanical and Smart Meters.

Entity	Description	Acceptable Percentage
CPUC	Both Electromechanical and Smart Meter range	± 2.0%
PG&E	Smart Meter range	± 0.5%
Meter Manufacturer	Smart Meter range	± 0.2%
Meter Manufacturer	Electromechanical Meter range	± 2.0%

Figure 26: CPUC, PG&E, and Meter Manufacturer Meter Accuracy Criteria Ranges

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4.1 Laboratory Meter Testing

The following Figure displays the results from testing 156 PG&E Smart Meters, by Meter Manufacturer and Meter Form, as part of the accuracy test in Scenario 2: Warehouse Stock Smart Meter Accuracy Laboratory Test.

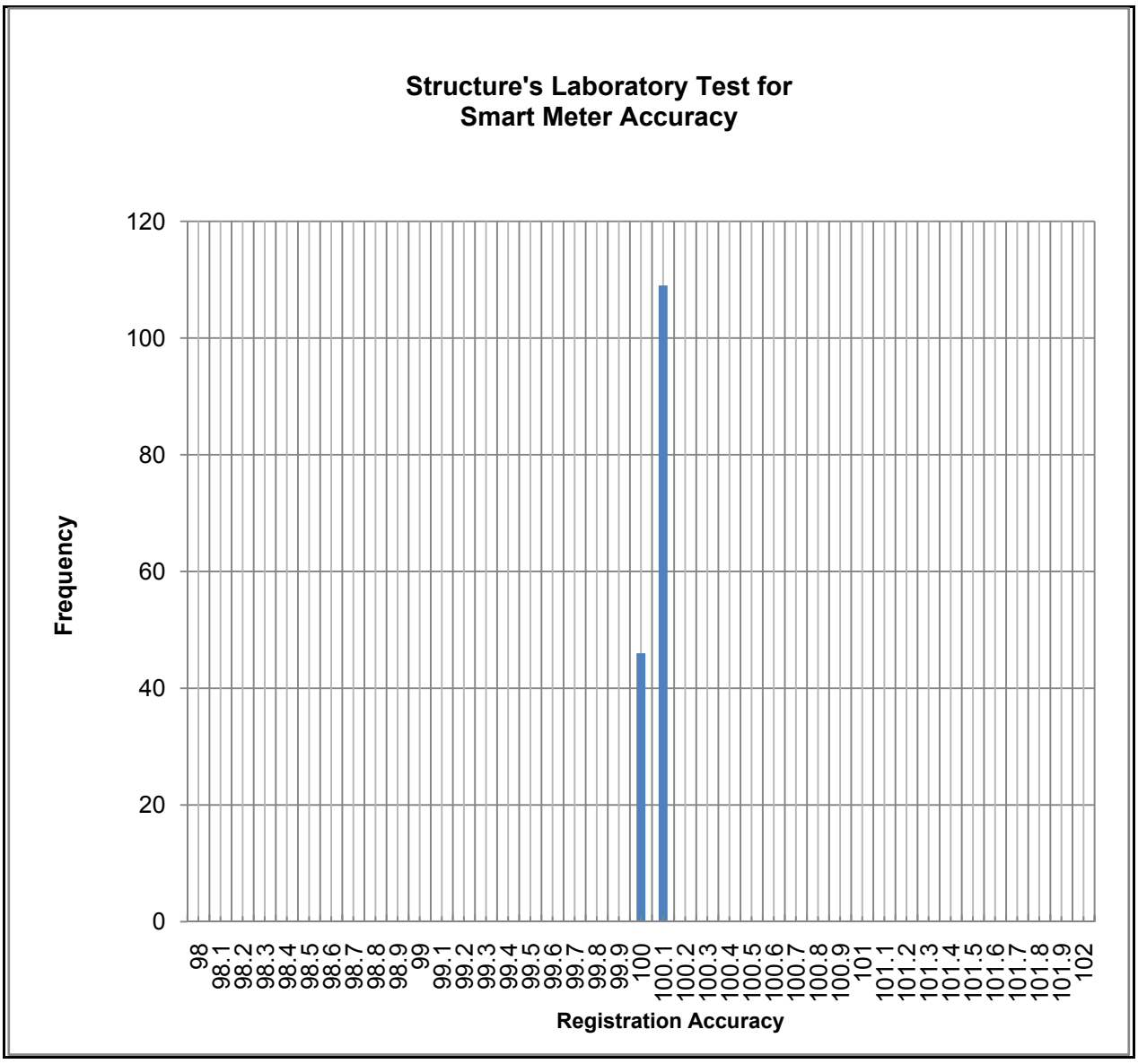


Figure 27: Structure's Laboratory Test for Smart Meter Accuracy

The 156 meters tested had an Average Registration Accuracy (defined as (Full Load % + Light Load %) /2) of 100.008% with a 0.028% standard deviation. The minimum registration reported was 99.77% and the maximum registration reported was 100.15% across all three tests for Full Load, Power Factor and Light Load.

One meter failed the manufacturer's Power Factor Registration Accuracy rating of ± 0.2 % with the reading of 99.77%, but passed on Average Registration Accuracy and PG&E's Acceptance Accuracy of ± 0.5%

The following Figure displays results from testing 26 Elster digital meters utilized for laboratory and field shadow meter tests.

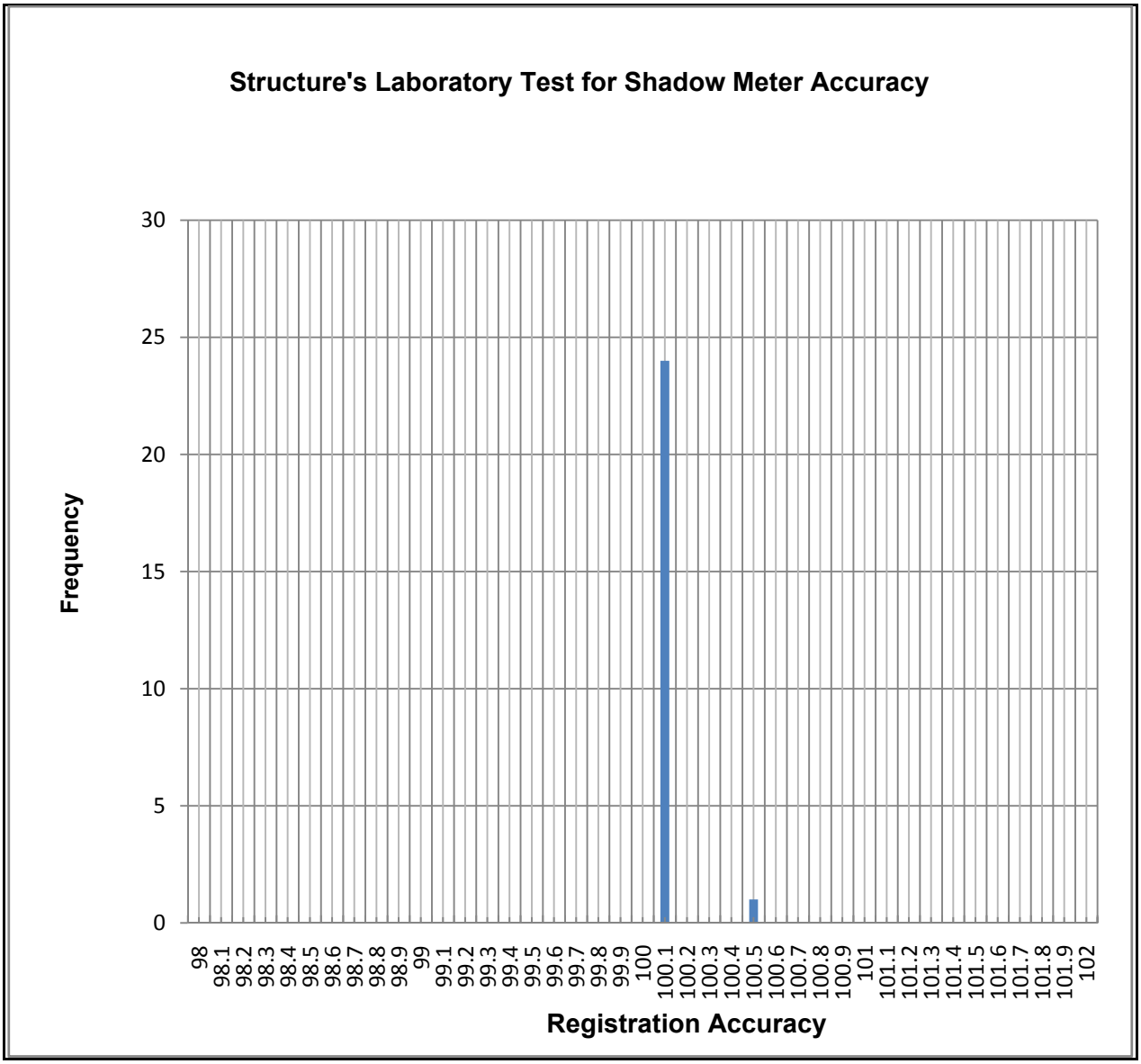


Figure 28: Structure's Shadow Meter Laboratory Test for Accuracy

The testing of 26 Elster digital meters to be used for Shadow Meter Testing resulted in an Average Meter Registration Accuracy of 100.0355% with a standard deviation of 0.092% and a minimum registration of 99.99% and a maximum of 100.95%. The maximum 100.95% was found on one meter failing the

manufacturer's Full Load Accuracy of ± 0.2 % and PG&E Accuracy Acceptance Full Load level of ± 0.5%; however the meter did pass on PG&E's Average Registration Accuracy of ± 0.5% with an Average Registration Accuracy of 100.485%

4.1.1 Environmental Laboratory Testing

The following Figures represent the results of Structure's test of six Smart Meters in the laboratory under varied environmental conditions. Per specifications in ANSI Standard C12.20, the six meters were subjected to temperatures of +50° Celsius (+122° Fahrenheit); a reference temperature of +23 degrees Celsius, ±5° (+73.4 degrees Fahrenheit, ±5°); and -20° Celsius (-4° Fahrenheit). Based upon ANSI standards, the load on the meters was varied at these temperatures to test registration accuracy at full load, light load, and with a power factor.

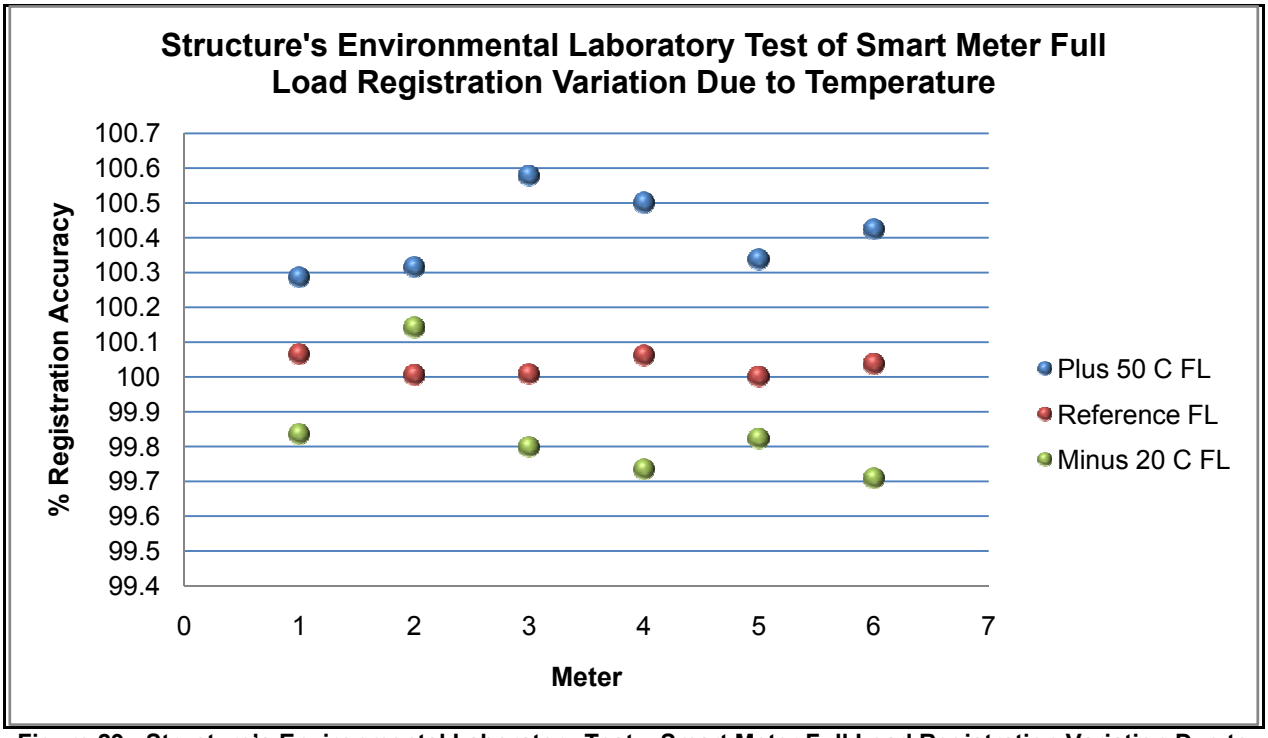


Figure 29: Structure's Environmental Laboratory Test – Smart Meter Full Load Registration Variation Due to Temperature

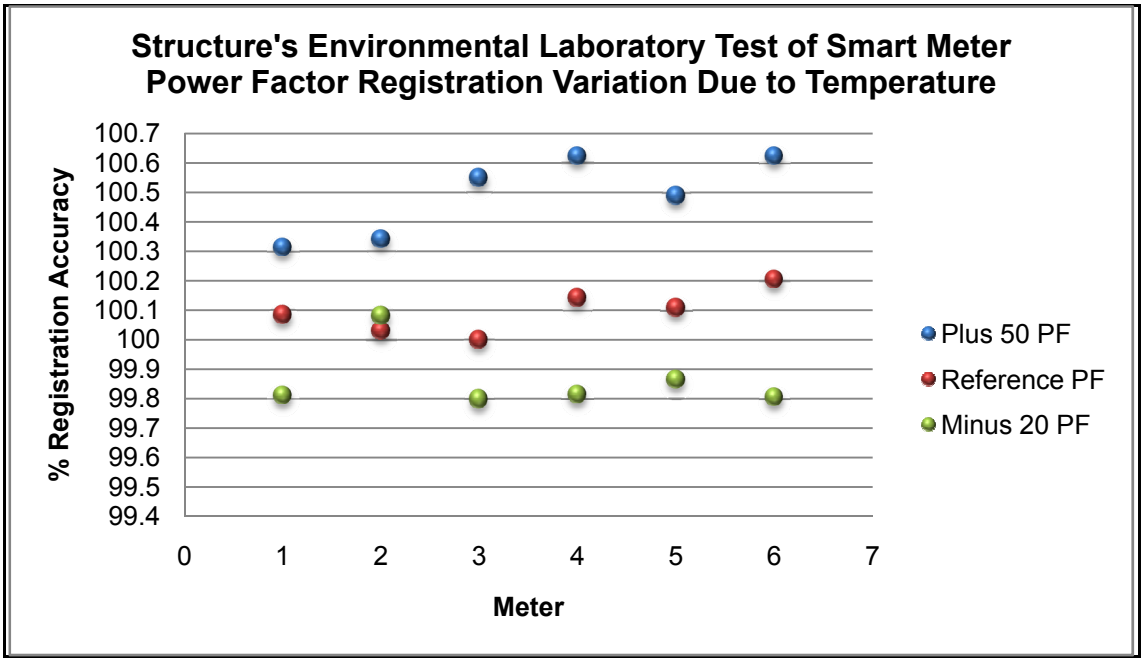


Figure 30: Structure's Environmental Laboratory Test – Smart Meter Power Factor Registration Variation Due to Temperature

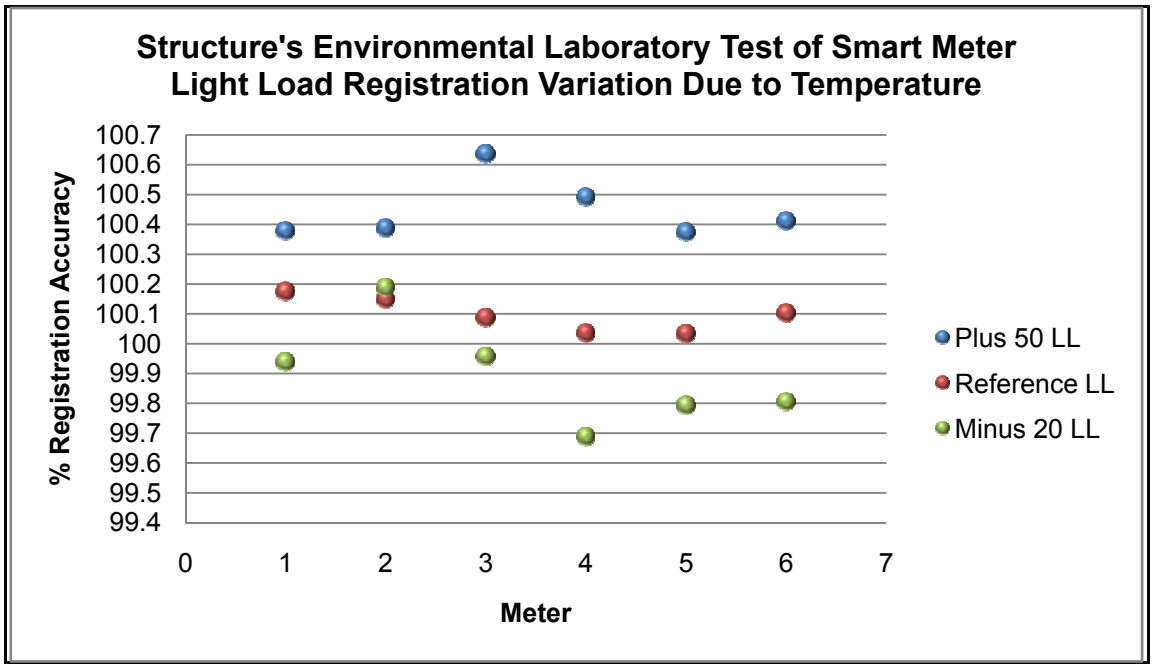


Figure 31: Structure's Laboratory Environmental Test – Smart Meter Light Load Registration Variation Due to Temperature

4.2 Field Meter Testing

The following Figure represents the Pass/Fail results of Structure's field meter accuracy tests:

Pass/Fail Results of Structure Field Meter Accuracy Tests by Scenario			
Scenario	**Total Meters**	**Pass**	**Fail**
3: Replace Electromechanical Meter with Smart Meter – Electromechanical Meter Test	47	41	6
3: Replace Electromechanical Meter with Smart Meter – Smart Meter Test	45	45	0
4: Smart Meters (Non-Complaint)	532	532	0
5: Smart Meters (High Bill Complaint)	36	36	0
6: Shadow Meters (High Bill Complaint, Structure)	*19*	*N/A-S*	*N/A-S*
7: Test Electromechanical Meter	100	100	0
8: Shadow Meters (High Bill Complaint, Structure-PG&E)	*18*	*N/A-S*	*N/A-S*
Total of all Field-Tested Meters	**797**	754	6
Total - Smart Meters	**613**	613	0
Total - Electromechanical Meters	**147**	141	6
Percentage of Total Smart Meters Tested	**-**	**100.00%**	**0.00%**
Percentage of Total Electromechanical Meters Tested	**-**	**95.92%**	**4.08%**

Figure 32: Pass/Fail Results of Structure Field Meter Accuracy Tests by Scenario

N/A–S: Not Applicable–Shadow Meter

The following sections present the detailed findings for each of the Structure's Field Meter Test Scenarios.

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4.2.1 Scenario 3: Electromechanical Meter Test & Smart Meter Field Replacement

Scenario 3's results are broken down into two components: the field testing of existing electromechanical meters and the field testing of previously laboratory tested Smart Meters used of replacement.

Field test results for the existing electromechanical meters found one electromechanical meter to be non-functional, registering zero on all tests; the meter was therefore excluded from testing. 41 of 47 tested electromechanical meters passed the CPUC's accuracy testing standard of ±2.0% in the field test. Six of the 47 tested electromechanical meters failed the CPUC Accuracy Standard of ±2.0%, with one failing the Full Load and Power Factor tests, one failing the Light Load test, one failing the Power Factor test, and three meters failing the Light Load and Power Factor standard tests. Two of the six electromechanical meter failures failed the Average Registration Accuracy standard. All field-tested electromechanical meters that were replaced with Smart Meters were returned to PG&E with an indication of whether or not they passed the field test.

The 47 tested electromechanical meters had an Average Registration Accuracy of 99.556%, with a Standard Deviation of 1.343% for the successful tests. The maximum Average Registration Accuracy was 101.12% and the minimum Average Registration Accuracy was 91.35%. Were the non-functional meter to be included in Average Registration Accuracy and Standard Deviation calculations, the Average Registration Accuracy would be 99.556%, with a Standard Deviation of 14.413%.

The following Figure indicates the distribution of Average Registration Accuracy of the Scenario 3 field tested electromechanical meters.

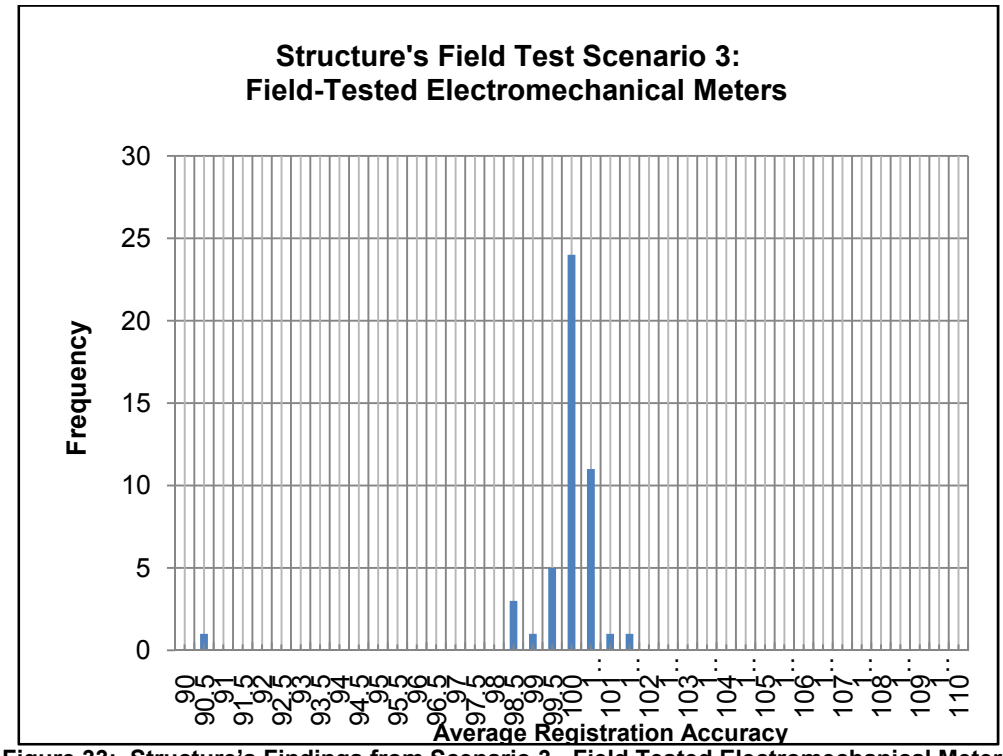


Figure 33: Structure's Findings from Scenario 3 - Field Tested Electromechanical Meters

Field test results for Scenario 3's Smart Meter accuracy tests found one Smart Meter with a serious event error that was malfunctioning upon installation; the meter was therefore excluded from testing. All 44 of the tested meters passed the CPUC accuracy standard of ±2.0%. 44 of the previously laboratory-tested Smart Meters indicated an Average Registration Accuracy of 100.27% during the field tests, with a Standard Deviation of 0.112%. The minimum registration found was 98.93% on Light Load registration on one meter, and a maximum of 100.31% on Full Load registration.

The following Figure indicates the distribution of Average Registration Accuracy of the Scenario 3 field tested Smart Meters.

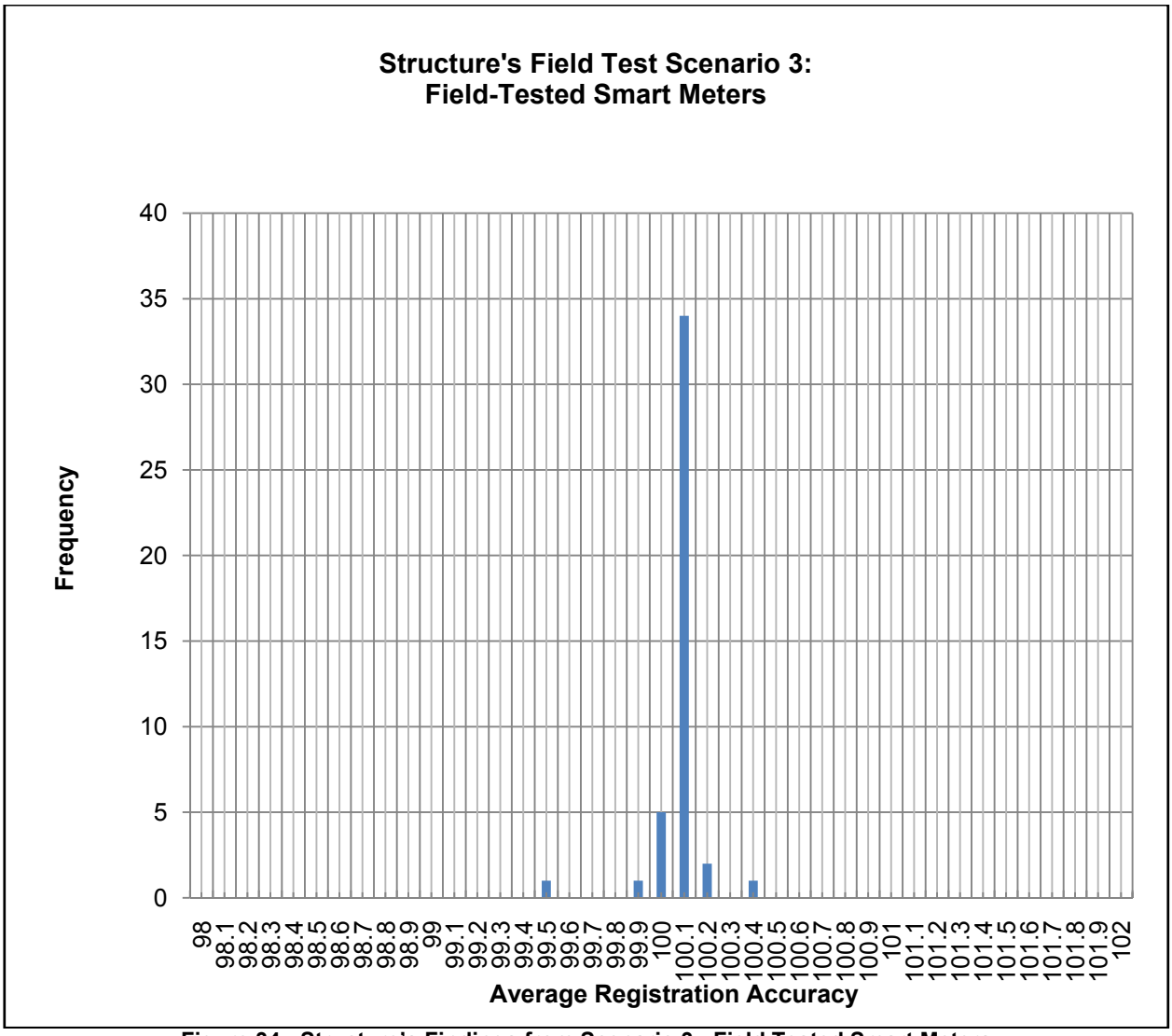


Figure 34: Structure's Findings from Scenario 3 - Field Tested Smart Meters

4.2.2 Scenario 4: Non-High Bill Complaint Smart Meter Field Test

Scenario 4's Non-High Bill Complaint Smart Meter Field Test involved a statistically valid test of 532 Smart Meters. One of the 532 Smart Meters was found with a serious event error, and was not registering; the meter was thus excluded from testing. The communication module on this device was functional and had been reporting zero usage for almost six months; thus, the meter was excluded from accuracy testing. 531 of the 531 tested meters tested within the CPUC accuracy standard of ±2.0%. The Average Registration Accuracy of the 531 Smart Meters was 100.075%, with a standard deviation of 0.275%, with all passing the CPUC standard of ±2.0%. The following Figure indicates the distribution of Average Meter Registration Accuracy for all of the meters tested with the exception of the one event error meter.

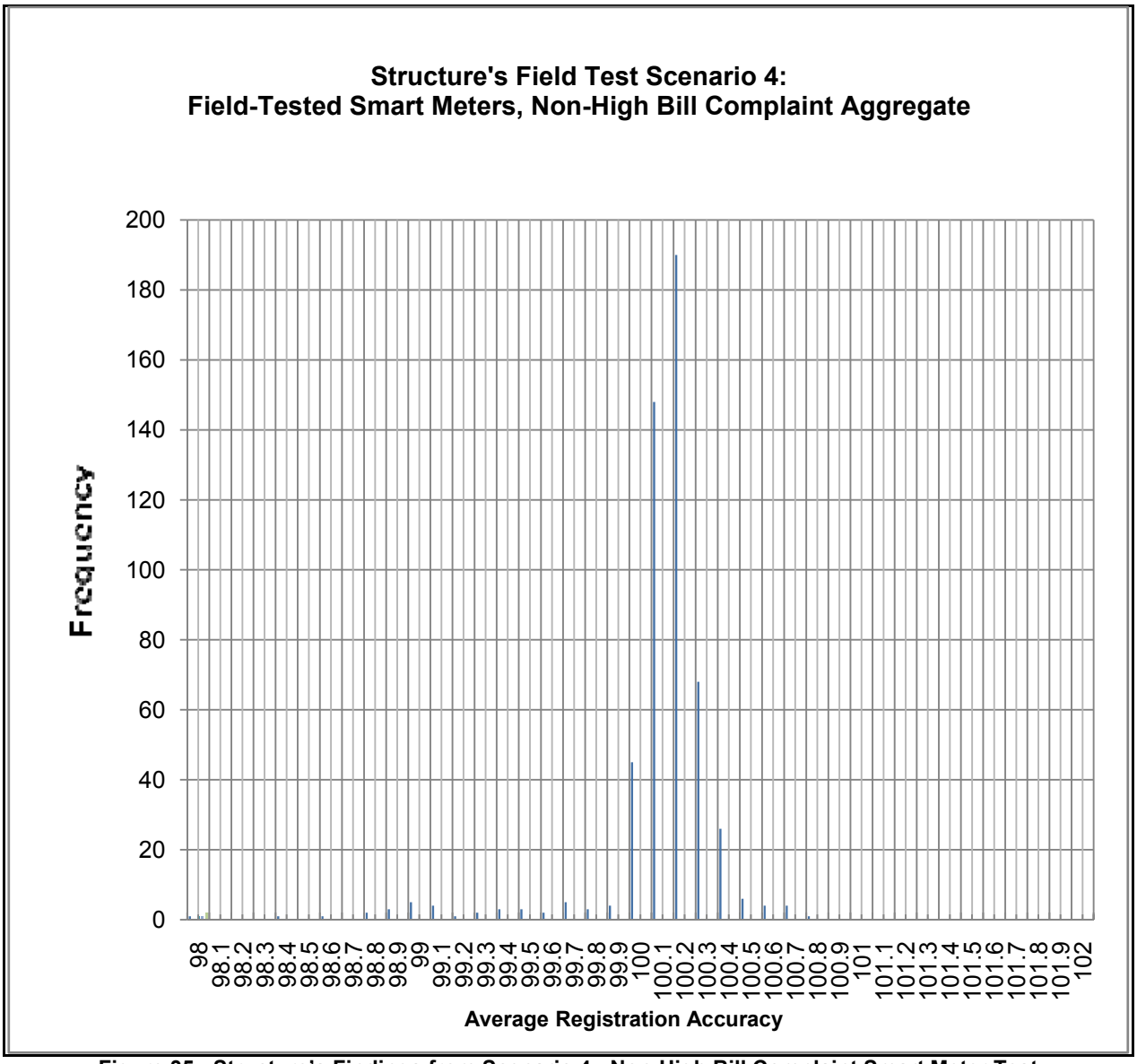


Figure 35: Structure's Findings from Scenario 4 - Non-High Bill Complaint Smart Meter Test

4.2.3 Scenario 5: High Bill Complaint Smart Meter Field Test

Scenario 5's High Bill Complaint Smart Meter Field Test involved 36 meters tested with an Average Registration Accuracy of 100.004% and a Standard Deviation of 0.351%. All of the meters tested passed the CPUC standard of ± 2.0%.

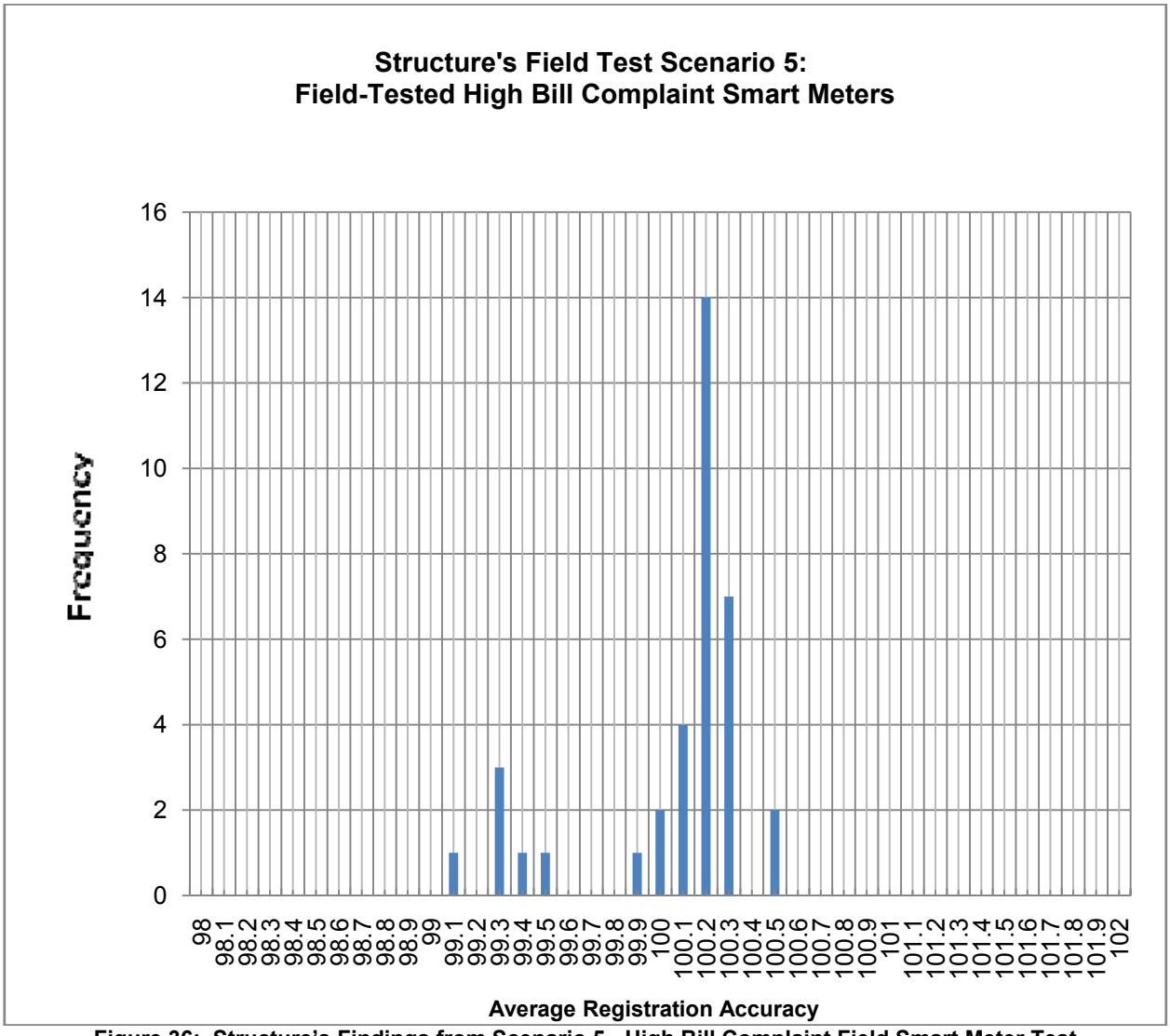


Figure 36: Structure's Findings from Scenario 5 - High Bill Complaint Field Smart Meter Test

4.2.4 Scenario 6: High Bill Complaint Shadow Meter Field Test

Structure identified 20 PG&E high-bill complaint smart meter customers for Scenario 6 Shadow Meter testing, and successfully tested 19 of the selected 20 premises. Shadow metering involved the installation of a pre-tested Elster digital meter into a dual meter-socket adapter. Both the PG&E Smart Meters and the Elster shadow meters were programmed to collect midnight cumulative register (anchor) reads and 60 minute interval registration. The Elster shadow meter was read by a Structure meter technician on a weekly basis.

Reads collected manually from the Elster meter were compared to Smart Meter reads collected through the Silver Springs Network. The results identified an average error between the Elster digital meter and the Smart Meter of 0.08% with a standard deviation of 0.0058632. The minimum error amount was a -1.14% difference, with a maximum error amount of 1.46%. The following Figure represents the comparison of the Elster meter and the Smart Meter register reads.

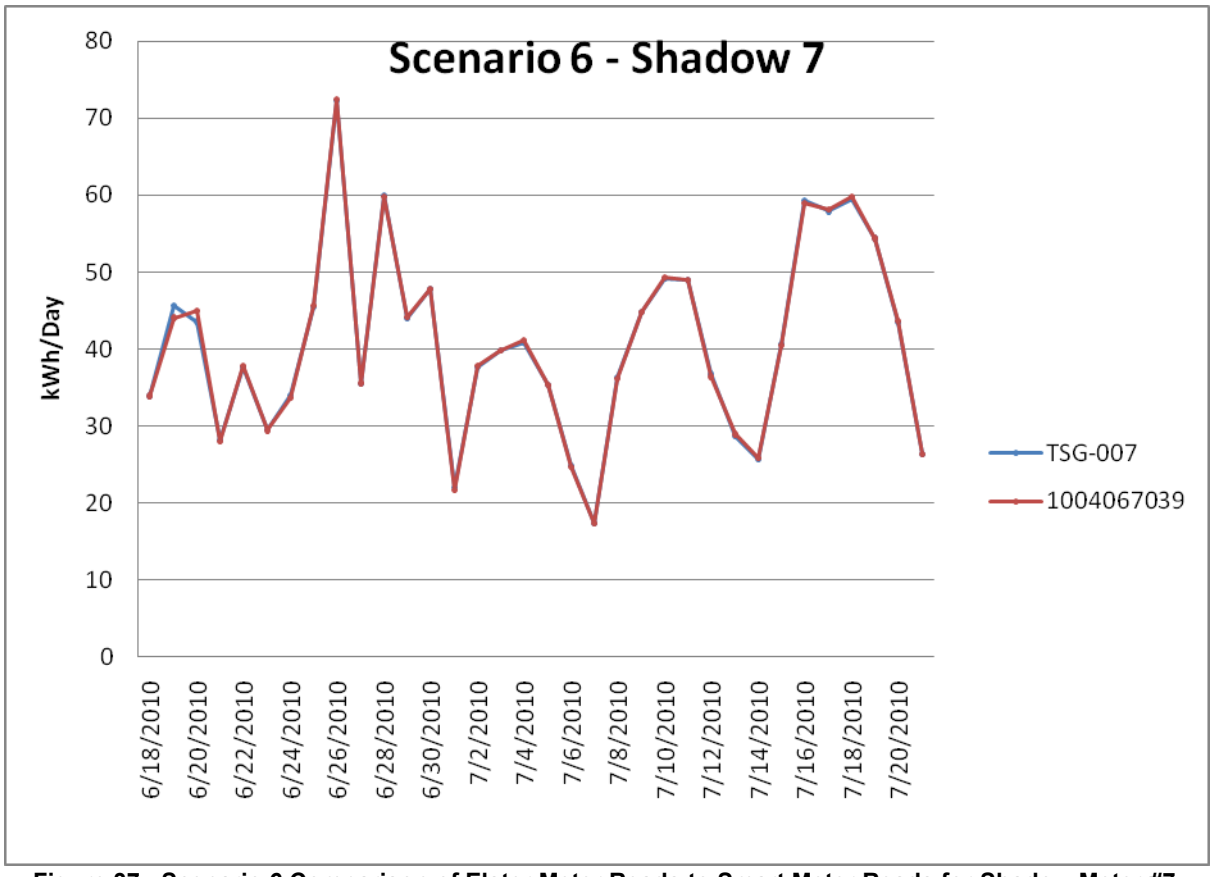


Figure 37: Scenario 6 Comparison of Elster Meter Reads to Smart Meter Reads for Shadow Meter #7

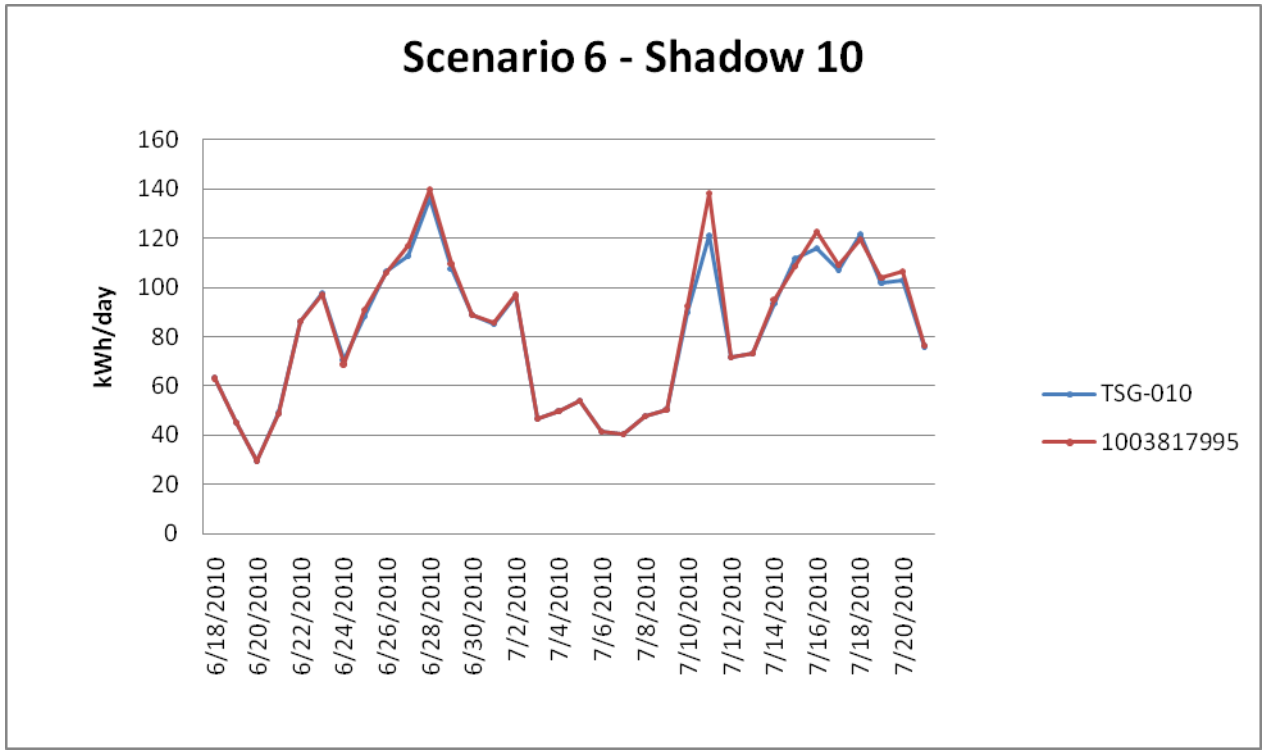


Figure 38: Scenario 6 Comparison of Elster Meter Reads to Smart Meter Reads for Shadow Meter #10

During the Scenario 6 testing, Structure encountered unauthorized PG&E meter swaps/meter tests during the execution of this scenario, as noted in the "Unauthorized PG&E Meter Swaps" Findings section of this report, and in Appendix F: Unauthorized Scenario 6 Meter Swaps Exhibitions.

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4.2.5 Scenario 7: Non-High Bill Complaint Electromechanical Meter Field Test

Scenario 7's test included 100 installed PG&E meters, with no failures on the CPUC Standard of ± 2.0%. The 100 meters had an Average Meter Registration Accuracy of 99.798% with a Standard Deviation of 0.528%. The minimum Registration across all tests (Full Load, Power Factor, and Light Load) was 98.1%, and the maximum registration across all tests was 101.95%.

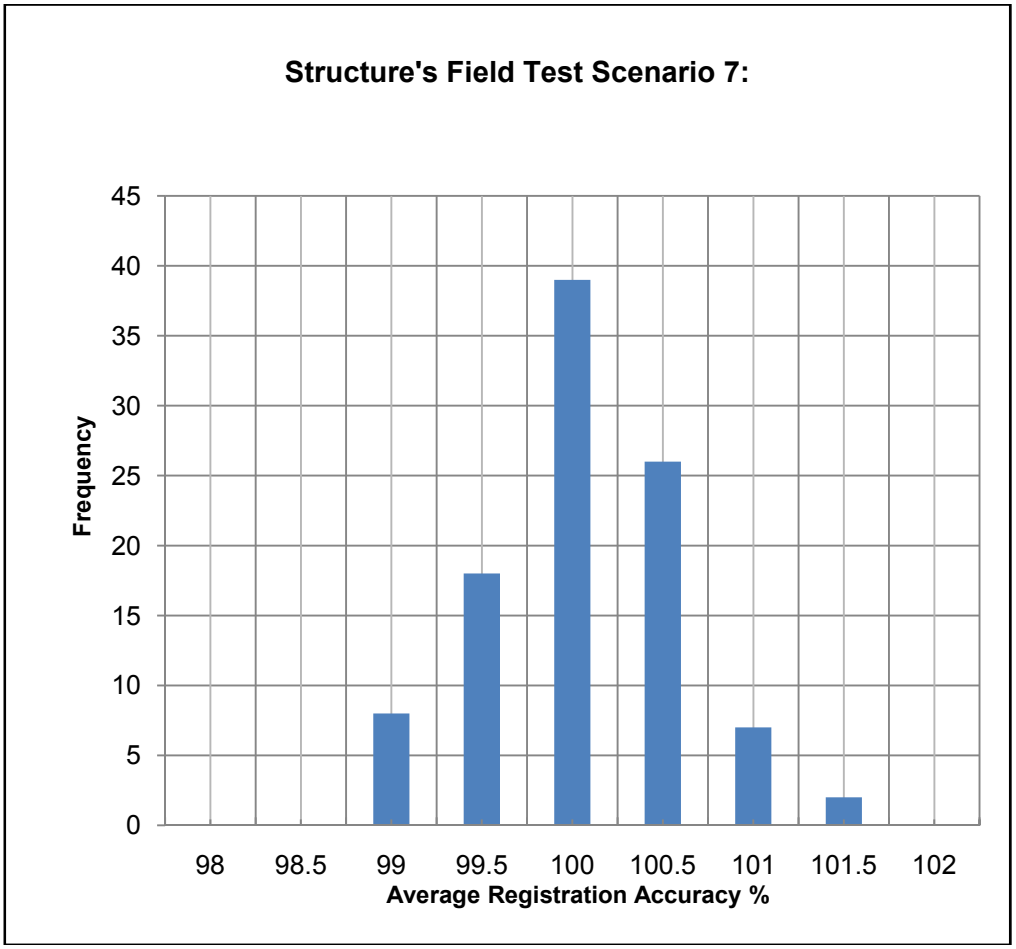


Figure 39: Structure's Findings from Scenario 7 - Field Tested Non-High Bill Complaint Electromechanical Meters

4.2.6 Scenario 8: High Bill Complaint PG&E Installed Shadow Meter Test Verification

In addition to 20 Scenario 6 shadow meter tests, Structure selected a supplementary 18 PG&E customers from the PG&E smart meter high-bill complaint population. As opposed to Scenario 6, where Structure performed the test and installation of the shadow meter, these customers were requested to participate in a PG&E-installed shadow meter test. Scenario 8 identified PG&E as the primary meter tester and shadow meter installer. Structure personnel served as witness to the field installation process. The following Figure outlines the high-level PG&E procedure for conducting the shadow meter test associated with Scenario 8.

PG&E Shadow Meter Test Procedure – Field Meter Test Scenario 8	
A	Receive Side-by-side test request from customer via PG&E Call Center or CPUC request.
B	Investigate customer account for shadow meter eligibility.
C	Schedule installation dates and issue dual socket installation field orders
D	One day prior to installation, send customer information dossier (Basic account information, Energy Cost Inquiry (ECI) history, results of any recent meter tests, and 12 months of billing and usage) to PG&E field technician who is to complete the installation.
E	Issue field orders to collect weekly reads by EMTs or T300. PG&E Technician collects reads and takes pictures of dual socket during each read.
F	Compile weekly summary of all collected reads. Calculate percent divergence between the customer meter and shadow meter.
G	Publish shadow comparison report to PG&E website.
H	Remove dual socket after three months of testing.
I	Send personalized “Report Card” containing the individual dual socket reads and explanatory cover letter to customer.

Figure 40: PG&E Shadow Meter Test Procedure – Field Meter Test Scenario 8

Structure’s objective was to identify variance from PG&E’s shadow meter protocol and analyze usage comparison test results between Smart Meters and shadow meters. Usage comparisons were provided by PG&E. Customer notification and web presentment were not in-scope for this test. In accordance with the CPUC-defined timeline to conduct Scenario 8 testing, Structure observed 2 weeks of shadow meter usage.

Structure’s applied study of PG&E field procedure observed full-load (FL) and light-load (LL) meter tests performed by PG&E personnel. FL and LL tests were performed on the PG&E SmartMeter and the electromechanical shadow meter, prior to dual-socket installation.

Structure reviewed the overall PG&E field procedure and found no significant deviation from standard field protocol. According to PG&E-test standards, all smart and electromechanical meters tested within specification. Over the two week test period, shadow meter comparison reports provided by PG&E identified an overall variance range of +16 to -3 KWH, and a mean variance of +2.25 KWH.

The following two figures present the PG&E-provided “Side-by-Side Test Results.”

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PG&E SmartMeter™ Side-by-Side Test Results — August 9, 2010

Location		Date Installed	Last Read Date	Mechanical Meter Present Reading (kWh)	(-)	Mechanical Meter Initial Reading (kWh)	(=)	Mechanical Meter Total Usage (kWh)	SmartMeter™ Present Reading (kWh)	(-)	SmartMeter™ Initial Reading (kWh)	(=)	SmartMeter™ Total Usage (kWh)	Cumulative Difference (kWh)	SmartMeter Type Gen 1 = DCSI Gen 2 = SSN
ANTIOCH															
	1	7/22/2010	8/5/2010	00412		00001		411	01521		01112		409	-2	Gen 2
	2	7/22/2010	8/5/2010	00399		00001		398	11482		11084		398	0	Gen 2
ATWATER															
	1	7/26/2010	8/5/2010	00391		00001		390	17018		16625		393	3	Gen 2
AUBURN															
	1	8/3/2010	8/5/2010	00089		00001		88	14001		13913		88	0	Gen 2
BAKERSFIELD															
	1	7/23/2010	8/5/2010	00530		00001		529	15080		14549		531	2	Gen 2
	2	7/26/2010	8/5/2010	00446		00001		445	08809		08363		446	1	Gen 2
CLOVIS															
	1	7/28/2010	8/5/2010	00351		00000		351	22542		22188		354	3	Gen 2
	2	7/28/2010	8/5/2010	00708		00000		708	32889		32181		708	0	Gen 2
	3	7/28/2010	8/5/2010	00802		00001		801	24924		24115		809	8	Gen 2
CONCORD															
	1	7/23/2010	8/5/2010	00257		00002		255	05842		05583		259	4	Gen 2
DANVILLE															
	1	7/30/2010	8/5/2010	00482		00198		284	14939		14654		285	1	Gen 2
FRESNO															
	1	7/27/2010	8/5/2010	00105		00000		105	01825		01719		106	1	Gen 2
	2	7/27/2010	8/5/2010	00456		00000		456	20094		19637		457	1	Gen 2
	3	7/28/2010	8/5/2010	00632		00000		632	14820		14180		640	8	Gen 2
LOOMIS															
	1	7/23/2010	8/5/2010	00192		00001		191	11008		10819		189	-2	Gen 2
PLEASANT HILL															
	1	7/23/2010	8/5/2010	00215		00001		214	06043		05827		216	2	Gen 2
SAN RAMON															
	1	7/30/2010	7/30/2010	00138		00138		0	02461		02461		0	0	Gen 2
SELMA															
	1	7/27/2010	8/5/2010	00121		00000		121	03775		03655		120	-1	Gen 2
STOCKTON															
	1	7/26/2010	8/4/2010	00275		00001		274	09020		08744		276	2	Gen 2
WALNUT CREEK															
	1	7/23/2010	8/5/2010	00190		00000		190	03686		03496		190	0	Gen 2
Total Generation 2 Tests			20									Average Difference		1.6	

Figure 41: PG&E-Provided Scenario 8 Field Meter Results - August 8, 2010

SmartMeter™ Side-by-Side Test Results

August 12, 2010

Location		Date Installed	Last Read Date	Mechanical Meter Present Reading (kWh)	(-)	Mechanical Meter Initial Reading (kWh)	(=)	Mechanical Meter Total Usage (kWh)	SmartMeter™ Present Reading (kWh)	(-)	SmartMeter™ Initial Reading (kWh)	(=)	SmartMeter™ Total Usage (kWh)	Cumulative Difference (kWh)	SmartMeter Type Gen 1 = DCSI Gen 2 = SSN
ANTIOCH	1	7/22/2010	8/12/2010	00579		00001		578	01687		01112		575	-3	Gen 2
	2	7/22/2010	8/12/2010	00537		00001		536	11620		11084		536	0	Gen 2
ATWATER	1	7/26/2010	8/12/2010	00664		00001		663	17292		16625		667	4	Gen 2
AUBURN	1	8/3/2010	8/12/2010	00327		00001		326	14240		13913		327	1	Gen 2
BAKERSFIELD	1	7/23/2010	8/12/2010	00772		00001		771	15323		14549		774	3	Gen 2
	2	7/26/2010	8/12/2010	00711		00001		710	09074		08363		711	1	Gen 2
CLOVIS	1	7/28/2010	8/12/2010	00885		00000		885	23081		22188		893	8	Gen 2
	2	7/28/2010	8/13/2010	01324		00000		1324	33505		32181		1324	0	Gen 2
	3	7/28/2010	8/12/2010	01561		00001		1560	25691		24115		1576	16	Gen 2
CONCORD	1	7/23/2010	8/12/2010	00345		00002		343	05930		05583		347	4	Gen 2
DANVILLE	1	7/30/2010	8/12/2010	00871		00198		673	15329		14654		675	2	Gen 2
FRESNO	1	7/27/2010	8/13/2010	00186		00000		186	01907		01719		188	2	Gen 2
	2	7/27/2010	8/12/2010	00759		00000		759	20401		19637		764	5	Gen 2
	3	7/28/2010	8/12/2010	01163		00000		1163	15357		14180		1177	14	Gen 2
LOOMIS	1	7/23/2010	8/12/2010	00335		00001		334	11149		10819		330	-4	Gen 2
PLEASANT HILL	1	7/23/2010	8/12/2010	00374		00001		373	06203		05827		376	3	Gen 2
SAN RAMON	1	7/30/2010	8/12/2010	00793		00138		655	03116		02461		655	0	Gen 2
SELMA	1	7/27/2010	8/12/2010	00222		00000		222	03877		03655		222	0	Gen 2
STOCKTON	1	7/26/2010	8/12/2010	00448		00001		447	09194		08744		450	3	Gen 2
WALNUT CREEK	1	7/23/2010	8/12/2010	00277		00000		277	03773		03496		277	0	Gen 2
Total Generation 2 Tests			20								Average Difference			3.0	

Figure 42: PG&E-Provided Scenario 8 Field Meter Results - August 12, 2010

4.2.7 Customer Call Notifications

Calls were made from the Structure Customer Call Center to the Customers selected for possible participation in the evaluation. The Structure Customer Call Center also fielded inbound Customer calls, and followed the protocols outlined in the Approach section of this document, and followed the documented Customer Communications Procedure. The breakdown of the calls made and received through Structure's Customer Call Center is found in the following Figure.

Structure Customer Call Center Call Statistics		
Call Type		**Call Total**
Scenario 3	Notification of Electromechanical Meter Replacement with Smart Meter	120
Scenario 4	Test a Smart Meter - Non Complaint	663
Scenario 5	Test a Smart Meter - Billing Complaint	41
Scenario 6	Test a Smart Meter - Shadow Meter	51
Scenario 7	Notification of Field Testing and Possible PG&E Replacement of Electromechanical Meters with PG&E Smart Meters	112
Scenario 8	Test a Smart Meter and Shadow Meter	34
	Callback	19
	Inbound	40
	Customer Interview Calls	195
Total Calls		**1275**

Figure 43: Structure Customer Call Center Call Statistics

4.3 End-to-End System Testing

Data from both laboratory and field shadow meter tests that was used to evaluate PG&E's end-to-end system is presented in this section. Data from both laboratory and field tests is presented in this section. Laboratory and field shadow meter bill analysis for all nine shadow meters can be found in Appendix E – End-to-End Customer Bill Analysis.

4.3.1 End-to-End System Testing Meter Specifications

The following figure illustrates the types of meters used in the end-to-end system testing conducted with meters located in Structure's independent laboratory.

Structure's End-to-End Laboratory-Based System Testing Meter Specifications					
	Shadow Meter #1	**Shadow Meter #2**	**Shadow Meter #3**	**Shadow Meter #4**	**Shadow Meter #5**
Structure Badge #	TSG 001	TSG 002	TSG 003	TSG 004	TSG 005
Mfg Serial #	11876358	11939883	11939880	11939882	12074014
Manufacturer	Elster	Elster	Elster	Elster	Elster
Mfg. Type	A3TL	A3TL	A3TL	A3TL	A3TL
Form	2S	2S	2S	2S	1S
	Meter Under Test #1	**Meter Under Test #2**	**Meter Under Test #3**	**Meter Under Test #4**	**Meter Under Test #5**
PG&E Badge #	1007216524	1006334261	1007186727	1006327586	1005776354
Mfg Serial #	42912285	105811649	42690619	105804974	1005776354
Manufacturer	GE	L+G	GE	L+G	GE
Mfg. Type	I-210+	AXR-SD	I-210+	AXR-SD	I-210+
Form	2S	2S	2S	2S	1S
SSN NIC ID	0013500100C53910	0013500100C330CF	0013500100C2F531	0013500100C359DC	00135001001462B7

Figure 44: Structure's End-to-End Laboratory-Based System Testing Meter Specifications

Shadow meters 1-5 referenced above were located and evaluated in the laboratory; shadow meters 6-9 utilized meters from Field Meter Test Scenario 6 as part of the End-to-End testing.

4.3.2 End-to-End Laboratory Test Case #1 Non-Time-of-Use Read Accuracy Report

The following Figure illustrates the End-to-End Laboratory Test Case #4 comparisons of midnight register reads collected by the PG&E Meter Data Management System (MDMS) vs. midnight register reads collected manually from the Structure shadow meter.

Structure End-to-End Test: Midnight Register Read Report for Shadow Meter #4					
Customer Name	Stacey Structure				
Premise ID					
SP ID	2312175466				
Account ID	1239442971				
SA (Rate) ID	1239442443				
Historical ADU					
	Shadow Meter #4		**PG&E Meter**		
Meter Badge ID	TSG-004		1006327586		
Meter Manufacturer	Elster		L+G FOCUS		
Meter Mfg Serial ID	11939882		105804974		
Meter Form	2S		2S		
Network ID	N/A		0013500100C359DC		
DATE	**Register**	**Usage Calc**	**Register**	**Usage Calc**	**DELTA**
5/27/2010			113.18		
5/28/2010		0.00	178.89	65.71	
5/29/2010		0.00	296.70	117.80	
5/30/2010		0.00	414.79	118.09	
5/31/2010	316.00	316.00	532.50	117.71	
6/1/2010	433.72	117.72			
6/2/2010	501.55	67.82	603.09	70.59	2.77
6/3/2010	563.81	62.27	665.31	62.22	-0.05
6/4/2010	618.23	54.41	719.75	54.44	0.02
6/5/2010	706.23	88.00	804.19	84.44	-3.56
6/6/2010	836.62	130.39	934.79	130.60	0.21
6/7/2010	963.45	126.83	1061.67	126.88	0.05
6/8/2010	1042.87	79.42	1146.19	84.52	5.10
6/9/2010	1057.69	14.82	1160.96	14.77	-0.04
6/10/2010	1081.37	23.69	1183.81	22.85	-0.83
6/11/2010	1115.11	33.73	1217.54	33.73	-0.01
6/12/2010	1148.88	33.77	1251.32	33.78	0.01
6/13/2010	1182.74	33.86	1285.20	33.88	0.01
6/14/2010	1216.62	33.88	1319.13	33.93	0.05
6/15/2010	1249.98	33.36	1352.49	33.37	0.01
6/16/2010	1283.46	33.48	1385.97	33.48	-0.01
6/17/2010	1317.02	33.56	1419.55	33.58	0.02
6/18/2010	1350.47	33.46	1453.01	33.46	0.00
6/19/2010	1383.97	33.49	1486.47	33.46	-0.03
6/20/2010	1417.80	33.84	1520.29	33.82	-0.02
6/21/2010	1451.62	33.81	1554.10	33.80	-0.01
6/22/2010	1485.04	33.43	1587.54	33.44	0.01
6/23/2010	1518.16	33.11	1620.62	33.08	-0.03
6/24/2010	1551.30	33.15	1653.81	33.19	0.04
6/25/2010	1584.30	32.99	1686.78	32.97	-0.02
6/26/2010	1617.33	33.04	1719.81	33.03	-0.01
6/27/2010	1650.62	33.28	1753.08	33.27	-0.02
6/28/2010	1683.92	33.31	1786.34	33.26	-0.048

Figure 45: Structure End-to-End Laboratory Shadow Meter #4 – Midnight Register Read Report

4.3.2.1 Billing Accuracy Assessment

4.3.2.1.1 Comparison of Printed PG&E Bill to Structure's Rate Calculator

End-to-end shadow meter system testing commenced in the laboratory environment on May 28, 2010 and collected registered meter data through June 30, 2010. As per changes to PG&E rate structure kilowatt price tier allocation, effective June 1, 2010, the five end-to-end shadow meter accounts were billed through a split rate structure. The four field-based end-to-end shadow meter tests were not subjected to the rate change, as field shadow meters were installed subsequent to June 1, 2010. The Figure below presents a summary of PG&E's baseline allocations and their effective change dates.

PG&E Baseline Allocation Change Effective Dates				
3/1/2010 to 5/31/2010			6/1/2010 to Present	
Tier Allocation	$/KWH		Tier Allocation	$/KWH
Tier 1 (Baseline)	$0.11877		Tier 1 (Baseline)	$0.11877
Tier 2	$0.13502		Tier 2	$0.13502
Tier 3	$0.28562		Tier 3	$0.29062
Tier 4	$0.42482		Tier 4	$0.40029
Tier 5	$0.49778		Tier 5	$0.40029

Figure 46: PG&E's Baseline Allocation Change Effective Date

Printed bills delivered by PG&E for five laboratory end-to-end accounts broke out registered usage into two separate periods: May 28, 2010, through May 31, 2010; and June 1, 2010, through June 27, 2010. This segmentation was in line with Structure's expectations for billing through a Customer rate change. Manual calculations performed by Structure for each printed bill concluded that PG&E bill-print calculations were accurate. Moreover, the PG&E bill accurately parsed customer usage into the appropriate Tier groupings and presented accurate totalized KWH amounts.

In addition to manual review of printed PG&E bills, Structure utilized raw meter read data collected by the Meter Data Management System and meter reads registered by the shadow meter and compared these KWH values to the usage figures presented on the bill. This comparison identified only minor rounding errors in two calculations between the meter data source and the physical bill delivered to the Customer. Structure included a sample of a rounding error identified in a Customer bill in the Figure below. The difference between the bill amount of $377.44 and the calculated amount of $377.434 was $.006, and associated with rounding adjustment. No known issues are associated with this difference. The exact internal process of rounding and truncating in the CIS was not investigated.

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Structure's Example of Customer Bill Rounding Discrepancy		
kWh	**Price**	**Total**
364.80000	0.11877	$43.327
109.44000	0.13502	$14.777
255.36000	0.28562	$72.936
364.80000	0.42482	$154.974
175.60000	0.49778	$87.410
	Total	$373.424
	Tax	$0.279
	Franchise	$3.730
1270		
Total Seg		$377.434

Figure 47: Structure's Example of Customer Bill Rounding Discrepancy

The following Figures present Structure's findings of the end-to-end shadow meter bill analysis for sample laboratory and field shadow meter tests. The sample meters used are followed through the following analyses:

- Estimation of laboratory-based shadow meter bill, compared to actual bill results for the same meter.
- PG&E bill for the laboratory-based shadow meter.
- Estimation of field-based shadow meter bill, compared to actual bill results for the same meter.
- Comparison of the field-based shadow meter's KWH usage to the associated existing Smart Meter's KWH usage over the same period of time.

Laboratory and field shadow meter bill analysis for all nine shadow meters used in the five end-to-end laboratory tests and four end-to-end field tests is found in Appendix E – End-to-End Customer Bill Analysis.

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4.3.2.1.1.1 Estimation of Structure's Laboratory-Based Shadow Meter Bill, Compared to Actual Bill Results for the Same Meter

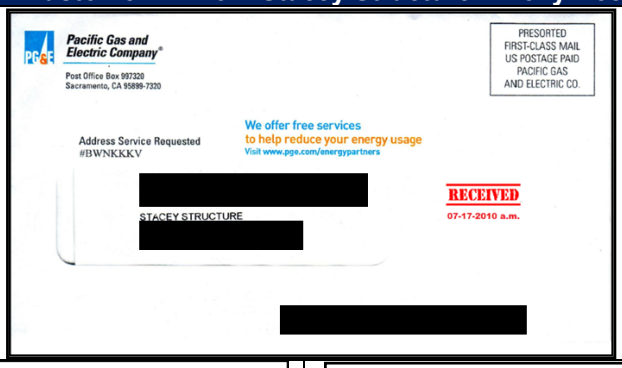
Structure's End-to-End Laboratory Shadow Test #4		
Customer Name	Stacey Structure	
Premise ID	N/A	
SP ID	2312175466	
Account ID	1239442971	
Smart Meter	L&G FOCUS	
Network	SSN	
Meter Form	2S	
City	Walnut Creek	
Bill Code	Basic	
Rate	E1	
Baseline	12.1 KWH	
Bill From Date	5/28/2010	
Bill To Date	6/24/2010	
Bill Cycle Length	28	
Tier Allocation	**PRINTED BILL**	
	Bill Segment 1	**Bill Segment 2**
Tier 1 (Baseline)	48.4000	290.4000
Tier 2	14.5200	87.1200
Tier 3	33.8800	203.2800
Tier 4	48.4000	290.4000
Tier 5	95.6571	573.9429
Tax/Other	$0.05	$0.32
USAGE	1,686.00	
MANUAL BILL CALC	$	537.25
ACTUAL BILL AMOUNT	$	537.25

Figure 48: Structure's End-to-End Laboratory Shadow Test #4 Bill Information

4.3.2.1.1.2 PG&E Bill for Structure's Laboratory-Based Shadow Meter

The four-page PG&E Customer Bill and stamped date of receipt for Structure's "Stacey Structure" Proxy Account associated with the end-to-end laboratory shadow meter test #4 is presented in the following Figure. The PG&E Customer Bills for all five laboratory-based proxy shadow meters are found in Appendix E – End-to-End Customer Bill Analysis.

PG&E Customer Bill for "Stacey Structure" Proxy Account



Pacific Gas and Electric Company®
Post Office Box 997320
Sacramento, CA 95899-7320

PRESORTED
FIRST-CLASS MAIL
US POSTAGE PAID
PACIFIC GAS
AND ELECTRIC CO.

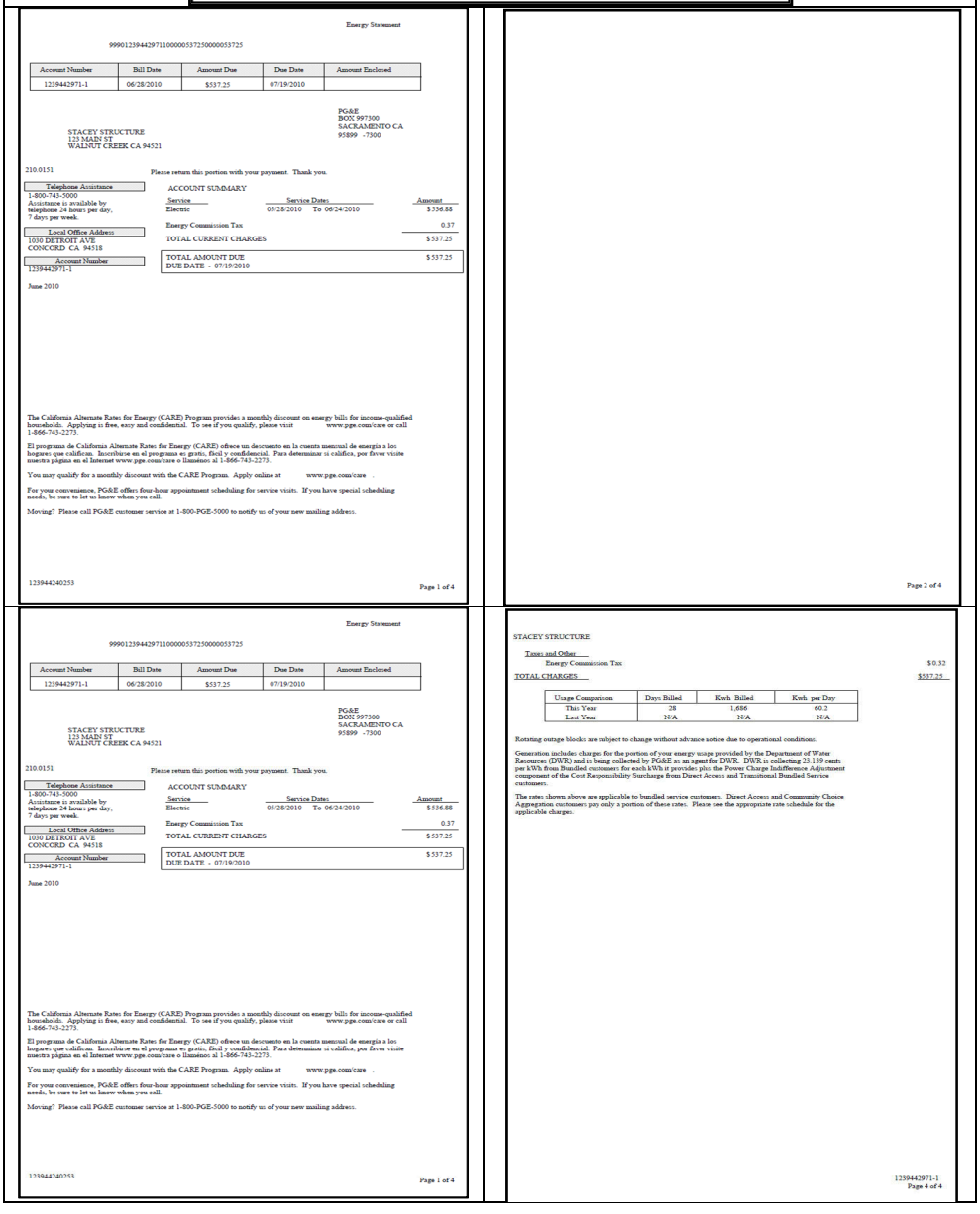
Address Service Requested
#BWNKKKV

We offer free services
to help reduce your energy usage
Visit www.pge.com/energypartners

[redacted]
STACEY STRUCTURE
[redacted]

RECEIVED
07-17-2010 a.m.

[redacted]



Energy Statement

9990123944297110000053725000053725

Account Number	Bill Date	Amount Due	Due Date	Amount Enclosed
1239442971-1	06/28/2010	$537.25	07/19/2010	

PG&E
BOX 997300
SACRAMENTO CA
95899 -7300

STACEY STRUCTURE
123 MAIN ST
WALNUT CREEK CA 94521

210.0151

Please return this portion with your payment. Thank you.

Telephone Assistance
1-800-743-5000
Assistance is available by telephone 24 hours per day, 7 days per week.

Local Office Address
1030 DETROIT AVE
CONCORD CA 94518

Account Number
1239442971-1

ACCOUNT SUMMARY

Service	Service Dates	Amount
Electric	05/28/2010 To 06/24/2010	$ 336.88
Energy Commission Tax		0.37
TOTAL CURRENT CHARGES		$ 537.25
TOTAL AMOUNT DUE DUE DATE - 07/19/2010		$ 537.25

June 2010

The California Alternate Rates for Energy (CARE) Program provides a monthly discount on energy bills for income-qualified household. Applying is free, easy and confidential. To see if you qualify, please visit www.pge.com/care or call 1-866-743-2273.

El programa de California Alternate Rates for Energy (CARE) ofrece un descuento en la cuenta mensual de energía a los hogares que califican. Inscribirse en el programa es gratis, fácil y confidencial. Para determinar si califica, por favor visite nuestra página en el Internet www.pge.com/care o llámenos al 1-866-743-2273.

You may qualify for a monthly discount with the CARE Program. Apply online at www.pge.com/care .

For your convenience, PG&E offers four-hour appointment scheduling for service visits. If you have special scheduling needs, be sure to let us know when you call.

Moving? Please call PG&E customer service at 1-800-PGE-5000 to notify us of your new mailing address.

123944240253

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Energy Statement

9990123944297110000053725000053725

Account Number	Bill Date	Amount Due	Due Date	Amount Enclosed
1239442971-1	06/28/2010	$537.25	07/19/2010	

PG&E
BOX 997300
SACRAMENTO CA
95899 -7300

STACEY STRUCTURE
123 MAIN ST
WALNUT CREEK CA 94521

210.0151

Please return this portion with your payment. Thank you.

Telephone Assistance
1-800-743-5000
Assistance is available by telephone 24 hours per day, 7 days per week.

Local Office Address
1030 DETROIT AVE
CONCORD CA 94518

Account Number
1239442971-1

ACCOUNT SUMMARY

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June 2010

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You may qualify for a monthly discount with the CARE Program. Apply online at www.pge.com/care .

For your convenience, PG&E offers four-hour appointment scheduling for service visits. If you have special scheduling needs, be sure to let us know when you call.

Moving? Please call PG&E customer service at 1-800-PGE-5000 to notify us of your new mailing address.

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STACEY STRUCTURE

Taxes and Other
Energy Commission Tax $ 0.32
TOTAL CHARGES $537.25

Usage Comparison	Days Billed	Kwh Billed	Kwh per Day
This Year	28	1,686	60.2
Last Year	N/A	N/A	N/A

Rotating outage blocks are subject to change without advance notice due to operational conditions.

Generation includes charges for the portion of your energy usage provided by the Department of Water Resources (DWR) and is being collected by PG&E as an agent for DWR. DWR is collecting 23.139 cents per kWh from Bundled customers for each kWh it provides plus the Power Charge Indifference Adjustment component of the Cost Responsibility Surcharge from Direct Access and Transitional Bundled Service customers.

The rates shown above are applicable to bundled service customers. Direct Access and Community Choice Aggregation customers pay only a portion of these rates. Please see the appropriate rate schedule for the applicable charges.

1239442971-1
Page 4 of 4

Figure 49: PG&E Customer Bill for Structure's "Stacey Structure" Proxy Account

4.3.2.1.1.3 Estimation of Field-Based Shadow Meter Bill, Compared to Actual Bill Results for the Same Meter

The estimated and actual bill results for Shadow Meter #6, associated with end-to-end field shadow test #1, are presented in the following Figure. This shadow meter was associated with a Customer's Smart Meter. The Customer's billing information was provided to Structure by PG&E at Structure's request, for comparison to Structure's estimated calculations. The estimated and actual bill amounts for all laboratory and field shadow meters are found in Appendix E – End-to-End Customer Bill Analysis.

Structure's End-to-End Field Shadow Test #1		
Customer Name	[redacted]	
Premise ID		
SP ID		
Account ID		
Smart Meter	L+G	
Network	DCSI	
Meter Form	2S	
City	Bakersfield	
Bill Code	Basic	
Rate	E1	
Baseline ADU	19.4 KWH	
Bill From Date	6/4/2010	
Bill To Date	7/2/2010	
Bill Cycle Length	29	
	Bill Segment 1	**Bill Segment 2**
Tier 1 (Baseline)	523.8000	38.8000
Tier 2	157.1400	11.6400
Tier 3	366.6600	27.1600
Tier 4	523.8000	38.8000
Tier 5	449.8759	33.3241
Tax/Other	$0.44	$0.03
KWH USAGE	2,171.00	
MANUAL BILL CALCULATION	$	623.15
ACTUAL BILL AMOUNT	$	623.15
HISTORICAL BILL ANALYSIS		
Bill From Date	5/5/2010	
Bill To Date	6/3/2010	
Bill Cycle Length	30	
	MDM Usage	**Printed Bill**
USAGE	1261	1261
USAGE CHARGE(+tax)	$250.51	$250.51
DELTA	0	0
Bill From Date	4/6/2010	
Bill To Date	5/4/2010	
Bill Cycle Length	29	
	MDM Usage	**Printed Bill**
USAGE	989	989
USAGE CHARGE (+tax)	$245.14	$245.14
DELTA	0	0
Bill From Date	3/5/2010	
Bill To Date	4/5/2010	
Bill Cycle Length	32	
	MDM Usage	**Printed Bill**
USAGE	1012	1012
USAGE CHARGE (+tax)	$251.23	$251.23
DELTA	0	0

Figure 50: Structure's End-to-End Field Shadow Test #1 (Shadow Meter #6) Bill Information

4.3.2.1.1.4 Comparison of the Field-Based Shadow Meter's KWH Usage to the Associated Existing Smart Meter's KWH Usage over the Same Period of Time

The kWh usage comparison of the first end-to-end field test shadow meter (shadow meter #6) to the corresponding existing Smart Meter is illustrated in the Figure below.

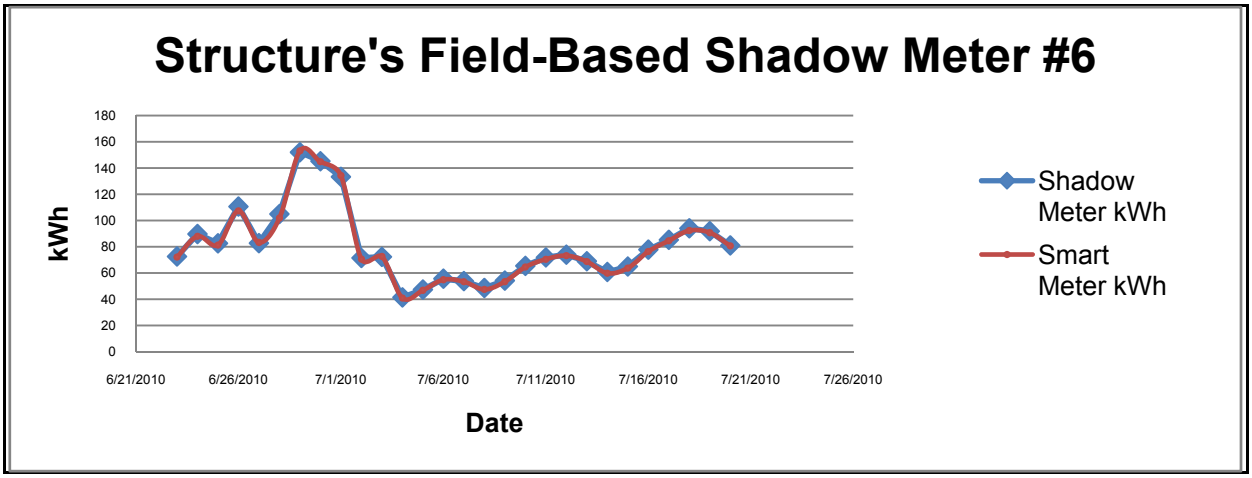


Figure 51: Comparison of Structure's Field-Based Shadow Meter #6 Usage to Corresponding Customer's Smart Meter Usage

4.4 High Bill Complaint Analysis

4.4.1 High Bill Complaint Analysis

Structure compared the July 2009 and August 2009 usage patterns to the same months in 2006 to determine if weather was a significant factor in the increase in Customer usage irrespective of the type of meter at the Customer premise. For reference purposes, the average monthly temperature for July 2006 and August 2006 were 87.8 and 81.0 degrees Fahrenheit in Bakersfield as compared to the average 2009 month temperatures for the same months of 86.4 and 82.7 degrees Fahrenheit. Structure found when comparing July 2006 and 2009 that only 295 Customer complaint accounts representing 14%of the high bill population reflected 2009 monthly usage greater than 110% of 2006 usage during these peak months. Similar results were identified when evaluating August 2006 and 2009 data. The impact to Customer complaint accounts reduced to 110% when evaluating a 20% increase from the same months in 2009 compared to 2006. While in warmer conditions the Customer profile appeared to be in line with prior years, the lower Customer usage in the years immediately prior to Smart Meter installation due to milder weather could have contributed to Customer perception that the installation of Smart Meters contributed to increased usage during 2009.

Structure also reviewed extent of actual versus estimated meter reads across all accounts since the Smart Meter installation period began to determine the extent of estimated meter reads and the associated impacts to billing. PG&E indicated that the classification of a meter as a Smart Meter varies based upon the process being analyzed. From an installation perspective, meters are considered Smart Meters, once installed. From a billing perspective, meters must no longer be read by Meter Readers in the field to be considered a Smart Meter. The basic four classifications for the collection of meter reads included:

- Enabled Meters – Interval based meters that continue to be read by a Meter Reader. Enabled meters are read and reported similar to electromechanical meters.
- Read Meters – Interval based meters that utilize one actual read that is utilized to calculate monthly billing as compared to the prior month's end read, also referred to as an anchor read. Monthly billing with estimation was performed by the Meter Data Management (MDM) system.
- Billed Meters – Interval based meters utilized for Time of Use meters with estimation performed by MDM for data gaps or interval usage that fails the interval usage validation rules.
- Disabled Meters – Meter no longer in service.

The following Figure presents a Structure-generated comparison of the actual vs. estimated read performances for the assessed PG&E high bill complaint Customers from September 2007 to March 2010.

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Read Performance Actual vs Estimated from September 2007 thru March 2010					
		Invoices Generated from Actual Read	%	Invoices Generated from Estimated Read	%
Overall SmartMeter and EMR		314,417,931	99.35%	2,057,625	0.65%
Overall SmartMeter		48,414,354	99.79%	99,987	0.21%
	Electric Only	18,927,787	99.65%	65,725	0.35%
	Gas Only	29,486,567	99.88%	34,262	0.12%
Overall EMR		266,003,577	99.27%	1,957,638	0.73%
	Electric Only	161,872,225	99.14%	1,398,574	0.86%
	Gas Only	104,131,352	99.47%	559,064	0.53%

Figure 52: Structure's Read Performance for PG&E High Bill Complaint Customers, September 2007-March 2010

Structure reviewed PG&E's cancel/re-bill report as part of this evaluation. The cancel/re-bill report outlined the reasons associated with PG&E either automatically cancelling a bill or performing a manual cancellation. The cancel/re-bill analysis performed after Customer interviews revealed that a source of Complaints was associated with receiving adjustments that could not be readily reconciled. The report provided by PG&E reflected the entire Smart Meter population and was not refined to include only the High Bill Complaints but does provide insight into the reason and numbers of Smart Meter bills that have been cancelled and re-billed. The following Figure provides the PG&E reason codes assigned by PG&E for Cancels/Re-bills. Due to the inability to obtain specifics from PG&E around each of the reasons specified in the following Figure, additional research may be required.

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Related	Reason	All	Bakersfield Fresno
PGE	Auto-Cancel Verified	1,254	105
PGE	Adjust Estimated Read	12,324	4,052
C	Incorrect Baseline Territory	8	3
PGE	Bill Beyond Required Change	11,138	5,289
PGE	Error in Bill Calculation	1,622	1,375
PGE	Clerical Read Correction	932	273
C	Incorrect Bill Component	1,715	1,189
C	CPPC	4	
C	CTC Correction	3	1
PGE	Customer Read Correction	526	144
C	Decreased Deposit	6	
C	Energy Commission Tax	1	
PGE	No EMR Reads Rcvd by System	1	1
PGE	Adjustment for Metering Equip	314	77
C	ESP Bill Adjust & Correct	1	1
PGE	Correct Estimated Billing	3,051	1,002
PGE	Fast Meter	1	
C	Final Bill	24,158	10,315
PGE	Incorrect Gas Line Segments	1	1
C	Correction to Load	21	13
PGE	Meter Malfunction	51	5
PGE	MDMA - Meter Read Correction	37	14
PGE	Miscellaneous	3,192	1,809
PGE	Incorrect Mtr Rd - Other	10,542	4,678
PGE	Incorrect Mtr Rd - Mtr Reader	2,561	596
C	PX Price Correction	1	
C	Rate Schedule Correction	7,777	4,150
C	Revenue Assurance Charge	1	
C	SMCR	32	18
C	Incorrect Svc Stop Dt/Read	1,253	636
C	Incorrect Svc Start Dt/Read	1,266	627
C/PGE	Switched/Crossed Meters	180	69
PGE	Incorrect Town & Terr Code	11	11
PGE	System-Error in Bill Calc.	5	
C	System-Landlord Bill Correct'n	68	53
	Total	84,058	36,507

Figure 53: PG&E Reason Codes for Cancel/Re-bills

C = Identified by Customer
PGE = Identified by PG&E

The following Figure provides an overview of PG&E's high bill complaint analysis and key reasons for the analysis, as provided by PG&E.

PG&E-Provided High Bill Complaint Analysis Components		
What was Analyzed	**Data Source**	**Reason for Analysis**
Usage History	CC&B	• Has usage pattern changed? • When did usage pattern change? • Does usage change coincide with Smart Meter install date? • How does usage compare to same month prior three years? • Has usage ever been as high or low as the period in question for that customer? • Has usage ever been as high or low as the period in question for that premise? • Were there any weather events that could have affected usage?
Billing History	CC&B	• When were bills generated? • Were any bills delayed? • Was customer previously over- or under-billed based on an erroneous EMR read and is that affecting the bill in question? • Is the number of billing days consistent?
Meter Reads and Intervals	MDMS UIQ CC&B	• What is the service point status? Is it Smart Meter enabled, read or billed? • When did Meter begin communicating? • If meter stopped communicating, when? • Which reads were validated actual vs. estimated? • Are estimated reads in line with validated actual reads? • Is there a relationship between meter event dates and usage or read status? • Does UIQ data align with MDMS data? • Does read data align with customer's stated usage? • Which estimation rules were used? • Are there meter events, what are the descriptions and dates? • Are night-time intervals higher than normal?
Rates	CC&B	• What is end use code and does customer have the proper baseline allotment • What is the Medical Baseline history and status? • Was the customer recently dropped from Medical Baseline? • Should we send a Medical application? • What is the CARE history and status? Did the customer recently drop from CARE? • Does the customer qualify for CARE? • When did rates change for the customer? • If the rate changed, did it contribute to customer's issue
Field Orders	CC&B	• What were the faceplate read details? • Meter exchange details • Alterations or modifications to meter/service • Were there any additional employee observations?

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PG&E-Provided High Bill Complaint Analysis Components		
What was Analyzed	**Data Source**	**Reason for Analysis**
SAP Information	SAP	• What were engineering plans for the building or residence? • Were there any paper tag exchanges? • Were there any unusual on-site observations?
Tier Review	CC&B	• If the bill was estimated, was it spread across the tiers properly? • Have tier changes affected the bill if comparing to previous year?
Customers' Perspective	Customer	• How does the customer describe their issue? • What is customers heating/cooling source? What is the temperature setting? Does it automatic on/off capability? • What is the connected load? Are there high usage appliances such as pool pump, spa, extra water heaters, water pumps, space heaters, etc.? • Are there any high consumption appliances on timers? • Has the customer added/removed appliances during the period in question? • What is the customer daily consumption pattern? What time do they sleep? How many in household? Has that number changed? • How did the issue first arise and when? • Dates/times of changes in customer behavior • When did the customer first contact PG&E? • Does the customer mention changes in household could possibly affect consumption? • Did the customer vacate the home recently and did usage change during that period? • Have been any additional people in the household?

Figure 54: PG&E-Provided High Bill Complaint Analysis Components

The PG&E high bill complaint analysis components looked at the potential issues that surfaced utilizing the questions that were consistent with historical practices associated with electromechanical meters. Additional interval data associated with Smart Meters should allow for more in-depth Customer focused questions.

4.4.2 Summary of Customer Interviews

Structure interviewed and documented 20 Customers' perspectives related to their PG&E Smart Meter high bill complaints. The following 13 Customer interview extracts provided in this report are included with permission by the Customer:

- Account ID: 3X; Division: Fresno
- Account ID: 5X; Division: Fresno
- Account ID: 8X; Division: Fresno
- Account ID: 9X; Division: Stockton
- Account ID: 12X; Division: Sierra
- Account ID: 13X; Division: Sierra
- Account ID: 14X; Division: Diablo
- Account ID: 15X; Division; Sierra
- Account ID: 16X; Division: Stockton
- Account ID: 17X; Division: Fresno
- Account ID: 18X; Division: Stockton
- Account ID: 19X; Division: Kern
- Account ID: 20X; Division: Diablo

Structure ruled out Smart Meters as the cause of these Customers' issues, but makes no further representation as to the cause of the Customer's issues.

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4.4.2.1 Account ID: 3X; Division: Fresno

Customer filed a complaint when electricity bill went from an average of $75-125 to $900.

4.4.2.1.1 Complaint Submission

Customer sent the November 2009 bill payment and a letter explaining the situation to the CPUC sometime in December.

4.4.2.1.2 Customer Scenario

Customer has two meters. One meter services a 4,000 sq ft house, the other services a 650 sq ft apartment and 150 sq ft trailer. Customer uses 100% of the electricity in the house, apartment, and trailer. Customer's bill was originally on a time-of-use bill. Customer shuts everything off during the day. Customer has three AC units: a 4-ton, 3-ton, and 2-ton. Customer's house bill averaged $300/month in winter. The Customer's highest bill was $1,100 because housekeeper left AC on while they were on vacation. Customer's apartment & trailer bill averaged $75-125/month until the November 2009 $900 bill. Customer stated it was the same month the Smart Meter was installed. (Structure records indicate Smart Meter was installed July 22, 2009)

4.4.2.1.3 Complaint Response

After Customer sent the original complaint letter and $900 payment to the CPUC, Customer continued to receive bills from PG&E for the $900. "After a while" it came off the bill. 60 days from the day of the complaint letter, Customer received a letter from PG&E indicating they would come out and test the meter. PG&E checked the meter and stated the meter was working properly. PG&E did not threaten to shut off power for non-payment during this period.

4.4.2.1.4 Complaint Resolution

Customer is now on the average billing system. After initial high bill, Customer's bills have returned to the historical $125 amount. Overall Customer is happy to see the bill reduced but does not trust PG&E as it relates to this matter.

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4.4.2.2 Account ID: 5X; Division: Fresno

Customer filed a complaint with PG&E when their electricity bill went from a $200-300 average to $700.

4.4.2.2.1 Complaint Submission

Customer called PG&E to request a payment plan due to current financial situation.

Customer also submitted a letter to the CPUC.

4.4.2.2.2 Customer Scenario

Customer received a Smart Meter in November 2009. Subsequent bill was $700. Customer does not recall anything that would warrant the increase in usage. Customer has both gas and electric in their house.

4.4.2.2.3 Complaint Response

PG&E did not offer credit for high bill during or admit anything was wrong with the meter. PG&E broke the bill into two payments for them.

In response to Customer's letter to the CPUC, the CPUC responded via letter to the Customer indicating PG&E would come investigate. PG&E tested the meter and determined the meter was working correctly.

4.4.2.2.4 Complaint Resolution

PG&E indicated Customer could submit an appeal to PG&E's decision by submitting additional, new documentation.

4.4.2.2.5 Usage Comparison by Month

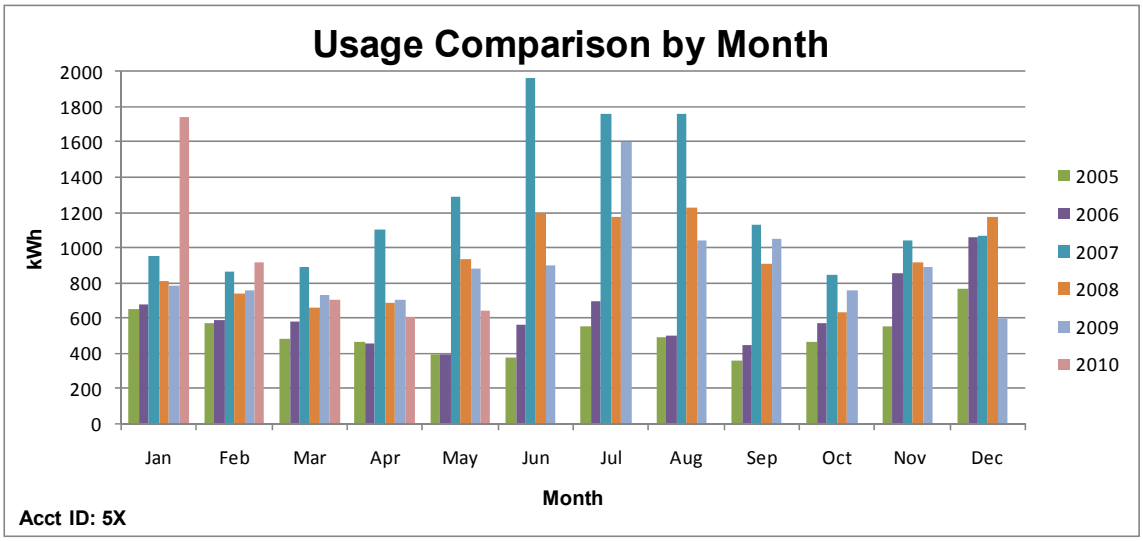


Figure 55: Usage Comparison by Month - Customer Interview Acct ID: 5X

4.4.2.2.6 Billing Comparison by Month

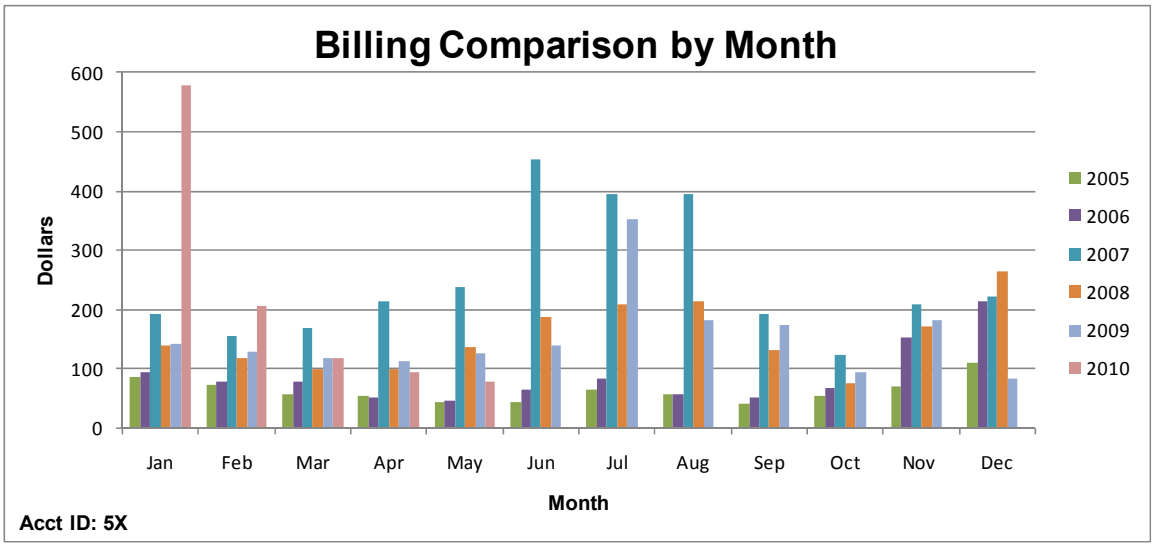


Figure 56: Billing Comparison by Month - Customer Interview Acct ID: 5X

4.4.2.3 Account ID: 8X; Division: Fresno

Customer filed a complaint when electricity bills doubled Customer's prior year, same period usage.

4.4.2.3.1 Complaint Submission

Customer first submitted a complaint at the local PG&E office. Customer contacted Sen. Florez's office and the CPUC to file a complaint. Customer also spoke with someone in Fresno regarding agricultural usage in the area.

4.4.2.3.2 Customer Scenario

Customer has lived in the house for 57 years and in the last few years replaced most major appliances with energy efficient appliances. Customer has propane for the winter and an electric hot water heater. Customer doesn't use central heating but noticed the winter bill was also high. Air conditioning is usually set to 83 degrees, supplemented with ceiling and floor fans.

4.4.2.3.3 Complaint Response

PG&E Representatives, based on the premise history, determined the old meter was not working properly as it had been operating at the house since 1957. PG&E was hesitant to help. PG&E informed the Customer they were using 300 kWh more a year. Since the old meter was discarded there is no way to verify if the old meter was functioning properly.

Customer did not receive much response from Sen. Florez and the CPUC.

PG&E tested Customer's meter and reported the meter was functioning properly. Customer wants to know who "calibrated" the Smart Meters.

4.4.2.3.4 Complaint Resolution

Customer has not received or determined an explanation for the increased bills and does not qualify for CARE rates. To the Customer's knowledge, not qualifying for this program is due to property and land ownership.

4.4.2.3.5 Usage Comparison by Month

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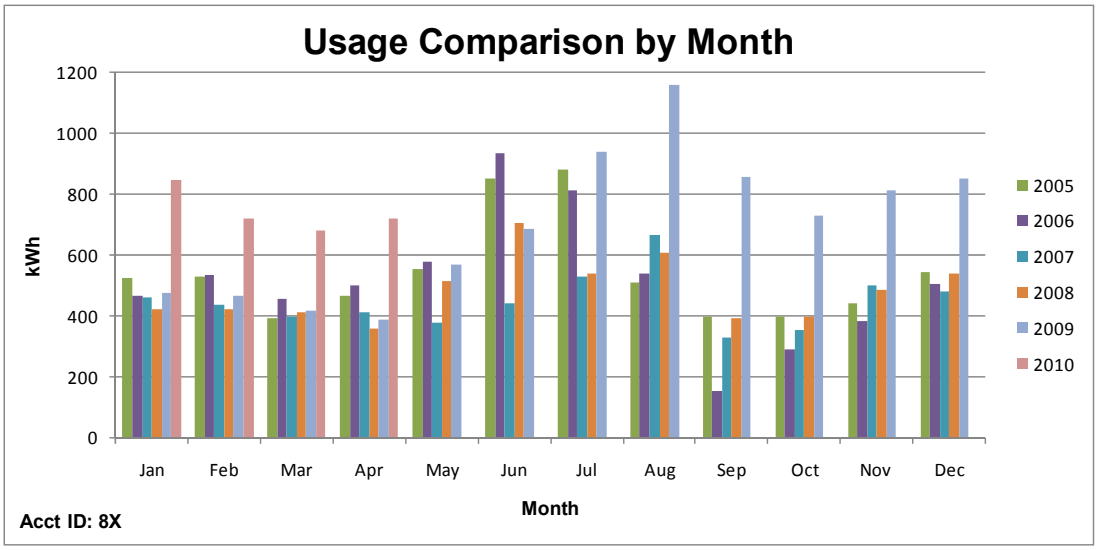


Figure 57: Usage Comparison by Month - Customer Interview Acct ID: 8X

4.4.2.3.6 Billing Comparison by Month

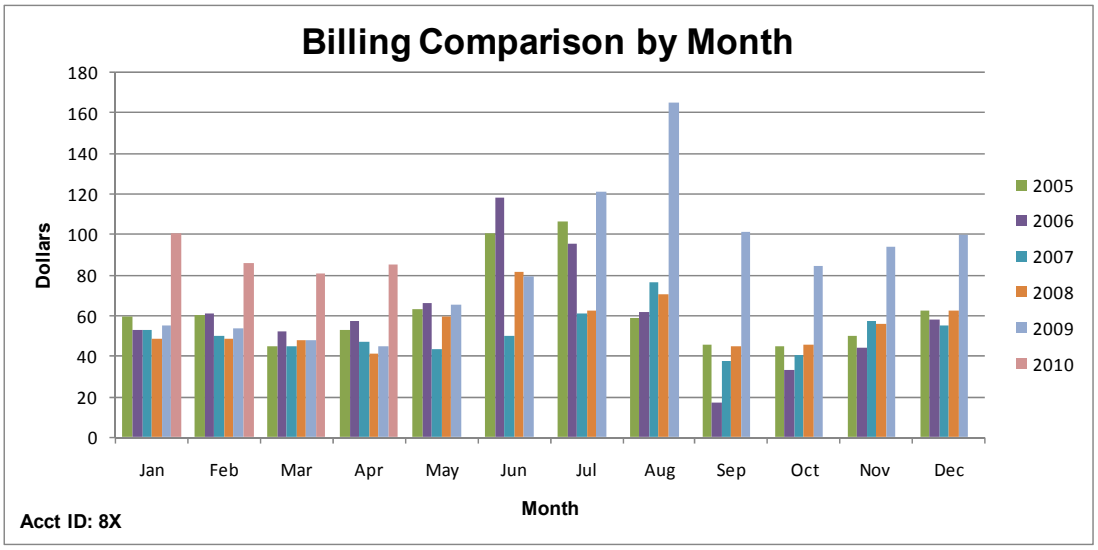


Figure 58: Billing Comparison by Month - Customer Interview Acct ID: 8X

4.4.2.4 Account ID: 9X; Division: Stockton

Customer filed a complaint when the kWh usage doubled in July 2009, the same month a Smart Meter was installed. Customer's electrical usage went from 229 kWh in January 2009 to 1,002 kWh in January 2010.

4.4.2.4.1 Complaint Submission

Customer initially contacted PG&E to make payment arrangements for the increased bill. Customer discussed with PG&E the increase in kWh. Through a series of conversations with PG&E, Customer's issue was escalated to the Escalated Complaints department and the CPUC.

4.4.2.4.2 Customer Scenario

Customer lives in Northern California in a converted barn. Customer's house is 800-900 sq ft with a basic two-bedroom/two-bath layout. Customer has lived in the house for 14 years. Customer had not changed or installed appliances and was more conscientious about reducing usage after billing increases. Customer uses propane when not using electricity. Customer was out of the house from May 2008 – November 2008.

4.4.2.4.3 Complaint Response

In Customer's initial conversation with PG&E, a payment plan was arranged. PG&E was "hesitant to recognize there was an issue." Customer has several discussions with PG&E before PG&E listened to Customer's concerns. PG&E sent the Customer to a Smart Meter Representative. After two or three calls the Customer was sent to an Escalated Complaints Representative.

PG&E and Customer reviewed usage history though PG&E was only able to provide two years of billing history. PG&E claimed the old meter was running slow. In discussions regarding billing, PG&E told Customer the CPUC set up baseline and tier rates. *(Our records show a discrepancy in the May-June kWh usage given to the Customer verbally by PG&E. PG&E stated 380 kWh, our records show 462 kWh.)*

PG&E tested the meter May 23, 2010 the meter was functioning properly. Customer is not aware of PG&E testing the original meter.

Customer qualified for the weatherization program. Customer's house did not need adjusting based on the House Energy Audit results. Representative had a few minor suggestions the Customer could do to be more energy efficient.

Customer received a letter from the CPUC dated May 21, 2010. One statement said, "…per PG&Es information from February 2008 – November 2008, your usage was not being logged correctly." Customer was away from the house during that period. Customer interpreted this information as PG&E using incorrect information for their final conclusion. A statement in the letter also stipulated the Customer promised to reduce electricity usage and Customer did not make a statement of this nature.

4.4.2.4.4 Complaint Resolution

Customer would like the CPUC to reexamine the baseline. Customer continues to see elevated kWh usage.

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4.4.2.4.5 Usage Comparison by Month

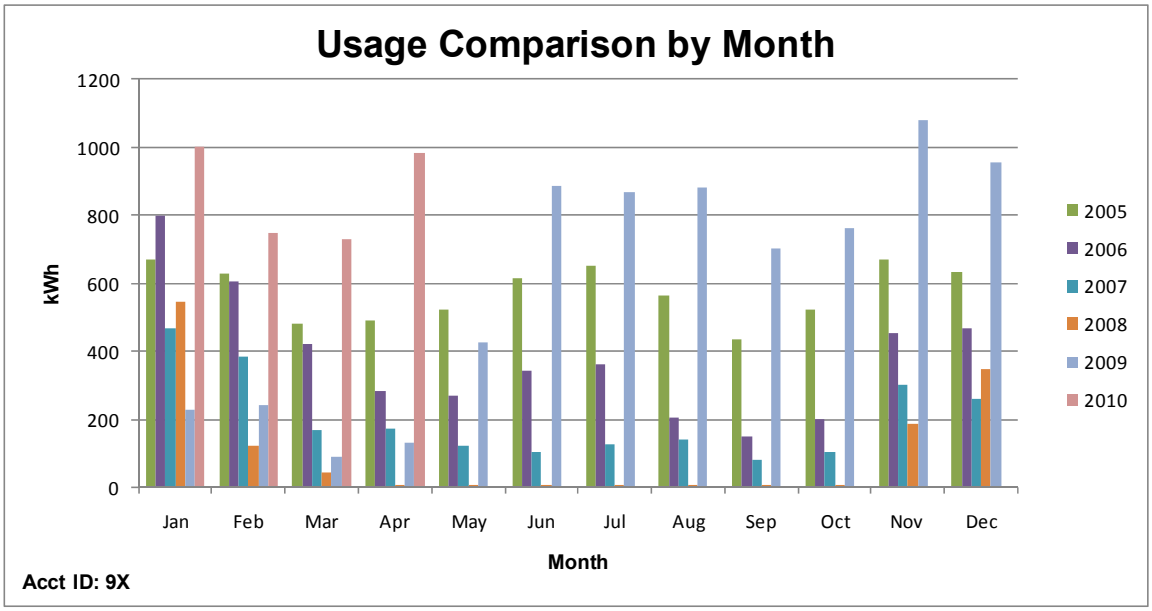


Figure 59: Usage Comparison by Month - Customer Interview Acct ID: 9X

4.4.2.4.6 Billing Comparison by Month

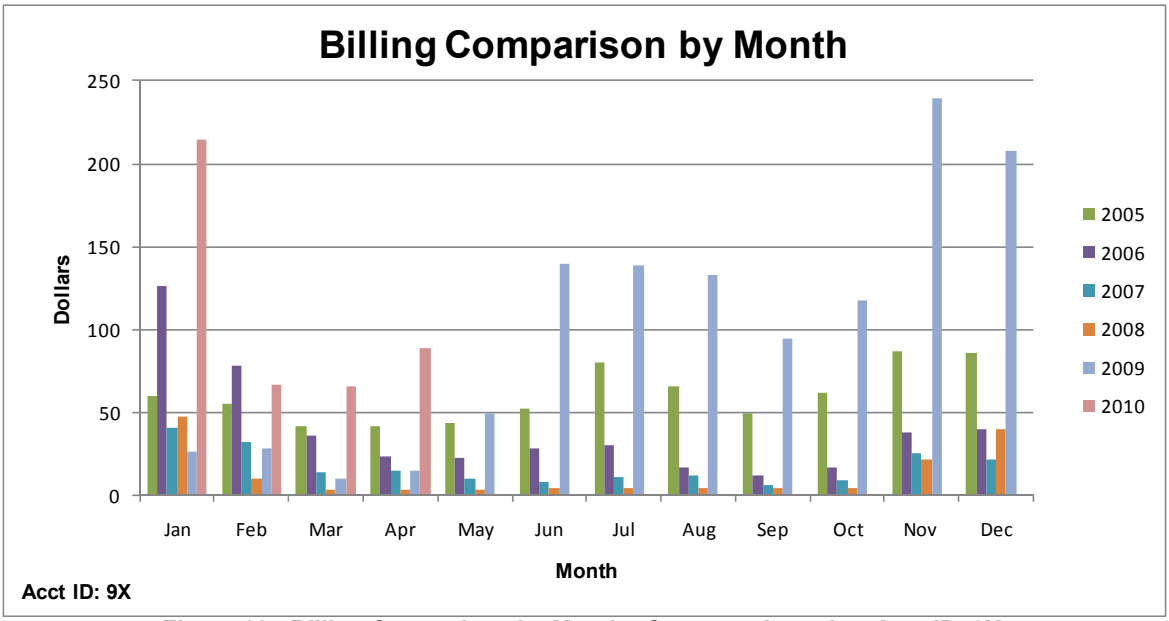


Figure 60: Billing Comparison by Month - Customer Interview Acct ID: 9X

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4.4.2.5 Account ID: 12X; Division: Sierra

Customer filed a complaint with PG&E and the CPUC when electricity bill went from $390/month to $795.

4.4.2.5.1 Complaint Submission

Customer submitted a letter to the CPUC September 2009.

4.4.2.5.2 Customer Scenario

Customer was on average billing and didn't notice the usage spike until Customer checked the bill online and noticed the high usage. Customer came off of average billing and called to report something wrong with the meter as well as a baseline too low for the house.

Customer used AC during the high month and has a gas water heater.

Customer did research with neighbors to determine their baselines and believes Customer's baseline is incorrectly calculated.

4.4.2.5.3 Complaint Response

PG&E contacted Customer after letter was sent to the CPUC.

In questioning the Customer's baseline, Customer provided evidence of another Customer's higher baseline that PG&E "did not believe" until specifically confirmed. PG&E did not confirm or provide baseline information of the neighbors.

PG&E did not test the meter due to Smart Meter's 99% accuracy. PG&E stipulated the old meter was not functioning properly.

4.4.2.5.4 Complaint Resolution

PGE did not follow-up with Customer regarding the resolution to the Customer's complaint. PG&E talked to Customer twice about the meter. Customer interpreted PG&E's actions as "the meter is fine and just deal with the high meter".

Customer was taken off of the average billing program and Customer's bill went down to $150. The highest was $170 when they ran the AC all day.

Customer wants to know the results of Structure's report.

Customer expressed confusion over the purpose of baselines in Structure's phone interview.

4.4.2.5.5 Usage Comparison by Month

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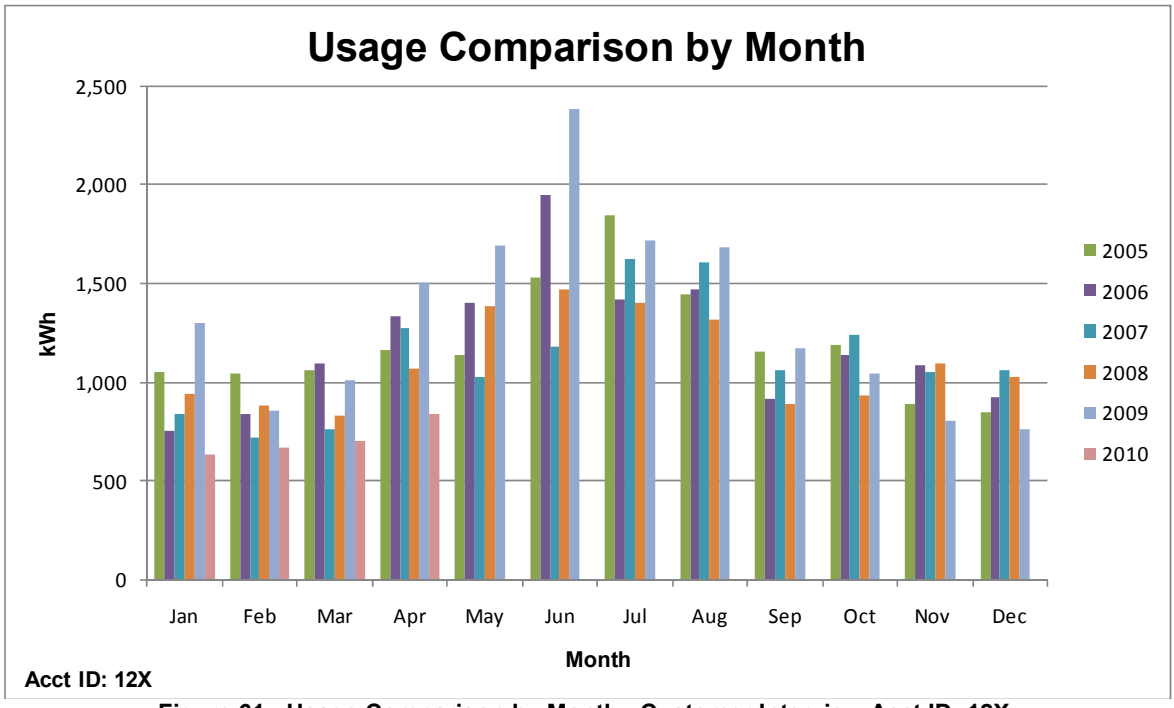


Figure 61: Usage Comparison by Month - Customer Interview Acct ID: 12X

4.4.2.5.6 Billing Comparison by Month

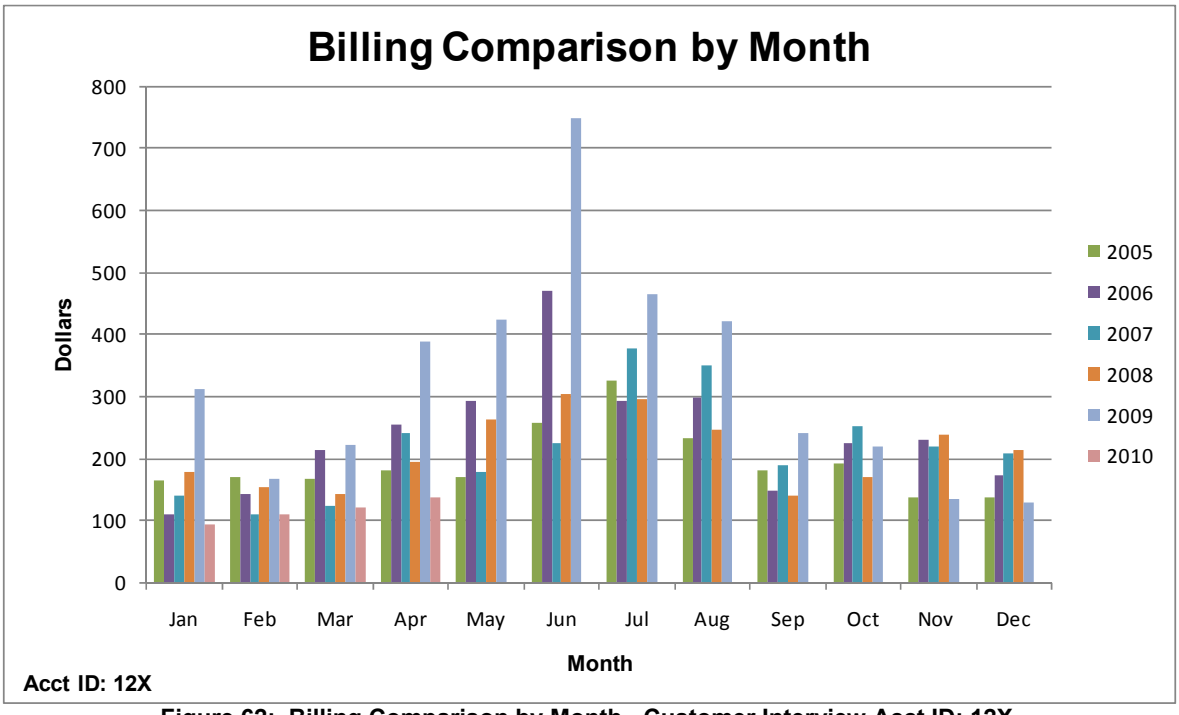


Figure 62: Billing Comparison by Month - Customer Interview Acct ID: 12X

4.4.2.6 Account ID: 13X; Division: Sierra

Customer filed a complaint when Customer did not receive a bill for a four-month period.

4.4.2.6.1 Complaint Submission

Customer initially called PG&E to report not receiving a bill in October 2009. Customer spoke with local PG&E office regarding not receiving a bill in several months. Customer also spoke with a PG&E Support Representative.

4.4.2.6.2 Customer Scenario

Smart Meter was installed at Customer's house in mid-October 2009. Customer received a bill for the first two weeks of October from the old meter and did not receive a bill once the Smart Meter was installed.

Customer did not receive notification from PG&E regarding non-payment during the four-month period where Customer did not receive a bill. Customer reached out to PG&E several times.

Customer reviewed usage and determined usage had steadily decreased over a five-year period.

4.4.2.6.3 Complaint Response

Both PG&E Representatives on the phone and at the local office told the customer that not receiving a bill sometimes occurs and to wait and see what happens.

Customer received a letter in February 2010 indicating the bill, restricted to three months in arrears, would arrive soon. Customer received a bill a short time later for three and a half months.

Customer called PG&E Support as a result of the perceived discrepancy between the letter and the Customer's actual bill. PG&E told Customer it was the policy, that the Customer did not understand the letter. PG&E Representative instructed Customer review rules, regulations, and billing rights online.

During one "particularly frustrating" call, the Representative mentioned the only thing left to do was a meter test. Customer agreed to meter test.

PG&E instructed the Customer not to pay the bill as it was an open issue. Customer had paid a portion of the original bill. PG&E told them a payment plan could be arranged. Two more months passed before the billing issue was resolved. Customer ignored a few bills during this period per PG&E's advice. Adjusted bill came in April 2010.

4.4.2.6.4 Complaint Resolution

PG&E called Customer after Customer reached out to PG&E several times. The PG&E Representative saw the usage decrease and agreed to recalculate bills to proper amounts based on usage decreases.

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From a financial standpoint, Customer is satisfied with the results however Customer does not feel meter functionality is resolved and is not satisfied with PG&E's customer service approach. Customer felt PG&E Representatives "threw up a lot of red tape to deter people."

Customer felt disadvantaged and mistreated in their own defense because true usage for the period in question was unavailable.

A shadow meter is currently installed at Customer's house. However, the shadow meter was installed on the Customer's apartment meter at the same premise rather than the house meter, and the test was terminated. The house meter is the meter responsible for the Customer's initial complaint.

4.4.2.6.5 Usage Comparison by Month

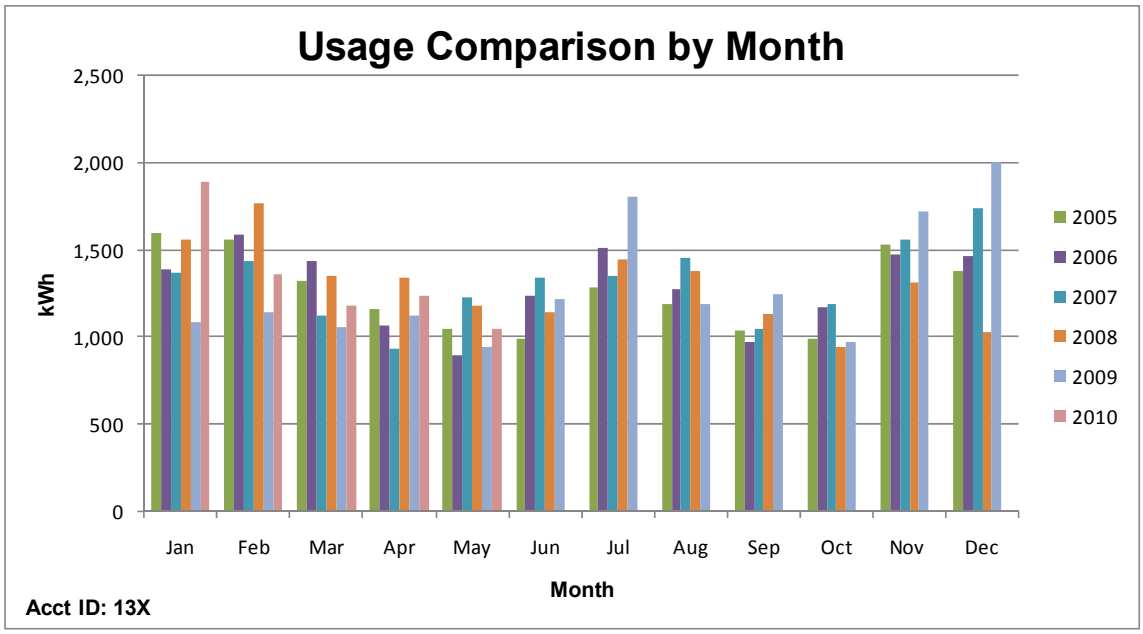


Figure 63: Usage Comparison by Month - Customer Interview Acct ID: 13X

4.4.2.6.6 Billing Comparison by Month

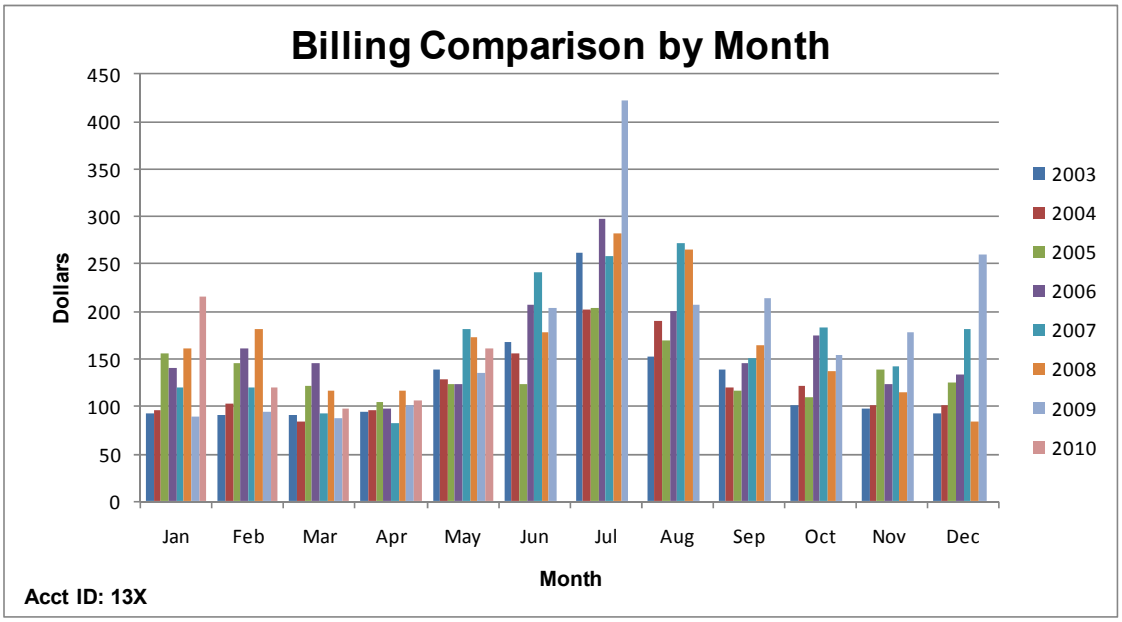


Figure 64: Billing Comparison by Month - Customer Interview Acct ID: 13X

4.4.2.7 Account ID: 14X; Division: Diablo

Customer filed a complaint due to a high bill received the first month a Smart Meter was installed.

4.4.2.7.1 Complaint Submission

Customer spoke with the Representatives at the local PG&E office, contacted TURN – Towards Utility Reform Network, and sent a letter to the CPUC with documentation to show the Smart Meter was not functioning properly.

4.4.2.7.2 Customer Scenario

Customer's 2,000 sq ft house received a Smart Meter December 22, 2009. Customer had removed some appliances from the house, does not have AC, and has made changes to decrease rather than increase the electrical usage. Customer's initial Smart Meter bill showed 2nd and 3rd tier rates. Customer independently did a historical review. The period ending December 16th, 2009 averaged 12kWh/day. The next billing period, four days were registered on the old meter at a 14kWh/day average. The remaining days of the billing period, on the new Smart Meter, logged an average of 31 kWh/day. Customer was away for 4 of 21 days included in the billing cycle. Customer noted meter reading before and after leaving the house for four days. With only two lights on timers, the house used an average of 4 kWh/day.

An additional occupant lived there the previous year, which added additional usage through an extra water heater, refrigerator, computer, etc. Occupant is no longer living at this address and the usage for the same month is higher than the same month prior year.

Customer's bill ending July 18th, 2010 registered 11.1kWh/day. The same period previous year registered 3.3kWh/day.

Customer independently researched Smart Meter billing with neighbors but others did not see the same billing increase.

4.4.2.7.3 Complaint Response

Customer went to local PG&E office and PG&E could not explain why each billing period's usage registered higher than the same period prior year.

Customer received a response from the CPUC stating nothing was wrong and outlining two methods to submit additional evidence documentation if available.

PG&E tested Customer's meter and said the meter was functioning properly.

4.4.2.7.4 Complaint Resolution

Customer's bill was not credited and is paid and up-to-date. A PG&E shadow meter is currently installed at Customer's house.

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Customer did not feel adequate opportunity to present the high bill evidence was afforded. Customer does not know what else can be done other than testing the meter but would like an explanation for what is happening. Customer didn't complete understand how the high bill complaint process worked.

Customer would have liked the opportunity to test the new meter against the original meter for one or two billing periods.

Customer is grateful for the opportunity to fully explain the situation.

4.4.2.7.5 Usage Comparison by Month

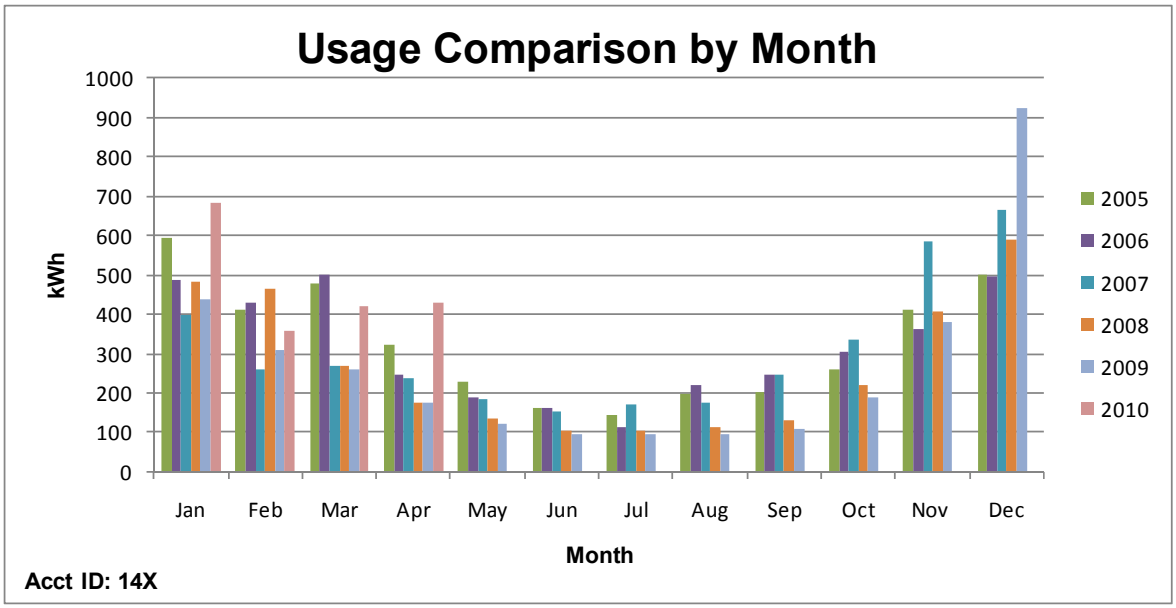


Figure 65: Usage Comparison by Month - Customer Interview Acct ID: 14X

4.4.2.7.6 Billing Comparison by Month

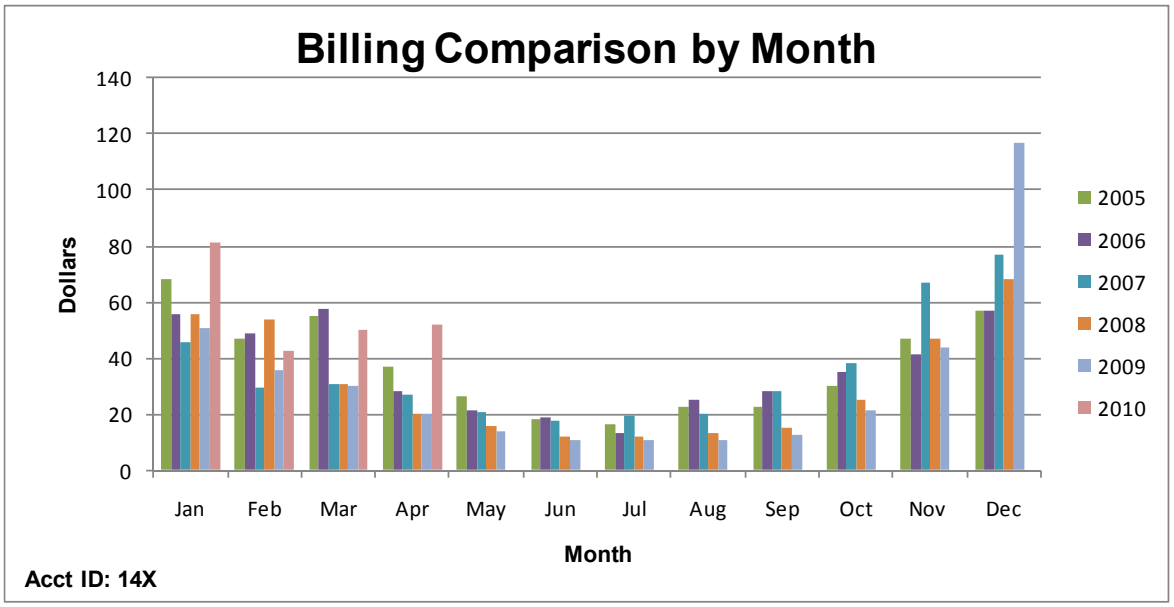


Figure 66: Billing Comparison by Month - Customer Interview Acct ID: 14X

4.4.2.8 Account ID: 15X; Division; Sierra

Customer filed a complaint with PG&E and the CPUC regarding an installed Smart Meter causing power surges to her house.

4.4.2.8.1 Complaint Submission

Customer submitted complaint to the CPUC and PG&E.

4.4.2.8.2 Customer Scenario

PG&E sent a letter to the Customer indicating a new meter would be installed. Smart Meter was installed and Customer began experiencing electrical surges to the house resulting in damaged Christmas lights, blown fuses in the well, hot tub pump, and hot tub circuit board malfunctions.

Customer is frustrated with electricity usage required to correct the hot tub temperature after each electricity surge.

Customer qualifies for a special rate due to a family disability however, the rate is not honored when a Smart Meter is installed.

Customer installed a new AC/heater system to improve energy efficiency – a $10,000 expense.

When PG&E first came to install a new meter, Customer communicated to PG&E that meter issues needed to be resolved before they installed a new Smart Meter. PG&E technicians came back with a supervisor to try again. Customer agreed but said PG&E would be responsible for any problems. The water pump blew after the new meter was installed.

After initial Smart Meter issues and several subsequent meter installations, Customer requested PG&E make an appointment and confirm with the Customer prior to installing a new meter. PG&E attempted to install a Smart Meter without Customer's consent. Customer refused new meter.

Customer has the compliant issue, resolution attempts, work orders, and communication documentation.

4.4.2.8.3 Complaint Response

PG&E paid for a well drilling company to correct the well issue. PG&E has also paid for the reheating costs of the hot tub. PG&E sent someone to look at the hot tub and submitted a report of findings to the Customer. PG&E technician said the hot tub cycling power because it was old. PG&E paid for the hot tub cycling power but does not agree the Smart Meter is responsible for the circuit board failure.

PG&E installed six (6) separate Smart Meters in an attempt to resolve the issue.

4.4.2.8.4 Complaint Resolution

Customer does not have a Smart Meter installed currently.

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Customer pays PG&E $100/month due to special rate stipulations and distrust of current meter reads. Customer is frustrated at time and emotional energy involved to resolve this issue.

Customer wants detailed daily usage reports from PG&E and PG&E will not provide them. Customer has requested the information three times and PG&E only provides copies of bills, the same information already sent to the Customer.

4.4.2.8.5 Usage Comparison by Month

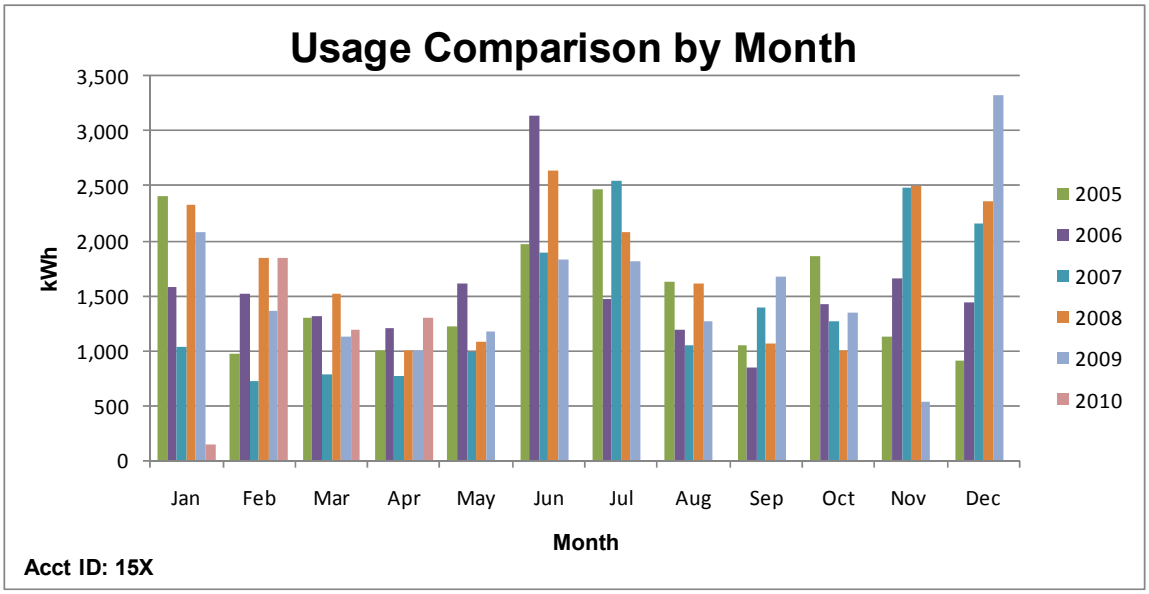


Figure 67: Usage Comparison by Month - Customer Interview Acct ID: 15X

4.4.2.8.6 Billing Comparison by Month

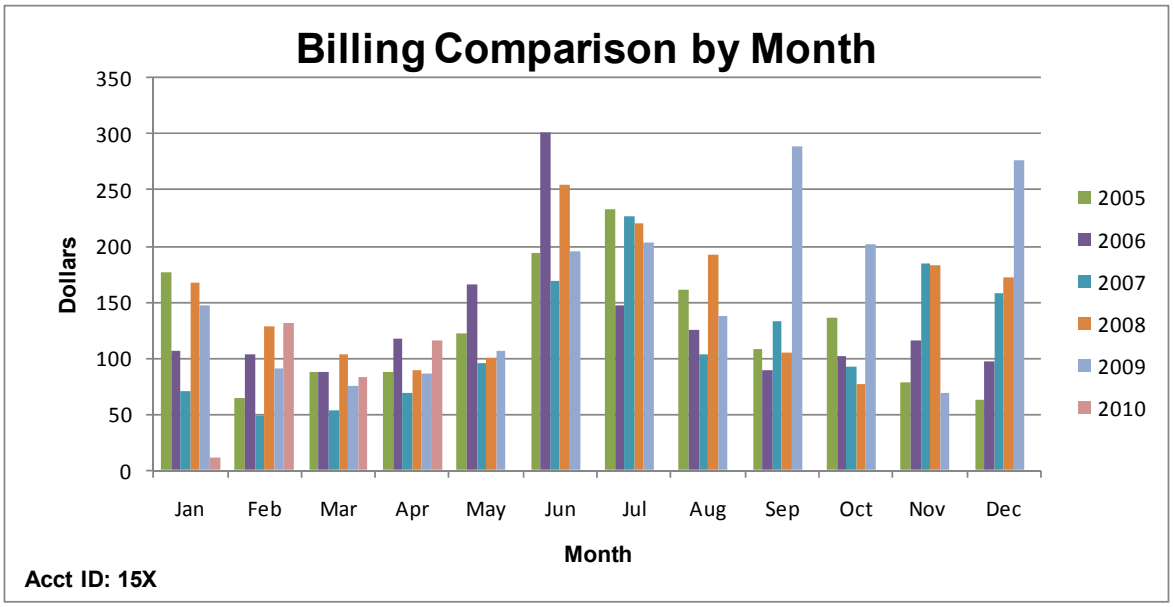


Figure 68: Billing Comparison by Month - Customer Interview Acct ID: 15X

4.4.2.9 Account ID: 16X; Division: Stockton

Customer filed a complaint with PG&E after receiving a high bill in July 2009 after a Smart Meter was installed July 7, 2009.

4.4.2.9.1 Complaint Submission

Customer called the number on the back of the bill for an explanation of the increased bill amount. Customer had two conversations with PG&E, each time feeling the Representative was not helpful.

Customer also sent a letter to the CPUC in September 2009.

4.4.2.9.2 Customer Scenario

Customer combined two houses into one bill in December 2008. The second house is a vacant condo in Sacramento which uses $6-7/month in electricity.

In the summer, with high ceilings and the AC running, Customer states bill should have been $140, instead the bill was $350.

Customer lives alone and is very conscientious about usage. Customer did not know of anything that could have caused the spike in usage.

Customer talked to neighbors and a few activists group who told the Customer not to miss payment on the overage amount so Customer wouldn't have anything wrong on the billing history.

Customer had withheld $200 for one month but added it to the next bill to avoid a late payment situation.

Structure records show the high bill covered 60 days however the Customer received and paid a bill every month.

A few months after complaint submission, Customer received a voicemail instructing Customer to call if complaint was unresolved. Customer did not "step up to the plate" at the time and felt the opportunity to protest had passed.

4.4.2.9.3 Complaint Response

The CPUC responded to the Customer's letter indicating they received the complaint and would research it further. The response was generic but polite.

4.4.2.9.4 Complaint Resolution

Customer's billing issue is not resolved. Customer has bills and payment records of the period in question.

Payment History:

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7/27/09 paid $98.24
8/30/09 paid $142.72
9/30/09 paid $135.42 (the bill was for 335.42. Customer withheld $200)
10/20/09 paid $98.63
11/3/09 paid $200 (payment for the Aug bill)
11/18/09 paid $34.20

4.4.2.9.5 Usage Comparison by Month

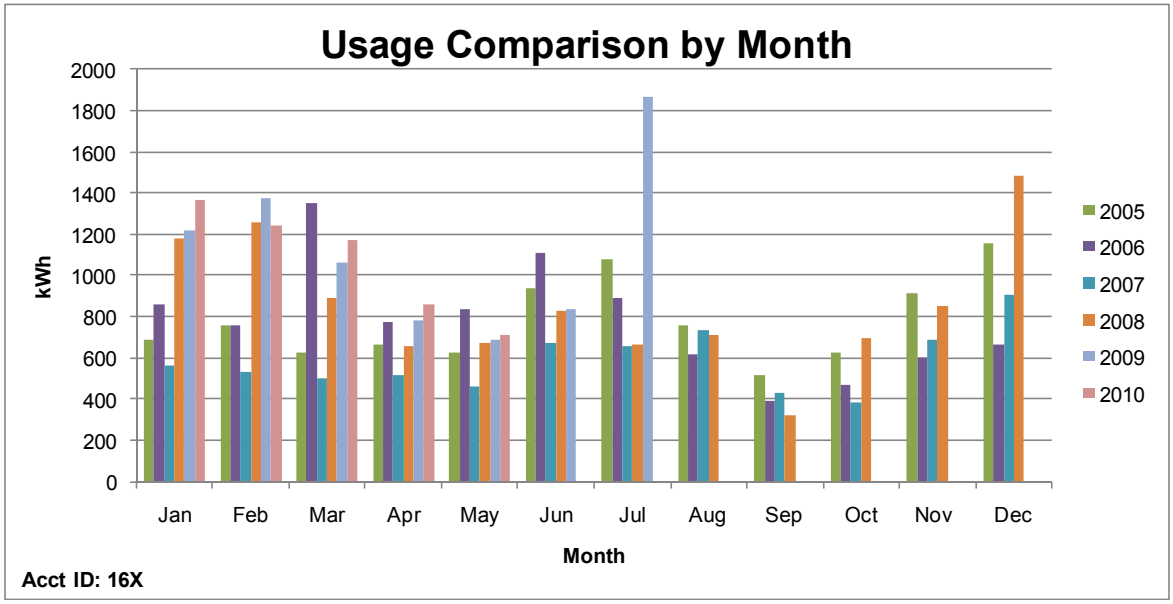


Figure 69: Usage Comparison by Month - Customer Interview Acct ID: 16X

4.4.2.9.6 Billing Comparison by Month

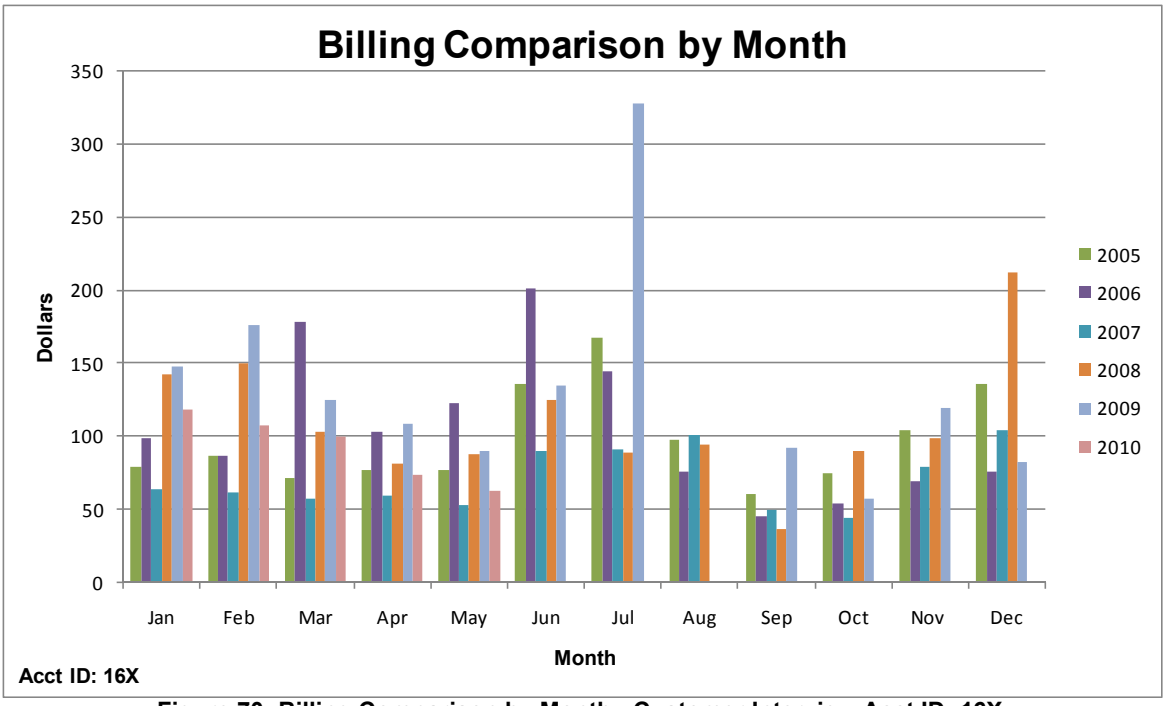


Figure 70: Billing Comparison by Month - Customer Interview Acct ID: 16X

4.4.2.10 Account ID: 17X; Division: Fresno

Customer filed a complaint when electricity bill went up to $500-700/month after a Smart Meter was installed.

4.4.2.10.1 Complaint Submission

Customer called PG&E to make the initial complaint.

4.4.2.10.2 Customer Scenario

Customer called when usage and electricity bill went up after Smart Meter was installed on May 28, 2010. Customer lives in a 2,500 sq ft house, garage square footage included. Customer does not know of any event, occupancy change, or usage change that would have caused bills to increase.

Customer was in the process of having solar panels installed and PG&E said the meter was showing significant draw when they were testing. One occupant was showering and using power while PG&E tested the meter.

Customer's solar panel installation was completed December 2009. PG&E installed a new dual socket meter to accommodate solar panels. Customer's usage has dropped significantly due to solar usage.

The meter responsible for the complaint is no longer installed at the Customer's house.

After researching account, it was found that energy usage in March 2009 started to double the previous year's usage on a continuous basis. It was also noted that square footage on house as told by customer were almost twice what county records showed.

4.4.2.10.3 Complaint Response

PG&E's response to Customer complaint was that Smart Meters were not wrong and the increase was solely due to Customer's usage. PG&E did not tell Customer whether the complaint was escalated.

PG&E told Customer an unidentified problem outside of the meter accounted for the increased usage.

4.4.2.10.4 Complaint Resolution

PG&E did not offer any resolution or explanation for Customer's increased usage beyond putting Customer on a payment plan to accommodate high bills.

4.4.2.10.5 Usage Comparison by Month

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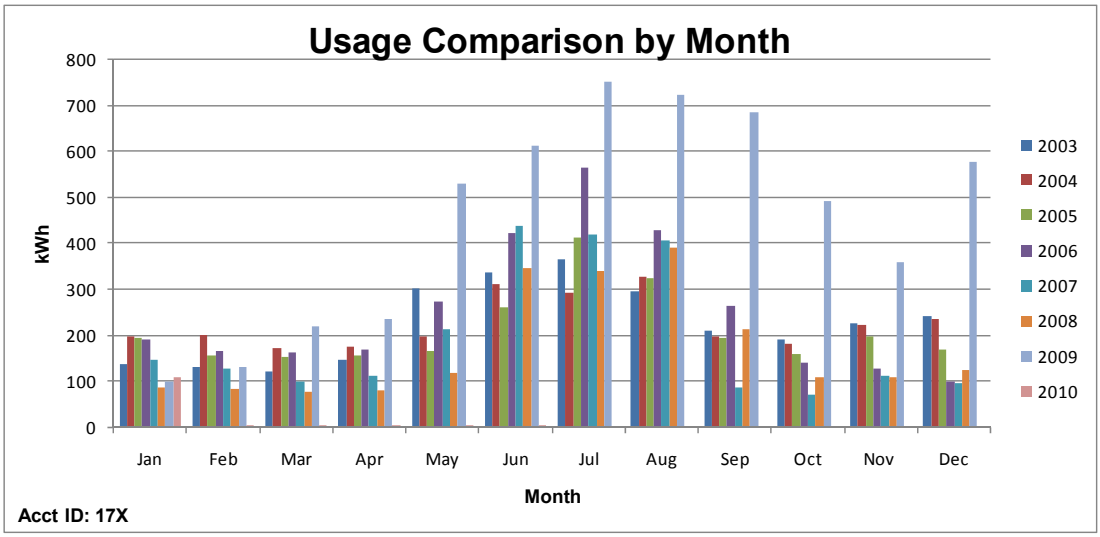


Figure 71: Usage Comparison by Month - Customer Interview Acct ID: 17X

4.4.2.10.6 Billing Comparison by Month

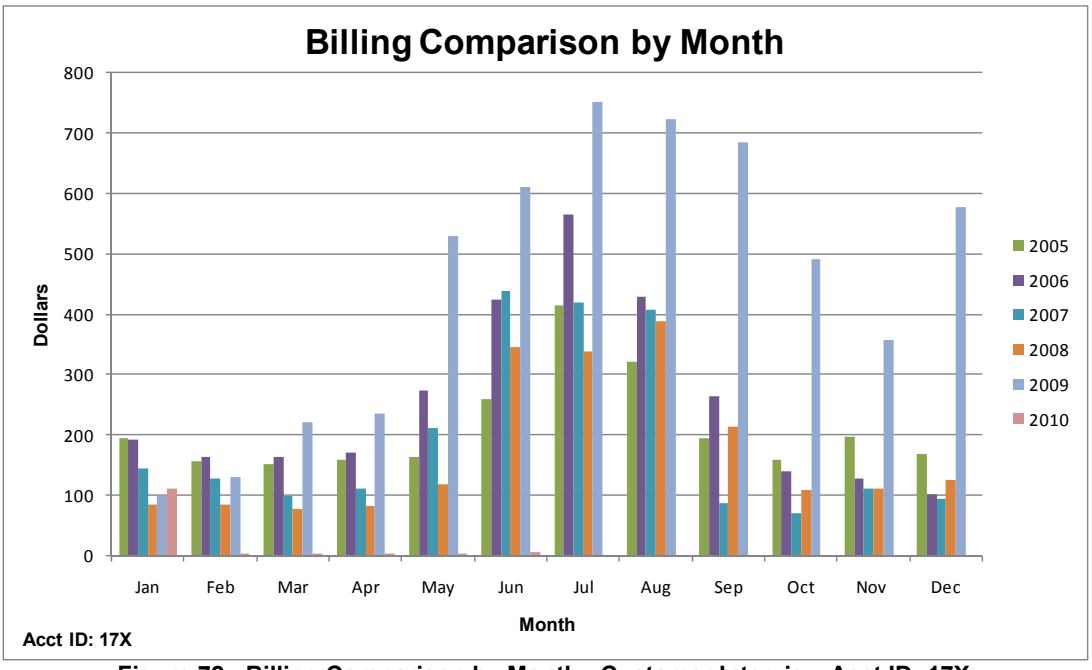


Figure 72: Billing Comparison by Month - Customer Interview Acct ID: 17X

4.4.2.11 Account ID: 18X; Division: Stockton

4.4.2.11.1 Complaint Submission

Customer called PG&E to report high bill compliant. Customer also called the CPUC during the course of the complaint process to file a formal complaint.

4.4.2.11.2 Customer Scenario

Customer's 1,000 sq ft house is a summer/skiing vacation house in the Sierras. Smart Meter was installed November 20, 2009.

Per PG&E's suggestion, Customer changed some things to reduce usage including replacing outdoor security lights with energy efficient bulbs. Customer replaced lights 4-5 times because lights would turn on/off constantly.

Customer had Pioneer Electric test the circuits and replace switches inside the house and usage still did not decrease.

4.4.2.11.3 Complaint Response

PG&E made suggestions for reducing electricity usage. Three-four weeks ago, PG&E performed a test on the Smart Meter and discovered the meter was responsible for the lights turning on/off, increasing electricity usage. Smart Meter was subsequently removed.

PG&E personnel were friendly and professional but Customer indicated the experience was frustrating due to the delayed time in discovering the root cause.

Customer was transferred to PG&E from the CPUC complaint and did not have any further interaction with the CPUC.

4.4.2.11.4 Complaint Resolution

PG&E removed Smart Meter per Customer's request when it was discovered that the Smart Meter was causing interference. PG&E indicated a lower watt Smart Meter would be installed when available.

PG&E also told Customer they would reevaluate the bills during the time the Smart Meter was installed and adjust amounts accordingly.

Customer asked PG&E Representative to pass on the results of Customer's experience to PG&E technical crew to avoid the situation in the future. PG&E Representative said they would pass on the information.

4.4.2.11.5 Usage Comparison by Month

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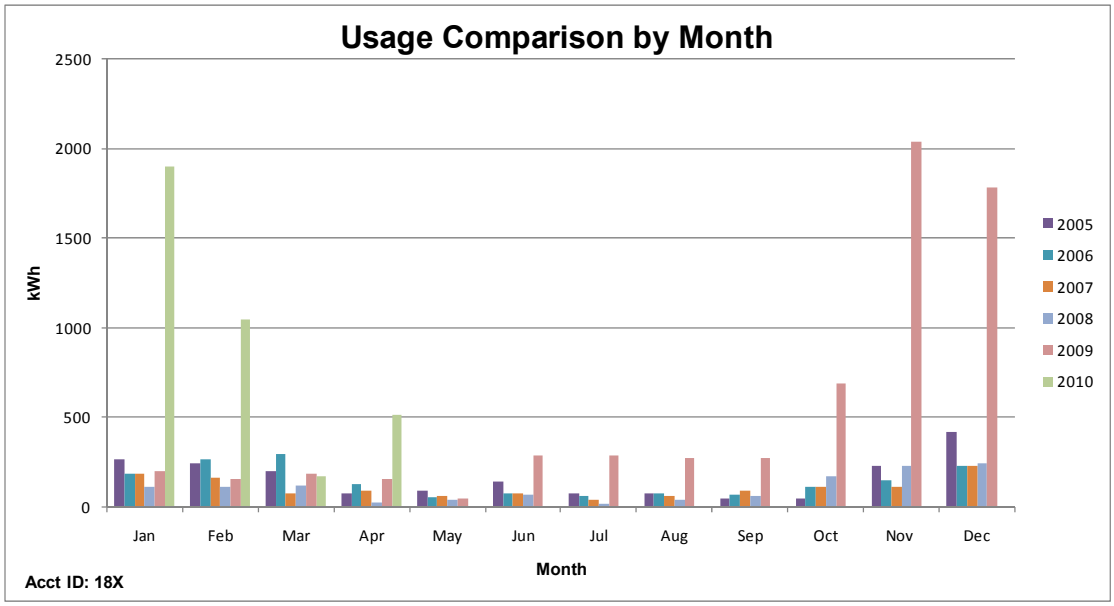


Figure 73: Usage Comparison by Month - Customer Interview Acct ID: 18X

4.4.2.11.6 Billing Comparison by Month

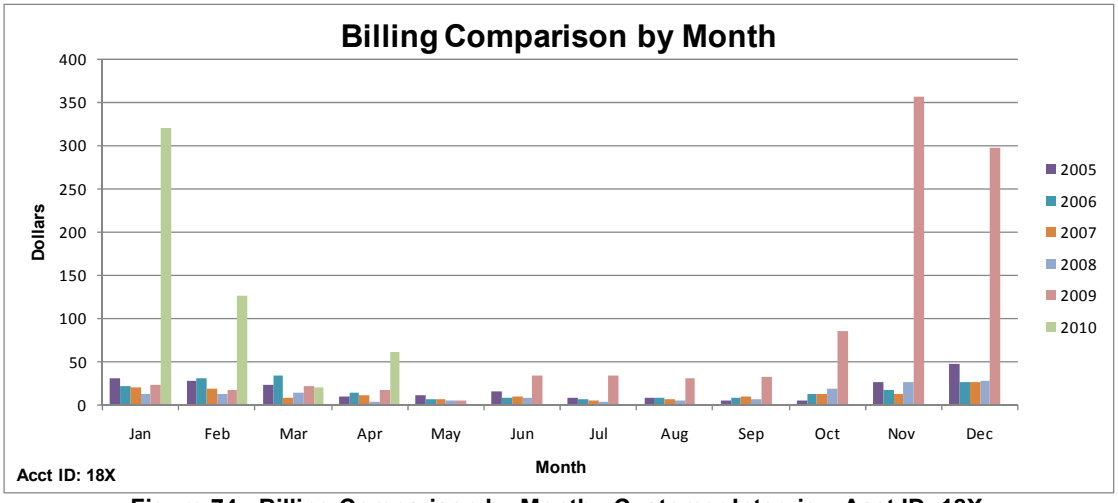


Figure 74: Billing Comparison by Month - Customer Interview Acct ID: 18X

4.4.2.12 Account ID: 19X; Division: Kern

Customer filed a complaint in response to steadily increasing electricity bills after Smart Meter installation.

4.4.2.12.1 Complaint Submission

From July 2007 to July 2009, Customer submitted complaints to PG&E. Customer submitted a complaint to the CPUC September 2009.

4.4.2.12.2 Customer Scenario

Customer's house is 1468 sq ft built in 1998. Customer installed a pool in January 2005. The Customer runs the pool pump for two hours a day.

The first Smart Meter, as part of the test population, was installed at Customer's house the summer of 2006. Three months after the installation every major appliance in the house broke within a three month period. Appliances were new in 1998 and included the refrigerator, washer, dryer, ceiling fan, dishwasher, and oven.

Customer's bill began increasing. The summer of 2007, Customer contacted PG&E to discuss increases.

PG&E told Customer they were installing Smart Meters at everyone's houses so they installed the "official" Smart Meter at Customer's house. Customer's bills continued to increase. Customer did laundry at night and set the thermostat at 80 degrees and the bill did not improve.

Customer received a letter indicating PG&E would be installing another Smart Meter. Customer called PG&E to express serious concerns. Customer told PG&E they did not want the Smart Meter and that the Customer would refuse installation if present when PG&E arrived. PG&E came one day while the Customer was gone and installed third meter.

When PG&E installed Customer's third Smart Meter, Customer contacted the CPUC.

PG&E also installed a Smart Meter on the Customer's gas meter.

Customer understands the tiered rate structure but doesn't understand how bill does not change when Customer is following PG&E's instructions for reducing usage.

Customer does not have copies of bills.

4.4.2.12.3 Complaint Response

PG&E did not offer an explanation for Customer's increased usage. PG&E instructed Customer to cook and clean at night to reduce peak time usage. Customer followed PG&E's advice and bill did not change.

The CPUC said that according to PG&E's records there is nothing wrong with the Customer's bill or the Smart Meter.

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PG&E did not review usage with Customer. PG&E explained rate increases to Customer.

4.4.2.12.4 Complaint Resolution

Customer's issue is not resolved.

4.4.2.12.5 Usage Comparison by Month

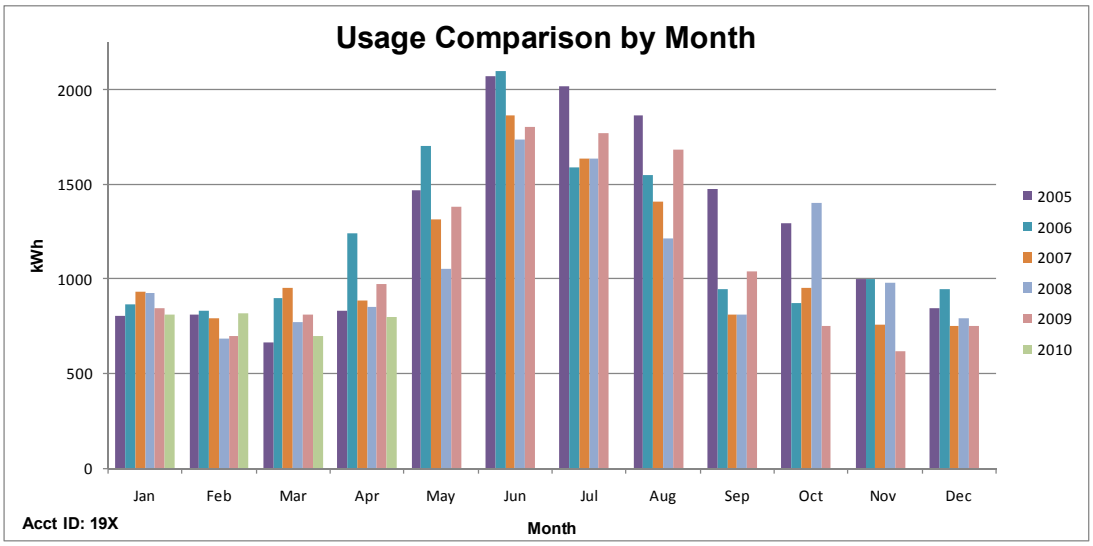


Figure 75: Usage Comparison by Month - Customer Interview Acct ID: 19X

4.4.2.12.6 Billing Comparison by Month

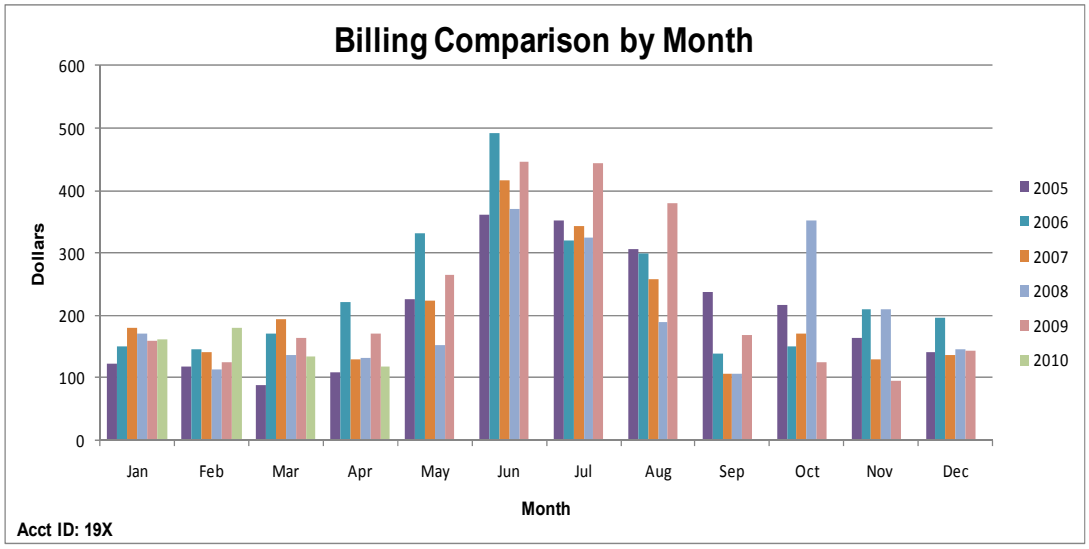


Figure 76: Billing Comparison by Month - Customer Interview Acct ID: 19X

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4.4.2.13 Account ID: 20X; Division: Diablo

Customer filed a complaint.

4.4.2.13.1 Complaint Submission

Customer submitted a complaint to the CPUC based on information provided by TURN.

4.4.2.13.2 Customer Scenario

Customer has lived in this 1690 sq ft house since 2003.

Smart Meter was installed July 2009. Per the Customer, bills rarely exceeded $250, the month after the Smart Meter was installed the bill increased to $322. Customer was diligent in reducing usage the following month and the next bill increased more than the initial high bill.

Customer experienced one high bill prior to the Smart Meter as a result of no insulation in the attic that month.

One month Customer did not use the AC and the bill was $400.

Customer continues to see high bills despite diligent, “uncomfortable” living conditions, and three less people living in the house now.

Though the Customer received many notices and communications regarding the Smart Meter program and installation, Customer did not receive any communication from PG&E regarding rate changes.

4.4.2.13.3 Complaint Response

PG&E was polite but did not communicate whether the complaint was escalated or provide an explanation for usage increases.

After several conversations, PG&E explained the rate tiers to the Customer. PG&E also explained where the Customer could find the information online and on the bill.

The CPUC sent the Customer back to PG&E. After several conversations Customer received a $30 credit on her bill.

PG&E tested meter and reported the meter was functioning properly.

4.4.2.13.4 Complaint Resolution

PG&E told Customer a new meter would be installed but instead Customer was placed on a TOU rate structure. According to PG&E Customer must stay on the time of use plan for a year. Customer feels the difference between a time of use meter and time of use plan was not clearly represented.

According to Customer, complaint remains unresolved. A PG&E shadow meter is currently installed at Customer’s house.

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Customer feels PG&E was deceptive in their practices, is currently thinking the majority of the issue is related to baseline and rate structure changes not properly communicated.

4.4.2.13.5 Usage Comparison by Month

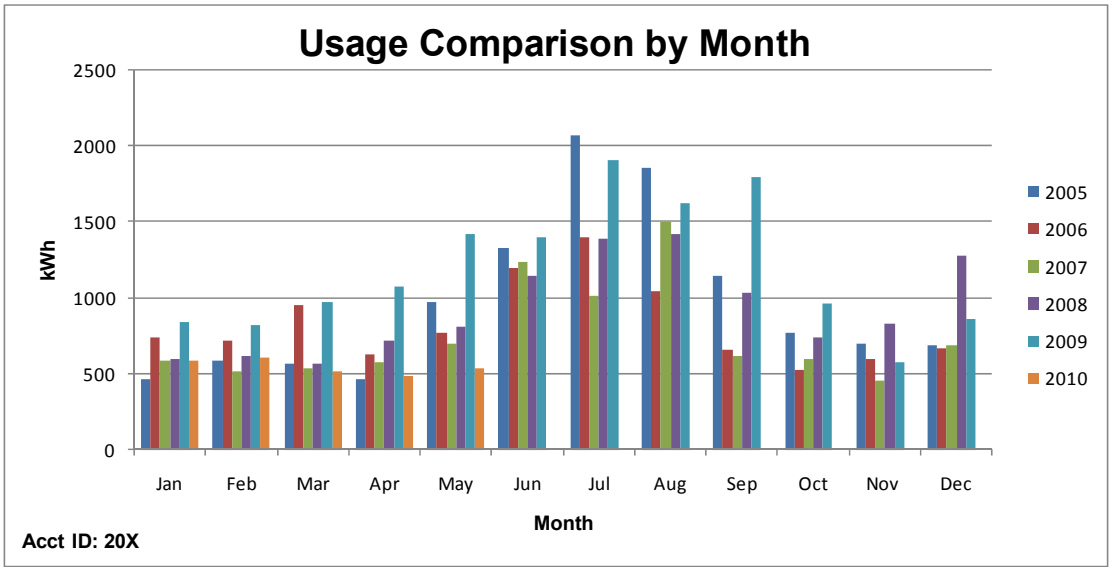


Figure 77: Usage Comparison by Month - Customer Interview Acct ID: 20X

4.4.2.13.6 Billing Comparison by Month

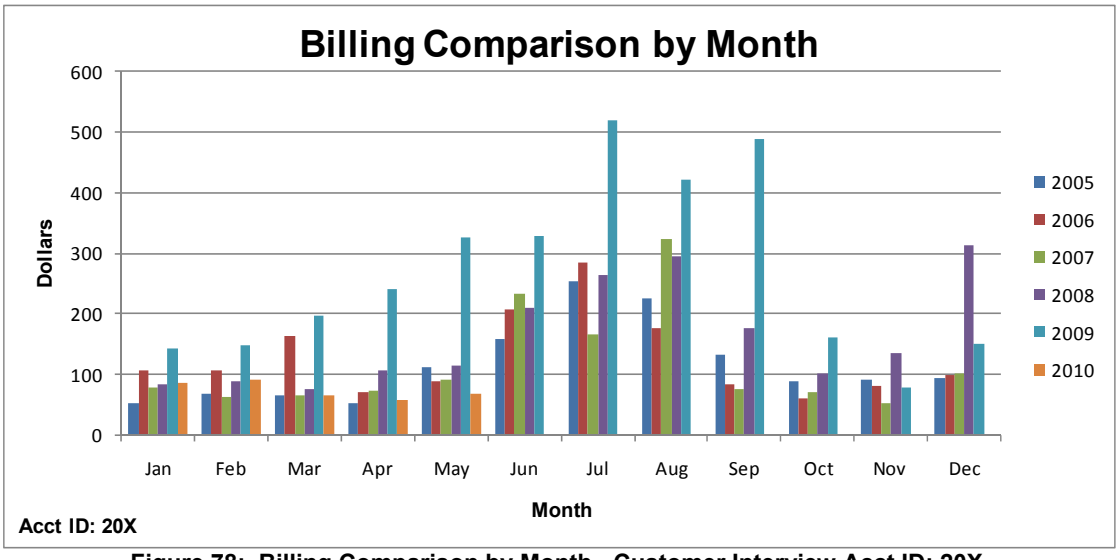


Figure 78: Billing Comparison by Month - Customer Interview Acct ID: 20X

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4.5 Best Practices Associated with Smart Meters

The data from the Best Practices evaluation is incorporated in the Findings section of this document.

4.6 Security Assessment

Due to the limited scope and confidential nature of the documents reviewed as part of the Security Assessment, no data related to the Security Assessment is provided as part of this Assessment report.

4.7 Data Requests

Structure submitted data requests, using PG&E's standard procedures or other specified means, to obtain information used as the basis for this report. At PG&E's request, Structure assigned priorities to the data requests to facilitate response focus and expedition. While PG&E accommodated the requests, a significant portion of the requests were substantially delayed, and thus required more time and resources to complete the Assessment.

The following set of figures represents Structure's tracked requests, prioritization, and receipt of information.

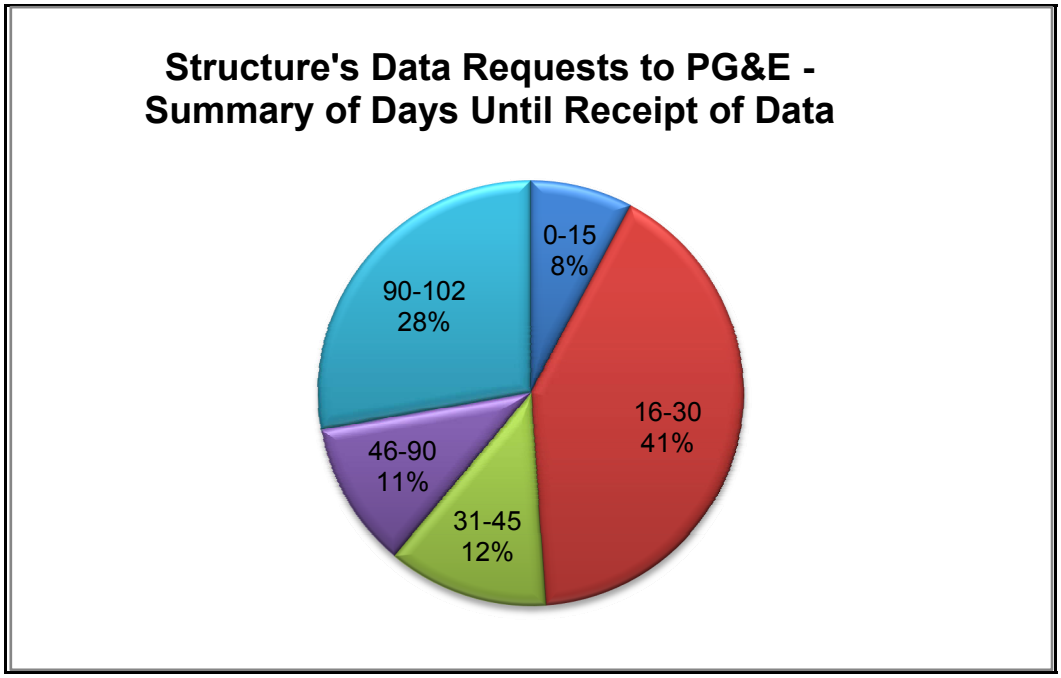


Figure 79: Structure's Data Requests to PG&E – Summary of Days Until Receipt of Data

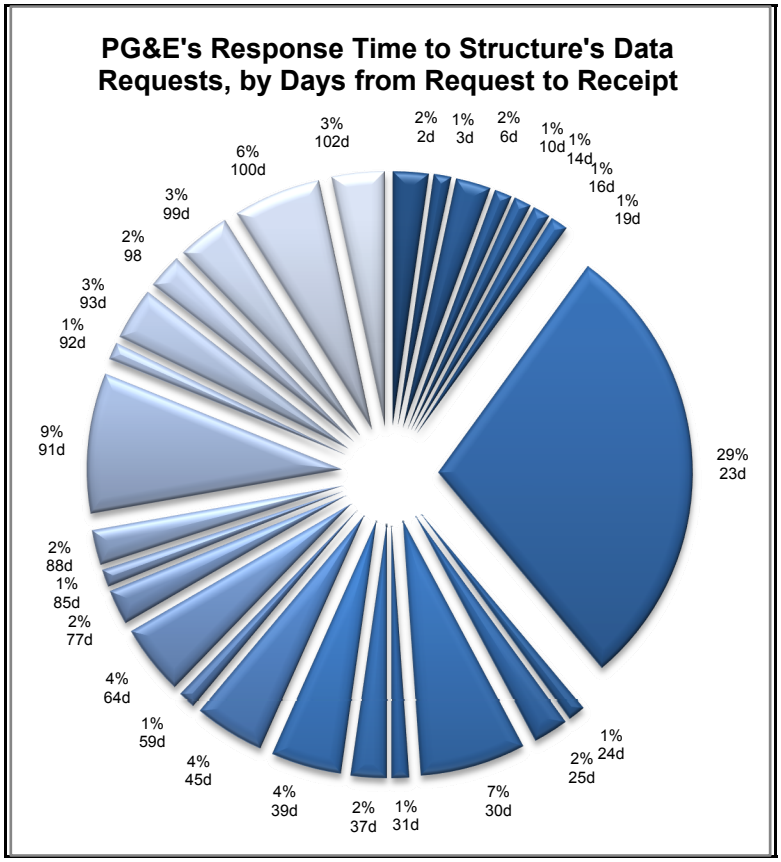


Figure 80: PG&E's Response Time to Structure's Data Requests, by Days from Request to Receipt

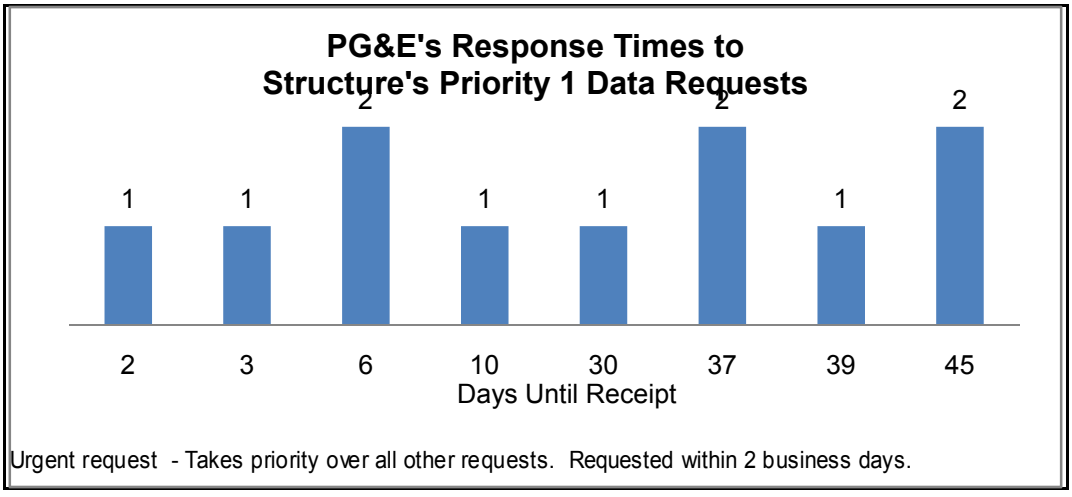


Figure 81: PG&E's Response Times to Structure's Priority 1 Data Requests

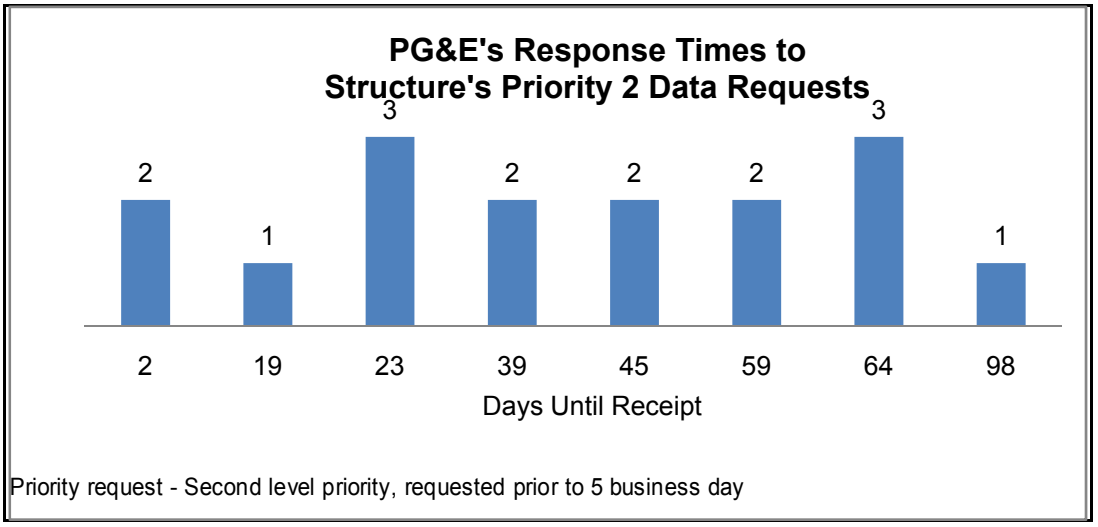


Figure 82: PG&E's Response Times to Structure's Priority 2 Data Requests

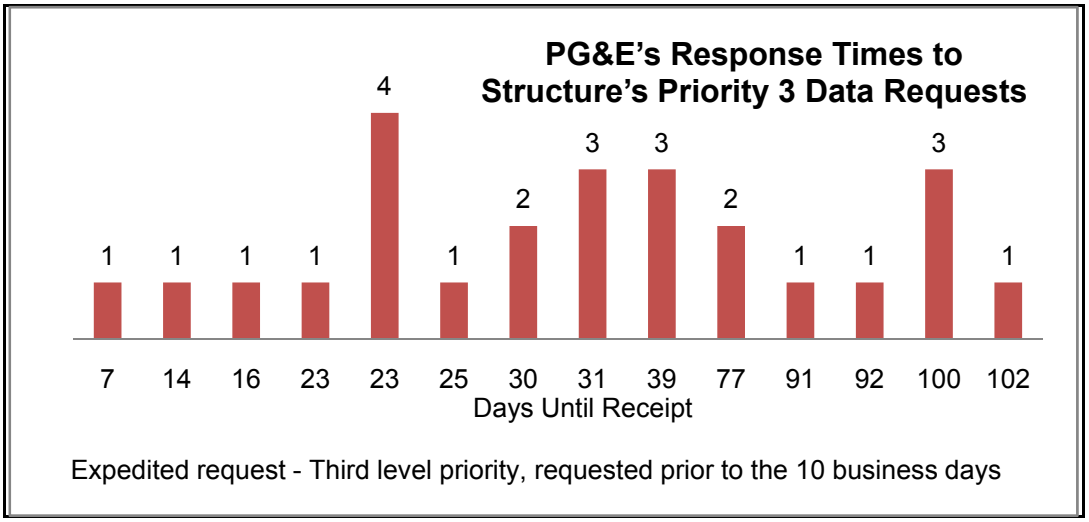


Figure 83: PG&E's Response Times to Structure's Priority 3 Data Requests

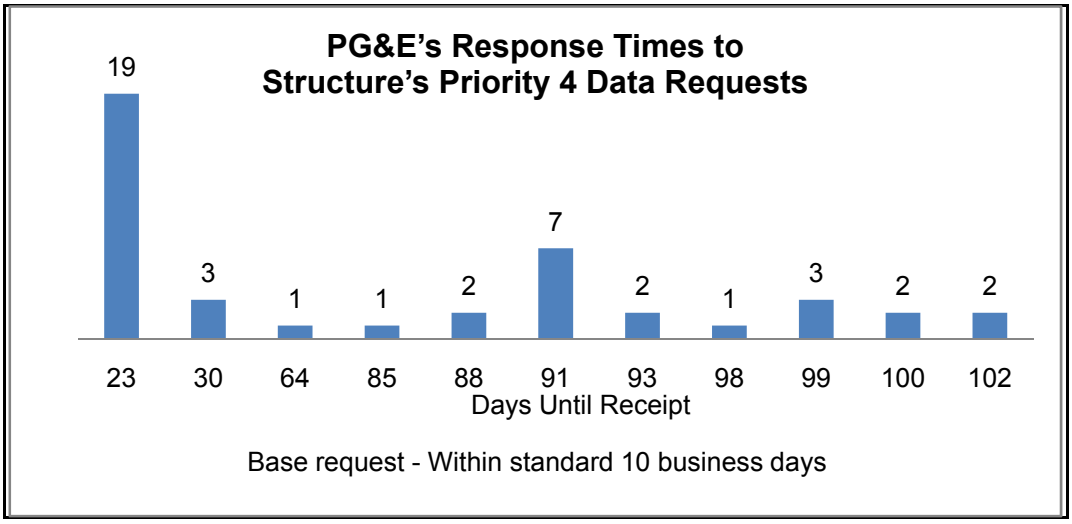


Figure 84: PG&E's Response Times to Structure's Priority 4 Data Requests

As of the completion of this Assessment, PG&E provided the following statistics on the data requests and supplemental non-data requests submitted by Structure and addressed by PG&E. The following figures present these statistics.

Data Requests as Tracked by PG&E					
	Total DR Questions Asked	**Responses Submitted**	**Responses Pending Approval**	**Responses In Progress**	**Responses Outstanding**
The Structure Group	125	124	0	1	1
TOTAL	125	124	0	1	1
Percent of Total		99%	0%	1%	1%

Figure 85: Data Requests as Tracked by PG&E

Non-Data Requests as Tracked by PG&E			
	Type	**Name/Title/Description**	**Date Completed**
1	Presentation	SmartMeter™ Program Overview	**4/6/2010**
2	Presentation	High Level Systems Overview	**4/6/2010**
3	Presentation	SmartMeter Assessment	**4/7/2010**
4	Presentation	SmartMeter Maintenance Update	**5/3/2010**
5	Presentation	ISTS Systems Overview	**5/5/2010**
6	Presentation	Billing and Complaints	**5/21/2010**
7	Meter Testing	Scenario 1 (Lab Testing - Warehouse Stock Smart Meters for Accuracy) ~ 11 Meters	**5/2010**

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Non-Data Requests as Tracked by PG&E			
	Type	**Name/Title/Description**	**Date Completed**
8	Meter Testing	Scenario 2 (Lab Testing - Warehouse Stock Smart Meters to Replace Electromechanical Meters) ~ 163 Meters	**5/2010**
9	Meter Testing	Scenario 3 (Field Testing and Replacement of Electromechanical Meters with Lab-Tested Warehouse Stock Smart Meters) ~ 50 Meters	Conducted from 5/20/2010 - **6/4/2010**
10	Presentation	Security 1	**6/23/2010**
11	Meter Testing	Scenario 7 (Field Testing and Possible PG&E Replacement of Electromechanical Meters with PG&E Smart Meters) ~ 125 Meters	Conducted from 6/7/2010 - **6/25/2010**
12	Presentation	Security 2	**6/29/2010**
13	Presentation	Process Improvements	**7/15/2010**
14	Site Visit	SSN Network Operations	**7/20/2010**
15	Site Visit	Fremont GEMMSS Meter Facility	**7/20/2010**
16	Site Visit	Concord Operations Center	**7/20/2010**
17	Presentation	Security 3	**7/21/2010**
18	Site Visit	Meter Installation Observation	**7/21/2010**
19	Site Visit	Complaint Resolution Observation Session 1	**7/21/2010**
20	Meter Testing	Scenario 6 (Shadow Meters) ~ 100 Meters	Conducted from 6/17/2010 - **7/26/2010**
21	Site Visit	Complaint Resolution Observation Session 2	**7/27/2010**
22	Meter Testing	Scenario 8 (High Bill Complaint PG&E Installed Shadow Meter Test Verification) ~ 30 Meters	Conducted from 7/19/2010 - **7/28/2010**
23	Site Visit	Complaint Resolution Observation Session 3	**7/29/2010**
24	Meter Testing	Scenario 4 (Smart Meters - Non-Complaint) ~ 600 Meters	Conducted from 6/30/2010 - **7/30/2010**
25	Meter Testing	Scenario 5 (Smart Meters - Billing Complaint) ~ 40 Meters	Conducted from 7/19/2010 - **7/30/2010**
26	Site Visit	Complaint Resolution Observation Session 4	**7/30/2010**
27	Site Visit	Complaint Resolution Observation Session 5	**8/2/2010**

Figure 86: Non-Data Requests as Tracked by PG&E

5 Findings

This section presents the detailed findings associated with each of the PG&E AMI Assessment's areas of focus. The areas of focus detailed are:

- Laboratory Meter Testing
- Field Meter Testing
- End-to-End System Testing
- High Bill Complaint Analysis
- Best Practices Associated with Smart Meters
- Security Assessment

5.1 Laboratory Meter Testing

5.1.1 Summary of Laboratory Meter Testing Findings

Structure utilized a laboratory testing facility that was independent from PG&E to conduct tests for meter accuracy, environmental stresses, and end-to-end system functionality. Structure selected 174 Smart Meters from PG&E's warehouses based on representative vendor and meter type criteria, and then tested the meters for accuracy in the independent laboratory. All of the tested Smart Meters passed the accuracy testing. Structure then utilized a portion of the selected Smart Meters for environmental stress testing, and found all of the meters to fall within the American National Standards Institute (ANSI) standards for average registration accuracy when tested in a controlled temperature chamber at reference, high, and low temperatures.

5.1.2 Detail of Laboratory Meter Testing Findings

Structure set aside 18 of the 174 meters selected from the warehouses as "spares", and conducted laboratory-based accuracy tests on the remaining 156 stock PG&E Smart Meters selected from the five randomly selected PG&E warehouses. The sample set consisted of a range of meter types and meter manufacturers representing a representative sample of meters available in the PG&E in-stock inventory, which were procured using a random meter selection methodology.

The Results of the Laboratory Accuracy Tests were:

- 100% of the 156 PG&E stock Smart Meters tested were within an accuracy range of 99.81% to 100.15%, with an average accuracy of 100.01% and a standard deviation of 0.0408%.
- The meters passed the ±0.2% acceptable accuracy standard established by the meter manufacturer, which also satisfied the CPUC accuracy requirement of ±2.0%.

Following an initial test to verify the accuracy of the meters at full load, light load, and with a 50% power factor in accordance with ANSI standards, a subset of these meters were used in Structure's laboratory and field test scenarios.

Environmental testing consisted of subjecting six of the PG&E Smart Meters to extreme hot and cold conditions in a controlled environmental chamber designed to accurately replicate these conditions in accordance with ANSI C12.20 specifications. The meters were placed into the environmental chamber for 24 hours and allowed to reach "equilibrium". The temperature was then adjusted, and the test performed.

The summary findings from the Environmental Laboratory Meter Tests were:

- When subjected to +50 degrees Celsius (+122 degrees Fahrenheit) for 24 hours, all of the meters tested within the ±2% CPUC standard; however, one out of the six meters failed the ANSI C12.20 maximum deviation of ±0.5% from reference test temperature standard used by the meter manufacturer but passed the average registration accuracy criteria utilized to determine the pass/fail criteria for a meter.
- When subjected to -20 degrees Celsius (-4 degrees Fahrenheit) for 24 hours, all of the meters tested within the PG&E and CPUC criteria of ±0.5% and ±2%, respectively. All of the meters passed the ANSI C12.20 maximum deviation of ±0.5% from reference test temperature standard used by the meter manufacturer.

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End-to-End laboratory testing was performed on five PG&E Smart Meters, with five Elster digital meters used as parallel, side-by-side measurement, referred to in this Assessment as “shadow”, meters. The findings from these tests are detailed in the End-to-End System Testing section.

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5.2 Field Meter Testing

5.2.1 Summary of Field Meter Testing Findings

Structure conducted field tests on 797 meters using defined procedures and protocols for each of the following six scenarios:

- Scenario 3: Electromechanical Meter Test and Smart Meter Field Replacement
- Scenario 4: Non-High Bill Complaint Smart Meter Field Test
- Scenario 5: High Bill Complaint Smart Meter Field Test
- Scenario 6: High Bill Complaint Shadow Meter Field Test
- Scenario 7: Non-High Bill Complaint Electromechanical Meter Field Test
- Scenario 8: High Bill Complaint PG&E-Installed Shadow Meter Test Verification

Structure's field tests measured accuracy of the meters at full load, light load, and with an applied power factor. The results were tracked to acceptance levels for the CPUC (±2% for both Smart Meters and electromechanical meters), PG&E (±0.5% for Smart Meters, ±2% for electromechanical meters), and the manufacturer (±0.2% for Smart Meters, ±2% for electromechanical meters). Structure's Pass/Fail Criteria was based upon the CPUC standard of ±2.0% for electromechanical meters and Smart Meters.

Structure's 897 attempted field meter tests resulted in 100 meters that were unable to be completed for normal reasons, such as meter banks on apartment buildings preventing the installation of the dual socket required for testing, for a total of 797 completed field meter tests. Two Smart Meters were found to have serious event errors and to be malfunctioning, and were thus not included in testing: one was found to have event errors on arrival, and one was found to have event errors upon installation. Using the CPUC pass/fail criterion of ±2.0%, 100% of the completed Smart Meter field tests passed accuracy readings. The Average Registration Accuracy of the 611 meters tested was 100.067%, with a Standard Deviation of 0.271%. Of the 151 completed electromechanical meter field tests, 141 of the 147 meters, or 95.92%, passed and 6, or 4.08%, failed accuracy readings.

Structure identified one meter that was registering a zero read during the field meter testing. After further examination of PG&E's issue logs, the error was identified as a "data storage" issue. These data storage issues had been identified by PG&E in 12,735 meters as of May 2010, potentially resulting in a subset of Customers receiving zero usage or lower estimated bills. Data storage issues are one type of exception disclosed by PG&E, and may include:

- Negative intervals
- Large intervals
- Zero table
- Negative register readings
- Table resets

Structure noted that these data storage issues were identified in early October 2009, with replacements starting in May 2010. These errors were disclosed to the public and to the CPUC in May 2010. PG&E subsequently initiated processes to address these issues in a timely and effective manner. As of July 2010, the outstanding data storage issues had been reduced to 1,526 meters.

The following Figure illustrates the number of meters that passed and failed accuracy tests for all of the Structure Field Meter Testing Scenarios, delineated by electromechanical meter tests in blue, and Smart Meter tests in yellow. The field testing scenarios were referred to as "High Bill Complaint" and "Non-High Bill

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Complaint" populations. The High Bill Complaint population was derived from complaints received directly by the CPUC or PG&E and those received at the town hall meetings organized by state senators. Non-High Bill Complaint refers to Customers who had not filed a high bill complaint through one of these channels.

Pass/Fail Results of Structure Field Meter Accuracy Tests by Scenario			
Scenario	**Total Meters**	**Pass**	**Fail**
3: Replace Electromechanical Meter with Smart Meter – Electromechanical Meter Test	47	41	6
3: Replace Electromechanical Meter with Smart Meter – Smart Meter Test	44	44	0
4: Smart Meters (Non-Complaint)	531	531	0
5: Smart Meters (High Bill Complaint)	36	36	0
6: Shadow Meters (High Bill Complaint, Structure)	*19*	*N/A-S*	*N/A-S*
7: Test Electromechanical Meter	100	100	0
8: Shadow Meters (High Bill Complaint, Structure-PG&E)	*18*	*N/A-S*	*N/A-S*
Total of all Field-Tested Meters	**795**	752	6
Total - Smart Meters	**611**	611	0
Total - Electromechanical Meters	**147**	141	6
Percentage of Total Smart Meters Tested	**-**	**100.00%**	**0.00%**
Percentage of Total Electromechanical Meters Tested	**-**	**95.92%**	**4.08%**

Figure 87: Structure's Field Meter Testing Pass/Fail Accuracy Results by Field Test Scenario

N/A–S: Not Applicable–Shadow Meter

Of the 613 completed Smart Meter field tests, 611 meters were successfully tested and 100% passed Average Registration Accuracy. One meter was found to have serious errors and be malfunctioning on arrival, and one was found to have serious event errors upon installation; these meters were therefore excluded from testing.

5.2.2 Detail of Field Meter Testing Findings

A description of Structure's field testing scenarios and summary of the scenario-based testing results are presented in the following Figure. The field testing scenarios were referred to as "High Bill Complaint" and "Non-High Bill Complaint" populations. The High Bill Complaint population was derived from complaints received directly by the CPUC or PG&E and those received at the town hall meetings organized by state senators. Non-High Bill Complaint refers to Customers who had not filed a high bill complaint through one of these channels. Average registration accuracy is calculated using the equation (Light Load Test + Full Load Test)/2 and refers to the average accuracy of a "register," which maintains a measure of the total power consumption that passed through the meter over time.

Each of the following scenarios was performed independently of each other, and involved a unique Customer premise.

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Structure Field Testing Scenarios and Results			
Scenario	**Description**	**Synopsis**	**Results**
Scenario 3	Electromechanical Meter Test & Smart Meter Field Replacement	Structure used a representative sample of 50 Customers that were scheduled to have their electromechanical meter replaced by PG&E. The electromechanical meters were removed and accuracy tested in the field at full load, light load, and 50% power factor. A laboratory-tested Smart Meter was then accuracy-tested in the field before being installed in the Customer's premise. The results of each of these tests were recorded by the Structure contractor. 47 successful electromechanical meter tests and 44 successful Smart Meter tests were conducted for this Scenario. The difference in number of electromechanical tests and Smart Meter tests was due to 6 electromechanical meters that failed. These meters subsequently did not receive a Smart Meter installation at the time of the test; therefore, Structure did not conduct a Smart Meter test at that premise.	• One Smart Meter was found to have a serious event error and be malfunctioning upon installation, and was therefore excluded from testing. • 100% of the 44 tested Smart Meters used for this scenario passed CPUC's accuracy testing acceptance standard of ±2.0% in the field test. • Field test results of 44 of the previously laboratory tested Smart Meters indicated an Average Registration Accuracy of 100.27% during the field tests with a standard deviation of 0.112%. • One electromechanical meter was not found to be functional, registering zero on all tests; and was therefore excluded from testing. • 41 of 47 tested electromechanical meters passed the CPUC's accuracy testing standard of ±2.0% in the field test. • Six of the 47 tested electromechanical meters failed the CPUC Accuracy Standard of ±2.0%, with one failing the Full Load and Power Factor tests, one failing the Light Load test, one failing the Power Factor test, and three meters failing the Light Load and Power Factor standard tests. • Two of the six electromechanical meter failures failed the Average Registration Accuracy standard. All field-tested electromechanical meters that were replaced with Smart Meters were returned to PG&E with an indication of whether or not they passed the field test. • The 47 tested electromechanical meters had an Average Registration Accuracy of 99.556%, with a Standard Deviation of 1.343% for the successful tests.

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Structure Field Testing Scenarios and Results			
Scenario	**Description**	**Synopsis**	**Results**
Scenario 4	Non-High Bill Complaint Smart Meter Field Test	A representative sample of 532 Smart Meters was chosen from the population of PG&E Customers where a Smart Meter had previously been installed by PG&E and the Customers were not in the High Bill Complaint list. These meters were removed from the Customer's meter socket and placed in a calibrated field test set on-site at the Customer's premise, where the meters were then accuracy-tested at full load, light load and a 50% power factor. In addition, the existing internal meter program was verified to confirm proper functionality.	• One Smart Meter (of the 532) was found to have a serious event error with a non-registering metrology, and was thus excluded from testing. The communication module on this device was functional and had been reporting zero usage for almost six months. • 100% of the 531 tested meters tested within the CPUC accuracy standard of ±2.0%. • Average Registration Accuracy ranged from 98.345 % to 100.78% with an average of 100.075% and a standard deviation of 0.275%. •
Scenario 5	High Bill Complaint Smart Meter Field Test	Structure selected 50 Smart Meter installations from the High Bill Complaint population to verify that the meter was properly installed and to field test the registration accuracy of the installed Smart Meter. 36 Smart Meter tests were conducted for this Scenario. At each location, the Smart Meter was removed and installed in a calibrated field test set, where the meter was accuracy tested at full load, light load and a 50% power factor. In addition, the existing internal meter program was verified as functioning properly.	• All 36 Smart Meters tested passed the CPUC acceptance standard of ±2.0%. • The Average Registration Accuracy for the Scenario 5 meters was 100.004%, with a Standard Deviation of 0.351%.
Scenario 6	High Bill Complaint Shadow Meter Field Test	Structure selected 20 locations from the High Bill Complaint population to install a Field Shadow Meter setup, and completed tests at 19 locations. The Field Shadow meter setup consisted of the existing installed PG&E Smart Meter and an Elster digital Shadow meter installed side-by-side to measure the Customer's usage simultaneously through both meters. These meters were used to establish the accuracy of the Customer meters already installed by performing a weekly accuracy check and comparing the readings from the two meters. In addition to verifying Smart Meter accuracy, these installations were also used to verify the end-to-end accuracy thru the PG&E AMI system to the customer bill.	• The results of the 19 shadow meter tests showed that the shadow meter reads were in concert with the Smart Meter reads. • The bills from both the lab-tested shadow meters and the field-tested shadow meters matched the expected results from manual bill calculations. • Structure encountered unauthorized PG&E meter swaps/meter tests during the execution of this scenario, as noted in the "Unauthorized PG&E Meter Swaps" section of this report, and in Appendix F: Unauthorized Scenario 6 Meter Swaps Exhibitions. These meters were subsequently not tested by Structure in the field, but were retrieved from PG&E and evaluated in the laboratory with no noted issues. Structure selected additional accounts to test in lieu of the meters excluded from test sample due to the unauthorized meter swap.

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Structure Field Testing Scenarios and Results			
Scenario	**Description**	**Synopsis**	**Results**
Scenario 7	Non-High Bill Complaint Electromechanical Meter Field Test	Structure used a representative sample of 100 installed PG&E electromechanical meters to verify the accuracy of these meters in the field. The meters were removed from the customer installation and placed in a calibrated field test set to verify their accuracy at full load, light load, and at a 50% power factor.	• Scenario 7's test included 100 installed PG&E electromechanical meters, with no failures on the CPUC Standard of ± 2.0%. • The 100 meters had an Average Meter Registration Accuracy of 99.798% with a Standard Deviation of 0.528%. • The minimum Registration across all tests (Full Load, Power Factor, and Light Load) was 98.1%, and the maximum registration across all tests was 101.95%.
Scenario 8	High Bill Complaint PG&E Installed Shadow Meter Test Verification	Structure accompanied PG&E Meter personnel during the installation of 18 shadow meter tests performed by PG&E. These installations consisted of the installation of a side-by-side electromechanical meter and Smart Meter at the site of Structure-selected High Bill Complaint Customer's premises. Structure reviewed PG&E's installation practices to determine if they were in line with documented installation, testing and meter reading procedures and to determine if PG&E followed their documented practices and procedures.	• Of the 27 meters selected for Scenario 8, 18 were successfully completed, and nine were unable to be completed due to premise restrictions and meter installation routing schedules. • In all test cases, PG&E complied with internally documented practices and procedures for the shadow test verification.

Figure 88: Structure's Field Meter Testing Summary of Results

5.2.3 Unauthorized PG&E Meter Swaps

Structure selected 20 PG&E high-bill complaint Customers for field meter testing Scenario 6, High Bill Complaint Shadow Meter Field Test. These Customers were selected as the highest priority premises for complaint-meter testing based on the application of specific high-bill complaint analysis criteria.

CPUC protocol mandated that Structure personnel performing field meter tests be accompanied by a PG&E meter technician. To facilitate coordination of the premise and technician schedules, Structure created the Field Meter Test Schedule Summary, which served as the primary mechanism for coordinating PG&E and Structure field personnel. On June 17, 2010, Structure issued the Field Meter Test Schedule Summary to PG&E. The June 17 version of the Field Meter Test Schedule Summary included Structure-selected PG&E premises scheduled for testing through June 25, 2010. PG&E issued corresponding field work-orders for these premises on June 17.

Of the 20 Customer premises to be tested for the shadow meter scenario, Structure encountered 4 instances where PG&E protocol pertaining to work-order management and coordination with Structure field personnel ultimately precluded Structure from performing the shadow meter test. This breach of protocol was

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encountered over a month into the testing process, with the initiation of the high-bill complaint shadow meter field test scenario that Structure had identified as the most critical high bill complaint Customers in the PG&E territory.

On June 21, 2010, Structure personnel executed shadow-meter tests in Bakersfield, Stockton, Antioch, and Walnut Creek. Upon arrival at two Walnut Creek premises scheduled for shadow-meter testing, Structure personnel discovered newly installed PG&E Smart Meters. Structure therefore terminated the shadow meter test. During the subsequent inquiry outlined below, Structure discovered that PG&E performed a smart meter swap the same day (June 21), prior to Structure's arrival at the Walnut Creek premises.

Also on June 21, 2010, Structure personnel arrived on-site at a Customer premise in Antioch at 1PM. The Structure tester contacted the designated PG&E field manager to inquire as to the estimated arrival time of the PG&E resource assigned to the Antioch premise. The PG&E field manager informed Structure that there was no work-order for the Antioch premise and that PG&E could not support the meter test. Structure therefore terminated the shadow meter test. During the subsequent inquiry outlined below, Structure identified that at 5:37PM that evening (June 21), PG&E performed a meter swap at the Antioch location, independently and without coordination or notification to Structure.

The evening of June 21, 2010 a conversation took place with the Field Metering supervisor and it was agreed that PG&E needed to make sure that this would not happen again.

The final instance involved a PG&E Smart Meter swap in Bakersfield that was completed several weeks in advance of Structure's issue of the Field Meter Test Schedule Summary to PG&E on June 17, 2010. Given PG&E's completed test two weeks in advance of Structure's testing, the premise should have been removed from Structure's testing schedule. However, this incident is noted in this report since the Customer was initially available for testing, and Structure had repeatedly discussed with PG&E the Customer's inclusion at the center of Structure's advanced high-bill complaint analysis.

Upon recognition of the above circumstances, Structure initiated a series of inquiries to determine root-cause for PG&E's failure to follow the agreed-to protocol for conducting Structure meter tests. The inquiry studied:

- Timelines of PG&E on-site field personnel
- Hard-copy review of work-orders initiated through the PG&E field work management system
- Acquisition, by Structure, of the removed high-bill complaint Smart Meters (identified via meter badge ID)
- Independent test at the Structure laboratory test facility of each of the original meters involved in the unauthorized meter swaps.

Appendix F - Unauthorized Scenario 6 Meter Swaps Exhibitions for a complete repository of correspondence between Structure and PG&E, documentation provided by PG&E (work-orders, timelines, etc.), and PG&E's formal response to the inquiry.

Structure reviewed the provided PG&E documentation and conducted a series of investigative interviews related to these unauthorized meter swaps. Structure concluded that the unauthorized meter swap conditions appeared to be a result of PG&E's failure to coordinate with field managers and PG&E's failure to properly code work-orders. Structure did not identify malicious intent on the part of PG&E to swap meters prior to Structure performing the meter tests.

Following Structure's inquiry into the unauthorized meter swaps, PG&E initiated a more explicit indication of Structure protocol to PG&E field personnel. Structure cannot vouch as to the implementation of this additional protocol; however, in Structure's experience this protocol was subsequently not followed on at least one other occasion, where Structure testers were scheduled to conduct a test, only to find that PG&E had just conducted

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a meter test without Structure. One Scenario 4 Customer reported that PG&E was at their residence for about an hour prior to Structure's arrival. Structure researched the PG&E work order management system and verified that no unauthorized work orders had been issued for the residence.

Structure's testing procedures included verification of meter badge identification and firmware version, which allowed Structure to conclude that the meter had not been compromised.

5.3 End-to-End System Testing

5.3.1 Summary of End-to-End System Testing Findings

End-to-end system testing, in both the laboratory and field environments, was used to verify the accuracy of the PG&E Smart Meters, data communications and associated systems, estimation routines, and the Customer billing system, including bill printing.

A laboratory end-to-end test scenario was used to simulate system exception handling in a controlled environment, including the addition of a meter access point that served as the collection point for the meter information that was sent back to PG&E.

These end-to-end laboratory tests involved creating a proxy Customer account, installing a Smart Meter for this account and an electronic meter side-by-side to shadow the account's usage, and conducting tests from the time of installation through to receiving a bill. Structure established shadow meter test boards and conditions in the independent laboratory for use in the end-to-end system testing, to determine whether the Smart Meters were accurately measuring energy consumption as compared to an independent electronic Meter. A field end-to-end test scenario, Scenario 6, was used to test the actual performance at Customer-installed facilities.

By utilizing a representative, small sample size to confirm meter-to-bill system accuracy, Structure did not identify deviations during testing that indicated a systemic problem in the meter billing system's accuracy. Structure did encounter an issue with PG&E's set-up of the proxy accounts, wherein Structure specified a specific billing address and PG&E sent all of the proxy account bills to the wrong address. PG&E indicated that this occurred because they did not follow their standard practices.

5.3.2 Detail of End-to-End System Testing Findings

Twenty-six Elster digital meters procured from the Elster meter manufacturer were laboratory-tested for accuracy and utilized as an auxiliary/additional meter to record energy consumption on the secondary meters, hereby referred to as a "shadow" meters in both the laboratory end-to-end testing and the field end-to-end testing scenarios.

End-to-end laboratory testing was performed on five PG&E Smart Meters, with five Elster digital meters used as shadow meters. Each of these meter pairs was subjected to a different amount of load, reflecting measurement at various rate tiers over the test period. In addition, the meters were also subjected to common exceptions to normal conditions often found in the field, including power outages, voltage swells, voltage sags, and loss of Radio Frequency reception. Inclusion of the common exceptions facilitated testing PG&E's capability to perform validation, editing, and estimation (VEE) processes in compliance with CPUC rules, and without introducing errors into Customer bills. The referenced VEE standard was California Interval Data VEE Rules Revision 2.0.

End-to-end field testing utilized the field test shadow meter installations on selected High Bill Complaint Customers. The field test shadow meter setup used the existing installed PG&E Smart Meter and the Elster digital shadow meter installed side-by-side to measure the Customer's usage simultaneously through both meters. Structure also utilized these installations to verify the flow of meter usage and event data from the Customer premise, through the PG&E AMI and Billing systems, to the Customer's receipt of the printed bill.
"Proxy" Structure Customer accounts were created within PG&E's billing system for each of the laboratory-based end-to-end meters, giving Structure the ability to determine PG&E's application of billing determinants

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and rate assignments accuracy and the timeliness of physical bill issuance to residential electric Customers. The end-to-end test process was designed for completion over the course of one PG&E billing cycle.

Structure experienced initial laboratory testing setup challenges that were resolved within the first days of testing. The challenges identified during setup did not impact the overall scope or development of testing conclusions. The results of the end-to-end tests included:

- End-to-end laboratory system testing verified that the representative sample of five Smart Meters being billed through the PG&E systems had average accuracies compared to the reference Elster meters of 0.06% with a standard deviation of 0.001%. Meter Data Management System (MDMS) validation routines were verified to be working accurately under the tested conditions, and billing matched the expected results.
- End-to-end field meter testing and bill evaluation verified that the Smart Meters at the Customer premises were accurately measuring and billing through the PG&E systems, as compared to the four reference Elster meters installed at the Customer premises. Meter Data Management System (MDMS) validation routines were verified to be working accurately under the tested conditions, and billing matched the expected results.
- Meter readings were verified as accurate between the Advanced Metering Infrastructure (AMI) head-end, the Meter Data Management System (MDMS), and the Customer Care and Billing (CC&B) systems.
- Application of billing determinants were verified as accurate, including the assignment of baseline allocations, transition of billing through seasons, and transition of billing through new tariffs.

Laboratory and field shadow meter bill analysis for all nine shadow meters used in the five end-to-end laboratory tests and four end-to-end field tests is found in Appendix E – End-to-End Customer Bill Analysis.

5.4 High Bill Complaint Analysis

5.4.1 High Bill Complaint Analysis Findings Summary

Structure obtained the complaint register associated with the electric Smart Meter High Bill Complaints from both PG&E and the CPUC since the implementation of Smart Meters through June 10, 2010, for inclusion in our analysis which included usage history for 1,378 records. A detailed analysis was performed on 1,066 of these records. The records were analyzed for usage sensitivity to weather, unusual spikes, meter problems, manual or system based issues, meter reading issues, rate impacts, and service issues. Structure further analyzed a targeted sample of 73 complaints that were identified as having multiple issues and would likely provide the greatest insight into potential PG&E system or process issues. Structure contacted 100 High Bill Complaint including the 73 researched complaints, and conducted interviews with 20 Customers that had filed complaints during the period and exhibited excessively high bill periods, cancel/re-bills, or complaint resolution codes that reflected a potential problem. The 73 complaint accounts were also included in the field meter tests.

As a result of the high bill complaint analysis, Structure did not identify problems with the Smart Meter data utilized for billing. Structure identified the following factors that contributed to high bill complaints during late 2009 and early 2010:

- Customer Usage:
  - Meter deployment schedules coincided with increased energy usage caused by a heat wave.
  - Some Customers experienced load changes that were reflective of changes in personal circumstances. Examples included room additions, pool additions, and equipment malfunctions.
  - Electromechanical meter degradation that was also identified as part of Structure's field meter testing.
- Rates:
  - Rate increases compounded the financial impact of the additional weather-related usage, resulting in higher bills that occurred as Smart Meters were being installed.
  - Incorrectly applied rates that were based upon historical premise assumptions.
  - Rate-based inquires that increased as Customer bills escalated. Requests for new or renewed financial assistance through California Alternate Rates for Energy (CARE) were identified as potential reductions of financial impacts related to higher bills.
- Customer Service:
  - PG&E processes did not address the Customer concerns associated with the new equipment and usage changes.
  - Customer skepticism regarding the new advanced meter technology was not effectively addressed by PG&E on a timely basis.
  - Customers interviewed during this assessment did not consider their complaint resolved, despite indications from PG&E and CPUC that the Customer agreed with the resolution
  - PG&E Customer complaint resolution did not provide of interval read information available with Smart Meters, which may have assisted Customers' understanding of hourly usage patterns.
- Process Issues:

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- Customers indicated that communications/notifications surrounding physical meter installation were lacking, or that the Customer had issues with the installation personnel.
- PG&E utilized field meter readers for an average of 131 days after Smart Meters were installed, resulting in similar meter reading errors as electromechanical meters. The transition to automate the Smart Meter data for use in billing was not clearly addressed with Customers.

PG&E's system tolerances related to billing quality control were not stringent enough, resulting in multiple bill cancelations and re-billings, which were confusing to Customers. Additionally, Structure determined that the PG&E complaint resolution process was inefficient and ineffective in providing Customers with resolution details and education related to Smart Meters. Recent process changes adopted by PG&E created Customer Relations resources that were focused on Smart Meters, along with a group focused on resolving escalated complaints. Structure performed a complaint walkthrough with both the PG&E groups and was satisfied that additional focus was being placed on resolving Customer complaints.

5.4.2 High Bill Complaint Analysis Findings Details

5.4.2.1 Customer Complaint Process

The Customer complaint process followed multiple paths, including contacting the CPUC Consumer Affairs Branch (CAB) to file a complaint and filing directly with PG&E's Customer Relations Department. In some cases, Customers registered complaints with both the CPUC and PG&E. Typically, Customers had filed more than one complaint with PG&E. Included in the CPUC complaint list were complaints received during town halls hosted by Senators Dean Florez (D-Shafter) in October 2009. The complaint process is illustrated in the Figure below, provided by PG&E.

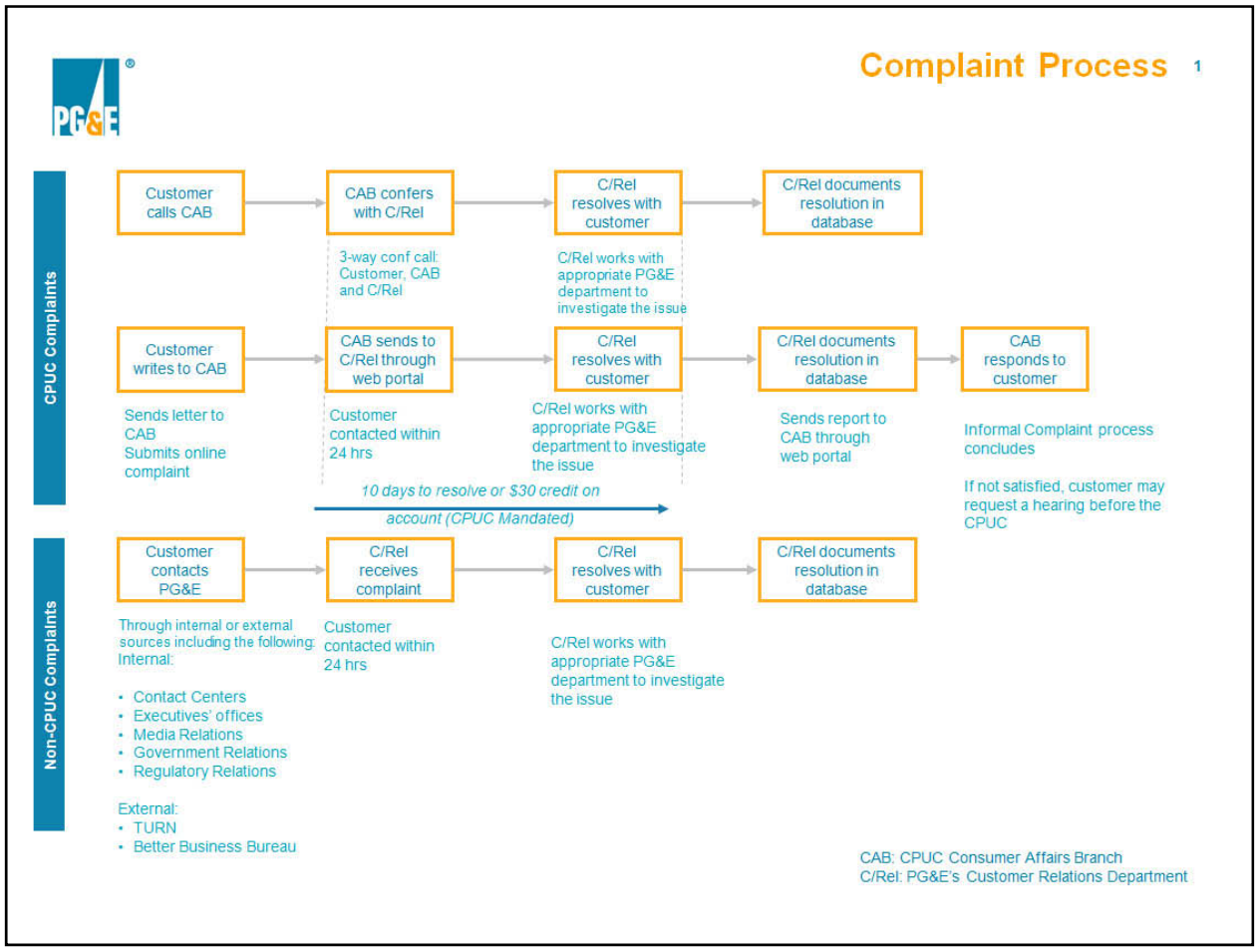


Figure 89: PG&E-Provided Customer Complaint Process

All complaints filed with the CPUC were provided to PG&E for resolution and expected to either be resolved in 10 days or to provide a required $30 credit to the Customer. CPUC was responsible for communicating results back to the Customer. Complaints filed with PG&E were handled through the Customer Relations call center and logged into the Customer's account profile.

The following Figure illustrates the number of Smart Meter high bill complaints received by PG&E on a monthly basis.

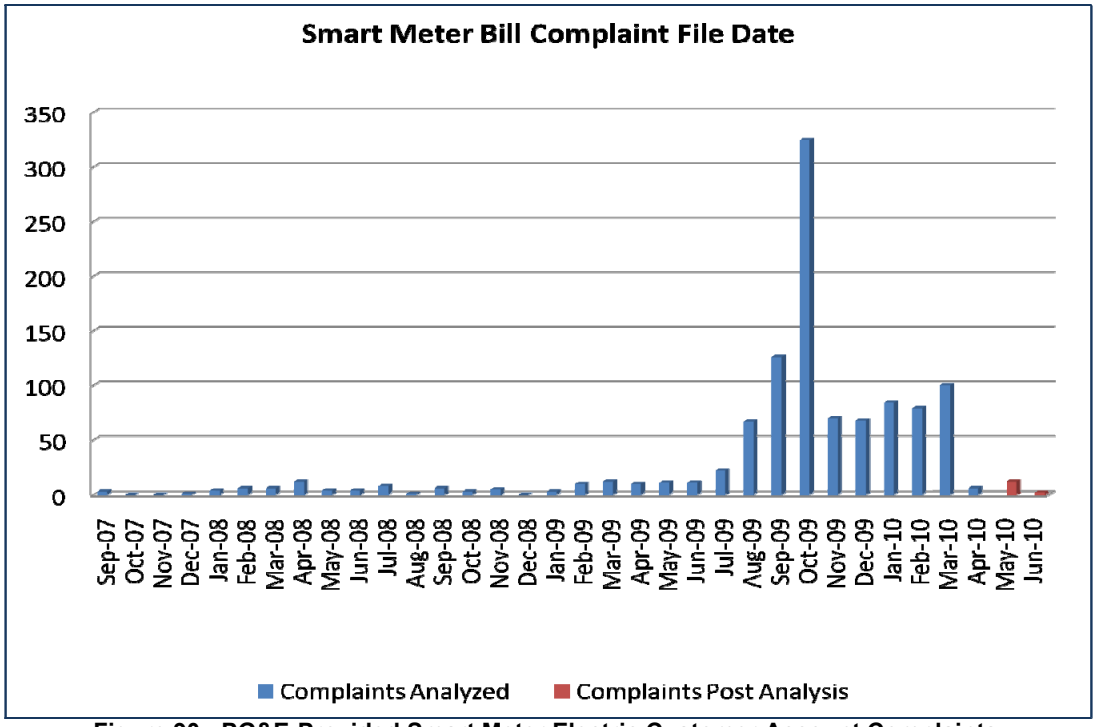
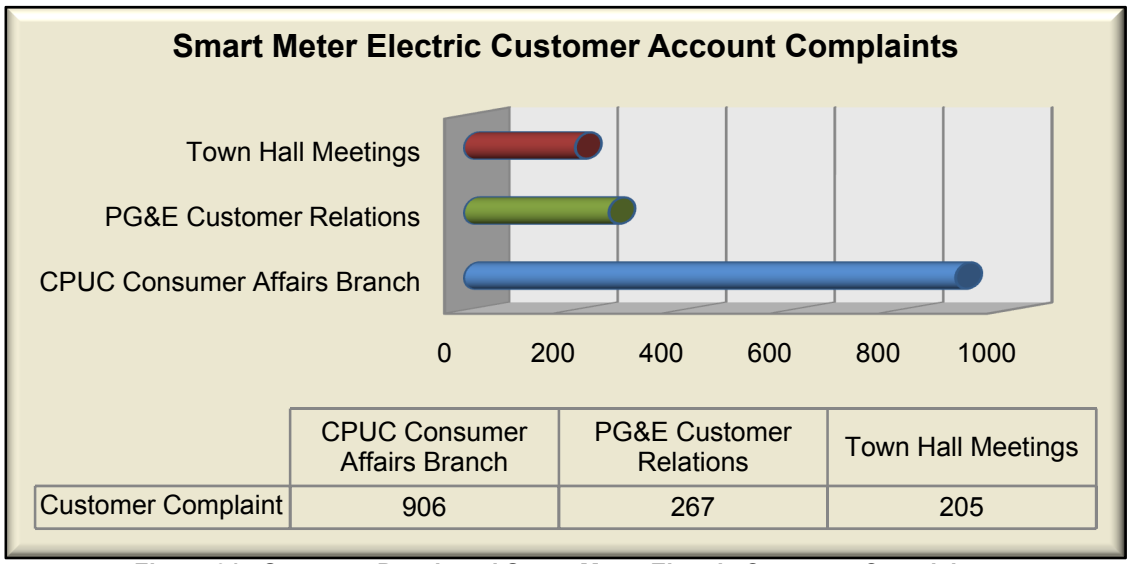


Figure 90: PG&E-Provided Smart Meter Electric Customer Account Complaints

Structure noted a disproportionate number of complaints filed with the CPUC than with PG&E, as indicated in the Figure below.



	CPUC Consumer Affairs Branch	PG&E Customer Relations	Town Hall Meetings
Customer Complaint	906	267	205

Figure 91: Structure-Developed Smart Meter Electric Customer Complaints

Structure was told by PG&E that a complaint was not marked as a Smart Meter complaint if the Customer did not mention that they had a Smart Meter. This approach may result in complaints not being accurately coded and reported as Smart Meter complaints. Some Customers interviewed indicated that complaints were registered with both the CPUC and PG&E, although only the CPUC record was identified.

Structure also performed a historical usage analysis utilizing an aggregated Smart Meter complaint inventory file provided by PG&E. The file included identification of the complaint source, relevant complaints, and related account detail. Structure conducted an analysis of the Smart Meter Complaint inventory to remove duplicate and non-Smart Meter billing data, and concluded that of the 2,915 Smart Meter complaints that were filed by PG&E Customers from September 2007 through April 2010, there were 1,378 distinct Customers that filed complaints related to residential electric accounts. Structure's evaluation included a further detailed review that evidenced 1,066 represented electric residential Smart Meter Customer accounts.

Subsequent to the conclusion of our analysis, Structure received additional high complaints from both PG&E and the CPUC. Structure reconciled the lists and determined that an additional 117 CPUC CAB Customer complaints had been excluded from the PG&E-provided consolidated list. Structure utilized the complaint lists and supplemental complaints as the basis for our testing selection, but did not include a complete analysis on these accounts.

As part of a follow-up to the Town Hall meeting complaint process, Structure reviewed the detailed Customer analysis performed by PG&E and the associated complaint resolutions. The PG&E analysis included a comparison of the Customer's average daily usage in kWh vs. the monthly average temperature for the region to demonstrate the trend in usage pre- and post- Smart Meter installation.

Structure reviewed the Town Hall Meeting historical usage profile for each complaint to determine accounts that were impacted by weather. Structure's evaluation evidenced three customers with a historical profile that varied significantly post-Smart Meter implementation. No conclusion was reached by PG&E regarding these three complaints, and no additional resolutions were provided to Structure by PG&E. Additional analysis may need to be performed on the Town Hall complaints to provide the resolution for these Customers.

Structure included the Town Hall complaints within the potential selection group for the Customer Interviews and in the Smart Meter High Bill meter tests for further validation.

Structure also performed an independent analysis on the high bill complaint Customer accounts by reviewing the historical usage and performing the following detailed analysis on the 1,066 accounts. The analysis performed included:

- Weather impacts on average daily usage
- Average Daily Usage prior month prior year
- Extended billing cycles
- Unresolved complaints
- Cancel/re-bill review

Structure compared the historic average daily kilowatt hours (kWh) usage for each of the 1,066 Customer accounts with the objective of determining if the high bill complaint Customers experienced increased kilowatt hour (kWh) usage after installation of Smart Meters due to weather. The comparison utilized the 2006 and 2009 years with similar summer profiles and determined that in 86% of the 2009 complaints, the average daily usage was less than the 2006 summer although the 2006 summer months were hotter. Structure verified that the weather in the same July/August period for 2007 and 2008 was 2 to 3 degrees cooler than in 2009. The

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remaining 14% of accounts required additional analysis to determine the potential cause for the increased usage.

Structure also reviewed the average daily usage for the same period of the prior year for each Customer Complaint account history, and identified less than 6% of the records for the complaint Customers that exceeded 150% of the same period prior year. Structure utilized the 150% value to reflect the differential in weather between 2008 and 2009 and focus on identifying unusual spikes in energy usage.

Additional complaint analysis focused on the extent to which bills were included in an extended billing cycle beyond the typical (27-32 day) billing cycle. Structure's evaluation discovered that in 2009 and 2010, approximately 9% of the bills reflected a billing period beyond the standard cycle, although less than 0.4% extended past a 45 day window. Extended billing cycles that resulted in higher overall bills were identified as contributing to high bill complaints. Structure recalculated several bills and determined that the appropriate baseline adjustments were included in the bills and that the bills were accurately calculated.

Structure also noted that during late 2009 and early 2010, a significant portion of complaints were not resolved within the CPUC-required 10 day complaint resolution period. PG&E indicated that the resolution time period extended well beyond the 10-day timeframe due to the influx of complaints during the second half of 2009 and early 2010. Structure calculated that PG&E took more than 10 days to resolve complaints for more than 67% of the Customer accounts during this time period. Structure did not review all accounts to identify whether the CPUC credit for account resolution was provided, but did identify that in several cases where detailed review was performed, the adjustment was properly applied after Structure's additional review and discussion with PG&E.

The cancel/re-bills documented by PG&E represented 1% of the total high bill complaints. A portion of the cancel/re-bills related to overbilling from estimated meter reads identified by Customers subsequently required adjustments by PG&E. Billing adjustments were also made to compensate for meter installation issues.

5.4.2.2 Customer Interviews

Structure contacted 100 high-bill complaint Customers for potential in-depth interview participation related to their high bill complaint. Of the 100 Customers contacted, 20 Customers agreed to be interviewed. Some Customers permitted inclusion of their information in The Assessment, and permitted Structure to follow up with PG&E on their behalf. The Customer interviews focused on the nature of the complaint described to PG&E, PG&E's approach to resolving the Customer's complaint, and the current status of the complaint. The 20 Customers participating in interviews were also included in the field meter testing population.

Based upon Customer interviews, Structure identified gaps in PG&E's approach taken to resolve Customer complaints, including but not limited to:

- Some Customer complaints were not logged into the service history on Customer accounts.
- Follow-up with Customer was not performed on a timely basis.
- PG&E indicated that account was resolved did not align with Customer perception.
- Lack of resolution communication back to Customer.
- Customer lacked clear understanding of complaint resolution process.
- Customer consistently treated by PG&E as wrong, until the Customer proved to PG&E that they were right.
- Customer perception of Smart Meter functionality resulted in complaint escalation.

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- PG&E front-line customer call representatives lacked professionalism while dealing with Customer complaints.
- Underlying cause of billing issue not discovered in most cases, even when monetary resolution was reached.

Recent process changes adapted by PG&E allocated Customer Relations resources focused on Smart Meters, along with a group focused on resolving escalated complaints. Structure performed a complaint walkthrough with both of the PG&E groups and was satisfied that additional focus was being placed on effectively resolving Customer complaints.

In regards to the CPUC complaint resolution process, Structure noted that the Complaint closure letter Customers received from the CPUC provided no further information than had been provided by PG&E, and both were considered to be ineffective.

Structure followed-up on the Customer interviews by reviewing the Customer Complaints with PG&E. As an outcome of Structure's review with PG&E, two accounts were adjusted based upon the Customer's satisfaction of certain criteria, including low income CARE eligibility and major customer equipment malfunctions, which were subsequently repaired by the Customer.

During the interview process, Structure identified discrepancies in the retroactive application of the CARE eligibility for two Customers. These discrepancies were later resolved by PG&E, following Structure's inquiries, in favor of the Customer.

Of the 20 Customer interviews completed, Structure identified the following non-unique account issues:

- 9 Customers experienced unusually high bills in the initial months after the Smart Meter was installed
  - Explanations identified:
    - Estimated meter reads
    - Cancel/re-bill adjustments
    - Weather related
    - Usage pattern adjustments
- 9 Customers do not have an explanation, personally or from PG&E, for the spike in electricity usage.
  - Potential explanation identified:
    - Electromechanical degradation (similar to those found in field testing)
- 5 Customers were on the wrong rate structure, or PG&E changed their rate structure as a result of their complaint.
  - Explanations included:
    - Historical premise classified incorrectly, affecting the baseline applied to the premise
    - Lapse in CARE qualification, or not registered for lower income-based programs
- 1 Customer experienced a 500% increase in kWhs used after Smart Meter installation
  - Explanation included:
    - Correction of estimated meter reads.
    - Note: The lack of adequate PG&E exception and validation controls resulted in the bill being processed.
- 2 Customers interviewed experienced electrical problems due to Smart Meters causing "surges" or interruptions in timed electrical services such as security lights and hot tub pumps.
  - Explanations included:
    - There is a possibility for a meter in close proximity to FCC Part 15 Unlicensed Radio Frequency (RF) devices and transmitting data via a 1 watt radio transmitter to create

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operational interference (e.g., static, trip, or outage) when the RF signal passes though these devices. This is an issue that is prevalent with any RF device, such as walkie-talkies, garage door openers, etc. Electrical issues may be due to a matter of proximity to the transmitter, strength of the transmitter, frequency of the transmitter, and the impact on the neighboring device.

- FCC Part 15 Unlicensed RF devices include:
  - Motion sensors
  - Garage door openers
  - Baby monitors
  - Wireless telephones
  - Wireless speakers
- PG&E has determined that certain models of Ground Fault Interrupter (GFI) breakers (such as those used on hot tubs) may be impacted if they are in close proximity to the meter. PG&E has also engaged Smart Meter manufacturers to develop low power transmitter solutions to the GFI interference issue, and has trained the installation contractors to listen for GFI tripping upon installation of a new meter.

On average, Customers indicated a 4.5 month delay between complaint submission and ultimate resolution. The quickest resolution was reached in four days; however, the longest resolution took 12 months and significant effort on the part of the Customer.

While the Customer interviews and related detail account reviews provided significant insight into potential issues within the Smart Meter program, Structure did not identify recurrent issues that impacted the overall population of High Bill Complaints analyzed.

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5.5 Best Practices Associated with Smart Meters

5.5.1 Summary of Best Practices Associated with Smart Meters Findings

Structure found PG&E to have been either historically in compliance, or to have recently come into compliance, with the majority of industry best practices associated with Smart Meters. Recognizing that some of these practices have matured over PG&E's three year AMI deployment period, it is only reasonable that PG&E has recently come into compliance with standards associated with best practices. Some concerns were noted around PG&E's practices related to Meter Deployment, Meter Data Management Interfaces, and VEE.

The following Figure presents a pictorial representation of Structure's evaluation of PG&E's historical and current adherence to industry best practices.

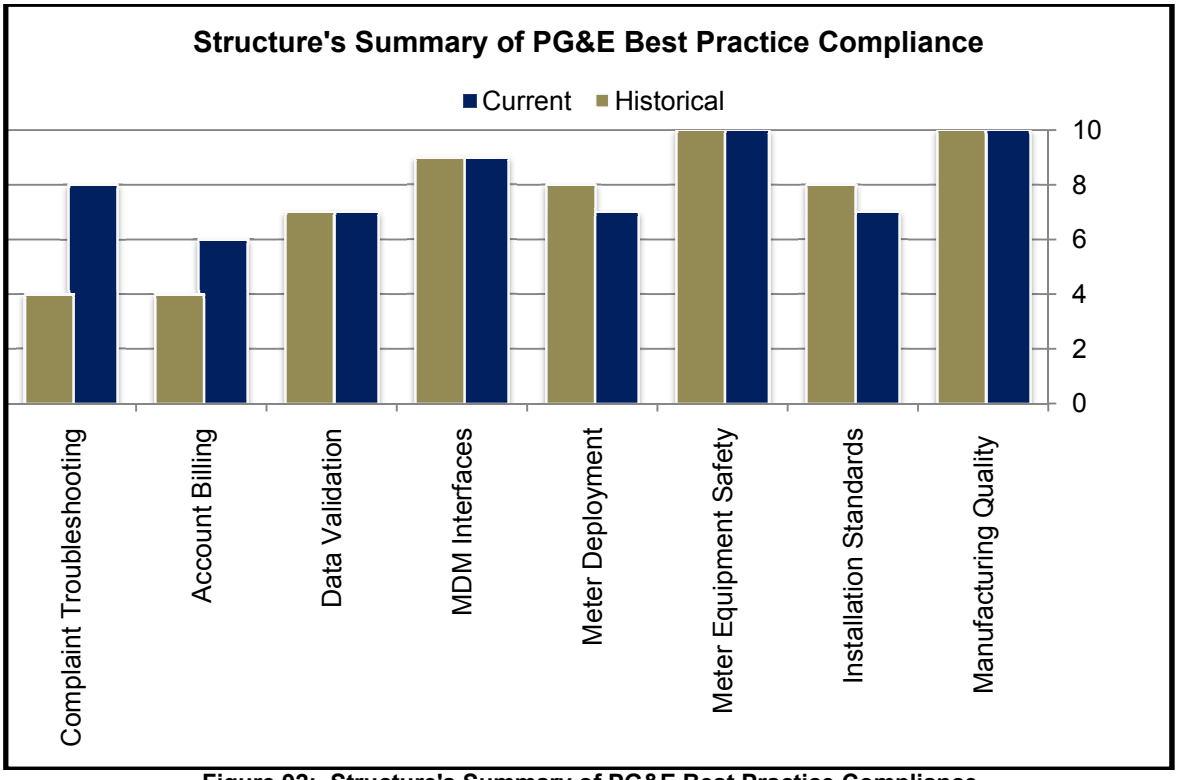


Figure 92: Structure's Summary of PG&E Best Practice Compliance

The detail findings in the following sections address the areas in which PG&E is historically and/or currently not compliant with best practices.

5.5.2 Detail of Best Practices Associated with Smart Meters Findings

Although PG&E was not in compliance with the recommendation to utilize IEC 61968-9 interoperability standards, PG&E provided documentation that it was employing a set of interoperability standards for MDM Interfaces.

Of some concern is the lack of documentation verifying compliance with the Meter Deployment best practice to deploy WAN/LAN collectors prior to meter deployment. By not deploying the communication backbone prior to meter deployment the time to transition meter reading from manual to AMI system readings is exacerbated, extending to an average of 131 days over the implementation period. This allows a continuation of the higher error rate associated with manual meter reading and may contribute to the perception that the Smart Meters are inaccurate.

Additionally, the inability to verify compliance around the Meter Data Management Interface Best Practice to "Correlate AMI meter events and alarms with VEE and CIS audits and checks for automated exception handling" and the VEE Best Practice of "MDMS must provide an on-line method, with workflow, resolving validation errors rather than reports "has created a situation where there is manual editing of data causing numerous cancel re-bills and delayed processing of customer data. This, coupled with extensive manual exception handling, instead of automated handling of issues has allowed many metering and billing errors to occur on a repetitive basis, over time, furthering the perception that the Smart Meters are not accurate.

PG&E has recognized, through the presentation of information, their shortcomings on these issues and has been actively pursuing remedies such as employing Best Practices and their recent consolidation of Billing, VEE, Smart Meter Engineering, and troubleshooting into one Operation Center.

The following Figures represent the findings from the analysis of PG&E's practices compared to industry standards, as evaluated by Smart Grid Subject Matter Experts. The areas evaluated assessed were:

- Meter Manufacturing Quality Control
- Meter Installation Standards
- Meter Equipment Safety
- Meter Deployment
- Meter Data Management Interfaces
- Validating, Estimating, and Editing for Monthly and Interval Data
- Account Billing
- High Bill Complaint Troubleshooting

The findings for each of the best practices areas indicate whether the best practice components are in full, partial, or non-compliance with industry best practices. The following criteria were applied in this evaluation:

- Full: Indicates that through documentation received, meetings and presentations discussing the issue, or on site visits and surveys that Structure's Smart Grid Subject Matter Experts determined that PG&E is in general compliance with that specific Best Practice.

- Partial: Denotes partial compliance with stated best practice. Indicates that that Structure's Smart Grid Subject Matter Experts determined that PG&E is in partial compliance with that specific Best Practice, based on evaluation of documentation received, meetings and presentations discussing the issue, or on-site visits and surveys.

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- Non-Compliant: Indicates that Structure's Smart Grid Subject Matter Experts determined that PG&E has either not implemented that specific Best Practice or has implemented only a minimal portion, based on evaluation of documentation received, meetings and presentations discussing the issue, or on site visits and surveys.

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5.5.2.1 Meter Manufacturing Quality Control Findings

To ensure that meters used for an Advanced Metering Infrastructure (AMI) implementation comply with meter manufacturing Quality Control, the utility should only purchase metering from manufacturers that have implemented the ISO 9001 Quality Control System. The Utility's responsibility will be to ensure that the manufacturer has indeed implemented the standard by requesting the ISO 9001 certification documents and that they continue to adhere to ISO processes and standards. This is best accomplished though on site review and auditing at the meter manufacturing location or locations. Specifically related to meter manufacturing the following standards and process should be followed.

Meter Manufacturing Quality Control Best Practices	PG&E Compliance	
	Historical	Current
Customer Related Processes Audit Areas		
Determination of requirements related to the product		
Meter Manufacturer determines: • Requirements specified by the Utility, including the requirements for delivery and post-delivery activities • Requirements not stated by the Utility but necessary for specified or intended use, where known • Federal, Statutory and regulatory requirements applicable to the product • Any additional requirements considered necessary by the Meter Manufacturer.	Full	Full
Review of requirements related to the product		

Meter Manufacturer should review the requirements and specifications related to the product as requested in the utility purchasing process. This review is conducted prior to Meter Manufacturer's commitment to supply a product to the Utility (e.g. submission of tenders, acceptance of contracts or orders, acceptance of changes to contracts or orders) and ensures that:
 	
• Product requirements are defined
• Contract or order requirements differing from those previously expressed are resolved
• Meter Manufacturer has the ability to meet the defined requirements.
  ○ ANSI certification: ANSI C-12 testing that is required for any meter product to demonstrate metrology accuracy, electric integrity and safety. This should be done at an independent third party
  ○ FCC certification: The meter with AMI module must be certified per the FCC requirements for transmission power, interference/interoperability, etc.
	Full	Full

Records of the results of the review and actions arising from the review are maintained. Where the Utility provides no documented statement of	Full	Full

Meter Manufacturing Quality Control Best Practices	PG&E Compliance Historical	PG&E Compliance Current
requirement, the Utility requirements are confirmed by Meter Manufacturer before acceptance. Where product requirements are changed, Meter Manufacturer ensures that relevant documents are amended and that relevant personnel are made aware of the changed requirements. NOTE: In some situations, a formal review is impractical for each order. In those cases, the review can cover relevant product information such as catalogues or advertising material.		
Utility Communication		

Meter Manufacturer determines and implements effective arrangements for communicating with Utility in relation to:
 	
• Product information
• Product roadmap and impending changes or enhancements
  ○ Change management: Need to validate and ensure that there are proper documentation and procedures whenever a manufacturing, firmware or design change occurs. This may include ANSI and FCC certification.
  ○ Configuration Management: Need to validate that the supplier is managing the configuration information to know exactly what was shipped and what the configuration is (including the numbering). This should be reflected in the NOS, but need to know that they have a system in place to manage this and resolve discrepancies.
• Manufacturing issues and delays during the project period
• Enquiries, contracts or order handling, including amendments
• Utility feedback, including customer complaints.
	Full	Full

Design and Development Audit Areas		
Design and Development Planning		
Meter Manufacturer plans and controls the design and development of product. During the design and development planning, Meter Manufacturer determines: • The design and development stages. • The review, verification and validation that are appropriate to each design and development stage, and • The responsibilities and authorities for design and development.	Full	Full
Design and Development Inputs		
Inputs relating to product requirements shall be determined and records maintained. These inputs shall include: • Functional and performance requirements. • Applicable statutory and regulatory requirements. • Where applicable information derived from previous similar designs, and	Full	Full

Meter Manufacturing Quality Control Best Practices	PG&E Compliance Historical	PG&E Compliance Current
• Other requirements essential for design and development. The inputs shall be reviewed for adequacy, requirements shall be complete, unambiguous and not in conflict with each other.		
Purchasing Audit Areas		
During the Purchasing process, the Meter Manufacturer ensures that purchased product conforms to specified purchase requirements. The type and extent of control applied to the supplier and the purchased product is dependent upon the effect of the purchased product on subsequent product realization or the final product.	Full	Full
Purchasing Information		
Purchasing information describes the product to be purchased, including where appropriate: • Requirements for approval of product, procedures, processes and equipment • Requirements for qualification of personnel • Quality management system requirements Meter Manufacturer ensures the adequacy of specified purchase requirements prior to their communication to the supplier.	Full	Full
Verification of purchased product		
Meter Manufacturer establishes and implements the inspection or other activities necessary for ensuring that purchased product meets specified purchase requirements. Where Meter Manufacturer or the Utility intends to perform verification at the supplier's premises, Meter Manufacturer states the intended verification arrangements and method of product release in the purchasing information.	Full	Full
Production and Service Provision Audit Areas		
Control of production and service provision		
As applicable, Meter Manufacturer plans and carries out production and service provisions under controlled conditions. Controlled conditions include: • The availability of information that describes the characteristics of the product • The availability of work instructions, as necessary • The use of suitable equipment • The availability and use of monitoring and measuring equipment • The implementation of monitoring and measurement activities The implementation of product release, delivery and post-delivery activities	Full	Full
Validation of processes for production and service provision		
Meter Manufacturer validates any processes for production and service provisions where the resulting output cannot be verified by subsequent monitoring or measurement and, as a consequence, deficiencies	Full	Full

Meter Manufacturing Quality Control Best Practices	PG&E Compliance Historical	PG&E Compliance Current

become apparent only after the product is in use or the service has been delivered. Validation demonstrates the ability of these processes to achieve planned results. As applicable, Meter Manufacturer establishes arrangements for these processes including:
 	
• Defined criteria for review and approval of the processes
• Approval of equipment and qualification of personnel
• Use of specific methods and procedures
  ○ First Article Testing: This is the testing that occurs on the first article of a first design, or major design changes.
  ○ Manufacturing Quality: The circuit boards should be wave soldered and processed according to mass volume quality standards. There should be adequate testing of each board during the manufacturing process to identify manufacturing defects.
• Requirements for records
• Revalidation		

Identification and Traceability		
Where appropriate, Meter Manufacturer identifies the product by suitable means throughout product realization. Meter Manufacturer identifies the product status with respect to monitoring and measurement requirements throughout product realization. Where traceability is a requirement, Meter Manufacturer controls the unique identification of the product and maintains record.	Full	Full
Preservation of Product		
Meter Manufacturer preserves the product during internal processing and delivery to the intended destination in order to maintain conformity to requirements. As applicable, preservation includes identification, handling, packaging, storage and protection. Preservation also applies to the constituent parts of a product	Full	Full
Control of Monitoring and Measuring Equipment		
Meter Manufacturer determines the monitoring and measurement to be undertaken and the monitoring and measuring equipment needed to provide evidence of conformity of product to determined requirements. Meter Manufacturer establishes processes to ensure that monitoring and measurement can be carried out, and is carried out in a manner that is consistent with the monitoring and measurement requirements. Where necessary to ensure valid results measuring equipment is: • Calibrated, verified or both at specified intervals, or prior to use, against measurement standards traceable to international or national measurement standards; where no such standards exist, the basis used for calibration or verification shall be recorded ○ Calibration Testing: Each meter should be tested and calibrated as it leaves the manufacturing process. The calibration results should be captured electronically and provided with the NOS file. The calibration equipment	Full	Full

Meter Manufacturing Quality Control Best Practices	PG&E Compliance Historical	PG&E Compliance Current
should be maintained against a Radian standard and calibrated/checked at least once each shift. • Adjusted or re-adjusted as necessary • Have identification in place to determine the individual meter calibration status • Safeguarded from handling practices and tampering that would invalidate the measurement result • Protected from damage and deterioration during handling, maintenance and storage.		
In addition, Meter Manufacturer assesses and records the validity of the previous measuring results when the equipment is found not to conform to requirements. Meter Manufacturer takes appropriate action on the equipment and any product affected. Records of the results of calibration and verification are maintained.	Full	Full
Measurement, Analysis, and Improvement Audit Areas		
Ensure that the Meter Manufacturer plans and implements the monitoring, measurement, analysis and improvement processes needed to: • Demonstrate conformity to product requirements, • Ensure conformity of the quality management system, and • Continually improve the effectiveness of the quality management system. This includes determination of applicable methods, including statistical techniques, and the extent of their use.	Full	Full
Monitoring and Measurement		
Customer satisfaction is one of the measurements of the performance of the quality management system. Meter Manufacturer monitors information relating to customer perception as to whether the Meter Manufacturer has met customer requirements. The methods for obtaining and using this information are determined by review.	Full	Full
Internal Audits		
Meter Manufacturer conducts internal audits at planned intervals to determine whether the quality management system: • Conforms to the planned arrangement to the requirements of ISO 9000 and to the quality management system requirements established by the Meter Manufacturer, and is effectively implemented and maintained. An audit program is developed by taking into consideration the status and importance of the processes and areas to be audited, as well as the results of previous audits.	Full	Full
The audit criteria, scope, frequency and methods are defined. The selection of auditors and conduct of audits ensure objectivity and	Full	Full

Meter Manufacturing Quality Control Best Practices	PG&E Compliance Historical	PG&E Compliance Current
impartiality of the audit process. Auditors do not audit their own work. The responsibilities and requirements for planning and conducting audits, and for reporting results and maintaining records are defined in a documented procedure. The management responsible for the area being audited ensures that any necessary correction and corrective actions are taken without undue delay to eliminate detected nonconformities and their causes. Follow-up activities include the verification of the actions taken and the reporting of verification results.		
Monitoring and Measurement of Processes		
Meter Manufacturer applies suitable methods for monitoring and where applicable, measurement of the quality management system processes. These methods demonstrate the ability of the processes to achieve planned results. When planned results are not achieved, correction and corrective action is taken, as appropriate.	Full	Full
Monitoring and Measurement of Product		
Meter Manufacturer monitors and measures the characteristics of the product to verify that product requirements have been met. This is carried out at appropriate stages of the product realization process in accordance with the planned arrangement. Evidence of conformity with the acceptance criteria is maintained. Records indicate the person(s) authorizing release of product for delivery to the customer. The release of product and delivery of service to the customer does not proceed until the planned arrangements have been satisfactorily completed, unless otherwise approved by a relevant authority and where applicable, by the customer.	Full	Full
Control of Nonconforming Product		
Meter Manufacturer ensures that product which does not conform to product requirements is identified and controlled to prevent its unintended use or delivery. A documented procedure is established to define the controls and related responsibilities for dealing with nonconforming products. Where applicable Meter Manufacturer deals with nonconforming product by one or more of the following ways: • By taking action to eliminate the detected nonconformity, • By authorizing its use, release or acceptance under concession by a relevant authority and, where applicable, by the customer, and • By taking action to preclude its original intended use or application. • By taking action appropriate to the effects, or potential effects, of the nonconformity when nonconforming product is detected after delivery or use has started.	Full	Full
When nonconforming product is corrected, the product is subject to re-verification to demonstrate conformity to the requirements. When nonconforming product is detected after delivery or use has started, Meter Manufacturer takes action appropriate to the effects, or potential effects, of the nonconformity such as recalls, bulletins, etc. Records of the nature of nonconformities and any subsequent actions taken, including concessions obtained, are maintained.	Full	Full

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Meter Manufacturing Quality Control Best Practices	PG&E Compliance	
	Historical	Current
Analysis of Data		
Meter Manufacturer collects and analyzes appropriate data to demonstrate the suitability and effectiveness of the quality management system and to evaluate where continual improvement of the effectiveness of the quality management system can be made. This includes data generated as a result of monitoring and measurement and from other relevant sources. The analysis of data provides information relating to: • Customer satisfaction • Conformity to product requirements • Characteristics and trends of processes and products including opportunities for preventive action • Suppliers	Full	Full
Acceptance Testing		
Acceptance testing of delivered meters and modules should be conducted in conjunction with ANSI/ASQC Z1.4. Sample lots should be randomly drawn from delivered truck loads and sample tested according to AQL standards. Should the sample fail the initial acceptance test the lot may be retested using more stringent acceptance levels. Should the second sample fail, the entire shipment should be returned to the Meter Manufacturer as non compliant and root cause analysis should be instituted to determine the reason or failure. This testing should be conducted either on-site (just in time sample testing) or at the utility facilities (typical batch sample testing).	Full	Full

5.5.2.2 Meter Installation Standards Findings

Meter Installation Standards	PG&E Compliance	
Best Practices	**Historical**	**Current**
Detailed Approach and Methodology		
The utility must develop a detailed approach, methodology, and standards for AMI meter installations. These requirements will serve as the key drivers in the AMI installation process and ultimately will serve as a major component of the success of the overall project.	Full	Full
A detailed work plan should be developed that includes the specific tasks, milestones, deliverables, and timing. The plan should also include resource ramp up and down and the corresponding equipment delivery schedule that will be needed to match the resource availability for the implementation.	Full	Full
Detailed Project Management Plan		
A detailed project management plan should include the following: • The details of the project team that will be utilized to support the project, and the roles and responsibilities of all of the proposed project members. An organizational chart of the project staff, identifying the number and type of resources needed from both the utility and contractors, along with their roles and responsibilities. Installation Call Center and Field Service support requirements should be included. • The number of full time, part time and contract employees that will be utilized on the project. • If the contractor is involved in multiple contracts simultaneously they should define the ability to support multiple concurrent installation contracts with multiple utilities. • Determine how staff is recruited, including pre-employment screening and background checks from any contractors. • Determine how new staff will be trained and include sufficient knowledge transfer and monitoring • Identified risks and mitigation plan, issues tracking, communication plan (both internal and external) • Detailed Project plan identifying tasks and dependencies • Change management plan should include both impacts to internal resources and external customers • Testing Plan and ongoing quality assurance monitoring/auditing • Equipment handling policy for new and retired assets	Full	Full
Staffing Plan		
Contractors should provide a staffing plan to the utility that demonstrates adequate staffing that will be available throughout the project. Potential contract employees should undergo background checks including driving records and drug and alcohol checks at the expense of the Contractor. This recruitment and retention plan should include details including; staffing requirements throughout the project, management and oversight personnel, external contactors to be utilized, recruitment literature and sources, training for multiple areas, training evaluation, field training etc.	Full	Full

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Meter Installation Standards Best Practices	PG&E Compliance Historical	 Current
Tools		
The contractor is generally expected to provide: • Signage for installation of AMI meters and AMI communication network ○ Some contractors will supply vehicles. Where vehicles are not supplied by the Contractor, the Contractor must ensure that employee supplied vehicles are safe and presentable. • Fire rated safety equipment and safety face shields • Personal Protective Equipment (PPE) and supplies • Tools and supplies for installing AMI meters and AMI communication network • Installer uniforms	Full	Full
In addition to the previous expectations the Contractor should provide a handheld field tool that supports the following functionality: • Field tool shall have ability to read the barcodes on new meters. • Installation tool shall have ability to test network and meter communication. • Field tool should have GPS recording capabilities, although this is not required. ○ The accuracy of the GPS should be 3-5 meters under normal conditions. The accuracy of the Contractor's GPS reading should be verified prior to deployment • Field tool shall have ability to capture and communicate to the Installation Contractor's Meter Management System the meters physical location (GPS coordinates), device location, removed meter number, and removed meter final read, and any field notes and flags/discrepancies. • Installation tool shall interface with the utility's Customer Information and /or Field Order System • The field tool shall be capable of communicating through either the public communications network (e.g. GSM) or be uploaded or downloaded through a docking station. • A field tool shall be configured to support the installation and communication testing of Smart Meters and support the close out of work orders through Work Management System. • The field tool shall be capable of initiating a new work order in the field if one is unavailable for the work. • The field tool shall be capable of verifying that the Smart Meter is working properly. • The field tool shall be able to initiate a meter self-test and support the trouble shooting of the meter through a display of meter diagnostics. • The field tool shall be capable of capturing manual field notes and attaching these notes to the work order. • The field tool shall identify if there is a discrepancy between a	Partial Field tool cannot communicate directly with meter	Full

Meter Installation Standards	PG&E Compliance	
Best Practices	**Historical**	**Current**
meter ID and associated address. • The field tool shall be able to communicate with the Smart Meter through an optical port or through RF communications. • The field tool shall perform all "normal" meter check functions e.g. validates read and notifies installer if read is outside specified variance, etc.		
Installer Training		
Meter Installation training should be provided to all meter Installers. Training should include but is not limited to the following subjects: • Customer interaction rules and guidelines • Utility meter replacement safety rules • Field safety • Identifying hazardous conditions • Meter reading accuracy • Field work practices • Defensive driving • Identifying potential meter tampering and energy diversion	Full	Full
Contractor should provide revenue protection training to all AMI meter installation technicians. This training should include how to spot meter tampering and energy diversion when replacing meters, safety concerns of revenue protection, procedures and policies dealing with revenue protection, safely handling customers who are not in compliance with the law, etc.	Full	Full
Identification		
All Contractor employees and subcontractors should be clearly identifiable as contractors. Identification badges should be utilized to enforce contractor identification and must be worn at all times while in the field. All vehicles should clearly display company logo and information.	Full	Full
Communication		
The Utility should be responsible for all communications to the public relating to the installation of the new AMI meters. A joint communication plan should be developed by the Contractor and utility for deployment of meters. All Contractor employees should be provided with communication materials and background information on the project and the AMI meters. All Contractor employees should be provided with phone numbers and contact information should customers request additional information	Full	Full
An attempt should be made to advise customers that their meter is being changed and that there will be a short interruption to service. The Contractor employee should ensure that the customer representative is of sufficient age and capability to understand the impending activity. In the event the customer is not available at the time of the installation and the Contractor can safely access the meter without interference, a door hanger or flyer should be left at the premise following the successful installation advising the customer of the installation or, in the case of inadequate access or safety, advising	Partial Procedures based upon electromechanical meter installation	Full

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Meter Installation Standards	PG&E Compliance	
Best Practices	**Historical**	**Current**
the customer to contact the Utility or call center.		
Installation Plan		
Contractors should work with the utility to develop a plan for the installation of the AMI meters that includes any pilot implementations and the full meter rollout. The installation plan should detail the hiring procedures for employees, the training methodology/content, detailed billing blackout days (days before and after billing cycle where meter should not be replaced), meter delivery schedules, AMI communication network deployment and target installation levels	Full	Full
The installation plan should ensure that the AMI communication network is in place and operational prior to the installation of any AMI meters within the coverage of the AMI communication network.	Full	Non-Compliant PG&E deployed WAN/LAN collectors prior to meter deployment but felt it was more economically viable to install meters first.
The Installation Plan should include the guidelines for when the Contractor has exhausted efforts for installing a meter and turns the work over to the utility. The process for the Utility to resolve UTC (unable to complete) cases should be included in this Installation Plan.	Full	Full
This plan should be jointly developed as early as possible and continuously updated and reviewed by both parties at an agreed upon interval	Full	Full
Key Performance Indicators (KPI)		
Key Performance Indicators (KPI) should be jointly developed by the Contractor and utility to provide a consistent objective measure of installation processes' performance. Daily reports should be generated and distributed by the Contractor to keep utility informed as to the installation progress. A standard set of KPI's typically used to ensure the project is meeting the defined objectives should include: • Project Schedule Compliance (Meters planned vs. Meters installed, AMI communication network devices planned vs. installed) • Meter and equipment failure (as a % of all devices) • Meter access failures (as a % of all attempts) • Unable to Complete (as a % of all planned installs) • Customer Complaints (response and resolution times) • Meter socket/panel unfit for installation (as a % of all attempts) • Safety breaches and employee accidents • Quality of workmanship • Route Saturation (% of meters installed on a route within the first billing cycle)	Full	Full
The Contractor should continually monitor the process to ensure the	Full	Full

Meter Installation Standards	PG&E Compliance	
Best Practices	Historical	Current
identification and resolution of commissioning and provisioning process issues. All installation data supplied back to utility should be validated through the appropriate validation criteria (Hi/Low, Missing, meter/service point relationship, etc.). Exceptions should be flagged and corrected (where possible) prior to upload to utility. All completed, and failed, installation work orders should be uploaded to the utility by midnight of the installation day to ensure all data can be properly processed and validated within one day of the installation.		
Exchange Meter		
Contractor's installers should complete the following steps to physically install a meter: • Attempt to contact each customer at the time of installation. If unable to directly advise the customer, a door hanger should be left at the premise advising the customer of the installation. • Ensure service is not interrupted without customer notice on accounts with medically essential equipment (identified on deployment file). If the customer cannot be directly advised, alternate arrangements (e.g., appointment) should be made with the customer. Where a medical condition is flagged, the Installer must ensure that the person answering the door is of adequate age and capability to understand that electric service will be interrupted. If such person is not available, the installer should skip the installation and arrange for a follow up. • Assess overhead / underground feed to the meter for damage and suitability of installation. • Assess the meter enclosure and lid for damage and suitability of installation. • Remove the existing meter seal, seal ring and meter enclosure lid. • Visually examine the meter enclosure and meter jaws for damage and suitability of installation. • Refer any damaged meter enclosures / facilities that preclude safe installation to their Field Supervisor for documentation / repair (see Customer Repair section below). • Identify and report current diversion condition found. (See Digital Imaging - Current Diversion section). • Capture removal reading and remove the existing meter. All readings that fail high/low validations should require that the meter be re-read and the reading be re-entered in the handheld. • Re-examine the meter enclosure and meter jaws for damage and suitability of installation. • If a meter is currently disconnected, the new AMI meter should be set in a disconnected state. The AMI meter should be set to the disconnected state before installation of the meter • Install meter and capture meter readings from the set meter. Verify there is no service caution flag evident on bottom of display. If meter display is blank, displaying 88888, presenting a service caution flag, or is otherwise not functioning properly, verify	Full	Full

Meter Installation Standards	PG&E Compliance	
Best Practices	**Historical**	**Current**
voltage is correct at socket. • If socket is dead and account is inactive, installer should install meter disconnect blank. • If voltage is correct, apply Unsatisfactory Performance Report (UPR) label to defective meter with applicable comments and set another AMI meter. • Capture new meter and module data from device bar codes. Meters whose meter-module serial number combinations fail validation against the meter-module relationship table provided by utility should not be installed. These meters should be tagged separately and returned to utility for investigation / correction. • New meters should be set as the existing meter was found (e.g., on, off) and their installed disposition communicated via the installation file. • New meters set "off" should have the Meter disconnect status set to disconnected. • Replace meter enclosure lid, replace lock (if present) • Re-seal the meter enclosure lid and seal ring with a new seal • Cleanup work site		
Premise Access		
In instances where the installation cannot be completed due to access (a skip), the installer should leave a door hanger explaining the installation was attempted and instructing the homeowner to call the appropriate call center (either Contractor or Utility) to set a convenient time for the installation to be completed. Call Center contact number should be listed on the door hanger.	Full	Full
All skips should receive up to three calls from Call Center requesting an appointment. These calls should span out at least over a one week period, with at least one attempted after normal working hours.	Full	Full
If after an agreed upon (typically three) in-person attempts and an agreed upon (typically three) telephone attempts, the installation has not been completed, the customer should be returned to utility as UTC (unable to complete) and the Utility is responsible for utilizing its standard processes for obtaining access to the customer premises for meter exchange.	Full	Full
Access to System Data		
Contractor should work with utility to provide online access to meter installation and inventory data. Contractor should provide daily reports from their WMS (work management system) and inventory management system that contains all of the data relating to the meter exchanges. Digital photographs of the meter prior to removal should be made available to utility. Contractor should identify all exceptions and identify accounts where premise access is still pending.	Full	Full
Reporting Framework		
Contractor should provide daily and weekly reports to utility that details project activity and provides status as defined by utility and the Contractor.	Full	Full
A reporting framework should be developed by the Contractor for use	Full	Full

Meter Installation Standards	PG&E Compliance	
Best Practices	**Historical**	**Current**
by the Contractor and the Utility. Reports should be automated and include items such as: • Planned vs. installed AMI meters • Planned vs. installed AMI communication network devices • UTC instances • Inventory levels (by meter base and form) • KPI's • Status reports • Tampering and Diversion cases • Customer complaint cases • Employee accident cases • Staffing levels • Other reports as defined in planning phase by Contractor & Utility		
The ability for the utility to run ad hoc reports at any time should be provided by the Contractor.	Full	Full
The Utility should be provided access to the Contractors databases for access to service orders, new installation information and meter exchange information	Full	Full
Access to revenue protection information and site access information should also be provided from the Contractors database	Full	Full
Daily and Weekly progress meetings should be held to address issues and concerns.	Full	Full
Customer Service/Complaints		
Contractor should employ a work force management and customer service system to track and resolve customer complaints. The customer service procedure should document the process employed by Contractor field technicians and Contractor call center personnel when responding to customer service requests.	Full	Full
This procedure should outline the data requirements and tracking process to complete service calls. • Contractor should contact customer within the two business days of receiving the complaint. • Contractor should forward an email to Utility the same day contact is made outlining arrangements made with customer. • Contractor should forward an email to the Utility outlining the actions taken and/or the results of their investigation • Contractor should forward customer complaints to the appropriate utility group, where the customer complaint is outside of the guidelines and responsibility of the Utility.	Full	Full
A summary of the customer complaints should be included in the weekly project summary, with details made available upon utility request	Full	Full
Inventory Management		
Tracking		
The Contractor or the Utility should supply an inventory tracking application and associated business processes for the receipt and tracking of the AMI meters and AMI communication network equipment. This application should track meters and equipment	Full	Full

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Meter Installation Standards	PG&E Compliance	
Best Practices	Historical	Current
through the meter lifecycle, from the receipt of the meter, sample testing, in route, received in warehouse, in inventory, assigned, on truck, installed, retired/scrapped etc. Tracking should be provided to the warehouse site location(s) and be made accessible to utility personnel.		
The Contractor or Utility should utilize an inventory management application to manage the depletion and replenishment of meters, equipment, parts, and supplies. Material shortages should be known in advance of a deployment and this information should be provided to utility. The inventory management application should be able to track small inventory items such as meter seals, tamper tools, miscellaneous hardware etc. Daily inventory reconciliation should be generated to ensure adequate staffing levels of materials and supplies. Any discrepancies in inventory should be investigated and remedied in an expedient manner.	Full	Full
Security		
Contractor or Utility should maintain security at each of the installation warehouses to ensure the security of the inventory. The Contractor is responsible for the security of Contractor held inventories. The warehouse employees should have adequate training on warehouse equipment including forklift training and safety procedures.	Full	Full
Material and Equipment Liability		
All equipment that is provided by Utility such as the meters and miscellaneous equipment are the property of Utility and must be returned at the completion of the project. The Contractor, if appropriate, should assume responsibility for any damage to or loss of equipment from the Utility including; meters, hardware, property or other supporting equipment	Full	Full
Tools		
The Contractor should furnish all necessary tools, test equipment and communication equipment necessary to complete the meter installations. It should be the responsibility of the Contractor to supply the technicians with these tools.	Full	Full
Diversion Detection and Resolution		
If a Contractor identifies a situation where tamper or energy diversion is suspected, the Contractor should contact a designated Utility representative or Contractor supervisor and skip the installation so that Utility personnel can investigate the diversion condition. This is the best practice as Contractor personnel are not adequately trained to investigate and resolve diversion situations and should not be put into the position of dealing with these situations.	Full	Full
New Meters		
Notice of Shipment files (NOS) should be received electronically from the meter manufacturer and not handled manually. This file contains the type of meter, meter serial number, communication module and communication ID. This information should be updated in the Utility's meter tracking system and inventory system. Meters are received by the Contractor at the individual warehouses, and appropriate inventory systems are updated.	Full	Full

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Meter Installation Standards	PG&E Compliance	
Best Practices	**Historical**	**Current**
The Contractor should work with the Utility, and the meter vendor to develop a project delivery plan. The plan should include the quantities of meters needed, meter types, needed delivery locations and dates. The plan should be updated on a regular basis throughout the project. The Contractor may also utilize a dedicated system to accomplish the deployment and provisioning of the AMI meters.	Full	Full
Contractor may receive pallets of meters directly from the meter manufacturer. The Contractor should send the utility a statistically valid sample of meters for testing. Alternatively, the Utility may arrange for Source Inspection of the meters such that sample testing is performed as meters complete the manufacturing process and prior to the shipment of the meter. The Contractor should verify that the shipment quantity received matched expected quantity, inspect shipment for damage, and should enter all meter update information into the meter inventory system. The Contractor should also provide utility delivery receipt for the shipment.	Full	Full
Meter acceptance testing is performed on a statistically valid sample batch of meters and if the batch is accepted the inventory status is updated. If any meters are damaged or do not pass initial acceptance testing, this information is updated in the inventory status and relayed to the Utility. The Utility should have access to the inventory system.	Full	Full
Customer Repairs		
Contractor or Utility should repair minor meter socket damage as they are identified or occur during the implementation of the project. An installer should notify their field supervisor when a potential site is identified as damaged during the course of meter exchange	Full	Full
The field supervisor should inspect the site, document the damage with a digital camera, and determine the level of repairs needed. • Premises that require electrical repairs before meter exchange can be completed should scheduled for repair with an utility preferred electrical contractor. Contractor and/or their designated electrical Contractor should be responsible for obtaining any permitting or licensing required for performing repairs. • Where damage is identified which would result in unsafe meter exchange and where the damage is greater than within the scope of the utility Contractor repair, the Contractor should immediately notify a Utility field supervisor and remain at the site until the supervisor arrives. The Utility field supervisor will work with the customer to resolve the unsafe condition. • Field supervisor should pull the existing meter, blank the socket and hang a yellow caution tag for any extreme wiring problem that is deemed unsafe and hazardous. Customer should be notified of the needed repairs. • Contractor should notify utility in the event utility crew assistance is required for repairs (e.g., service disconnect/reconnect) or service is terminated for an unsafe/hazardous condition. • All repairs need to meet NESC standards and comply with applicable local, county or city ordinances.	Full	Full

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Meter Installation Standards	PG&E Compliance	
Best Practices	**Historical**	**Current**
• Repairs should be completed within the same day unless necessary parts are not available.		
Defective Meters		
Meters that are installed and deemed as defective should be labeled and returned to the warehouse. The Utility should be informed of all defective meters at least on a weekly basis.	Full	Full
The Contractor's technicians should verify voltage and service conditions prior to replacement with another meter. If there are any issues with the installation, or there are issues with the enclosure, the Contractor should be responsible for correction of the issue. If any substandard service conditions are encountered, a qualified electrical Contractor should be contacted by the Contractor and the Contractor or Utility should coordinate all work involved in repairing the condition.	Full	Full
New serial numbers for the meter and communication module should be recorded in the handheld device and this information uploaded to utility. Metrics should be maintained by the Contractor on all defective devices.	Full	Full
Data Exchange		
The Utility and Contractor should exchange data in a mutually agreed upon format daily. The mode of transfer should be determined by the Contractor and utility.	Full	Full
Contractor should hold select installation records for the purposes of obtaining digital imaging, verifying out reads and remedying potentially erroneous data. Contractor should, however, in all cases send all completion data to utility by midnight after installation.	Full	Full
The Contractor should provide for a verification of the closing read of the removed meter. The first verification of the read should occur as part of the meter exchange process and is part of the validation algorithms in the handheld field tool to compare the closing read against a high/low check. A second verification should occur in the Contractors meter handling facilities. This second verification can be a second reading of the meter and comparison against the reported closing read or a digital image of the closing meter read.	Partial PG&E verification takes place in the handheld. Reading is not re-verified upon reaching meter handling facility	Partial PG&E verification takes place in the handheld. Reading is not re-verified upon reaching meter handling facility
The following files should be shared with the Contractor through a secure site on a daily basis: • Deployment File – Extract from Customer Information System containing customer information, meter type, form, and class data, and meter reads • Installation File – Listing of sites to be installed • AMI Meter Marriage File – File of Meter/Communication module relationships • UTC File - File of dates when a meter cannot be changed out.	Full	Full

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5.5.2.3 Meter Equipment Safety

Meter Equipment Safety Best Practices	PG&E Compliance	
	Historical	Current
Meter Equipment and Installation Safety training should be provided to all meter Installers and technicians	Full	Full
Training should include but is not limited to the following subjects: • Utility meter replacement safety rules • Meter testing rules and procedures • Field safety • Identifying hazardous conditions • Identifying potential meter tampering and theft • Field work practices • Defensive driving	Full	Full
Safety meetings should be conducted on a weekly basis. The content and dialog of these safety meetings should be recorded and included in the monthly reports to the utility	Full	Full
Contractors should provide a written Code of Safety Practices for review and approval by the utility.	Full	Full
Standards, regulations, and specifications related to Meter Equipment Safety include: • OSHA Standard 1910-269 Electric Power Generation, Transmission, and Distribution, Appendices A & B • ANSI C2-1993, National Electrical Safety Code. • ANSI/IEEE Std. 100-1988, IEEE Standard Dictionary of Electrical and Electronic Terms. • ANSI/IEEE Std. 516-1987, IEEE Guide for Maintenance Methods on Energized Power-Lines. • ASTM D 120-87, Specification for Rubber Insulating Gloves • ASTM F 496-93B, Specification for In-Service Care of Insulating Gloves and Sleeves. • ASTM F 1236-89, Guide for Visual Inspection of Electrical Protective Rubber Products. • ASTM F 1505-94, Standard Specification for Insulated and Insulating Hand Tools. • ASTM F 1506-94, Standard Performance Specification for Textile Materials for Wearing Apparel for Use by Electrical Workers Exposed to Momentary Electric Arc and Related Thermal Hazards.	Full	Full
Personal Protective Equipment (PPE) required for to safely remove and replace residential meters include: • Flame retardant shirt meeting ASTM F 1506-94 • Leather gloves for non energized work • Rubber gloves rated at 1000 volts with leather gauntlets meeting ASTM D 120-87 for work on energized equipment • Safety glasses for work on non energized equipment	Full	Full

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Meter Equipment Safety Best Practices	PG&E Compliance	
	Historical	Current
• Full face protection while inserting or removing residential meters		
Steps required to safely remove and replace a residential meter installation include: • The installer will visually inspect the weather head and meter panel for signs of tamper, damage or excessive wear. The installer should verify adequate and safe access to the meter panel. • The Installer will remove the meter or circuit panel door slowly. • If there is a bypass or a main breaker present at the meter, the Installer will operate the bypass or main breaker before removing the meter. • The Installer should examine the inside of the meter box for danger, theft, animal or insect infestation or other irregularities. • The Installer should take a voltage reading, checking for proper voltage and back feed, with an approved device. • The Installer will place both gloved hands on the meter. One hand will be placed on the bottom of the meter and will be used to steady the meter. The other hand will be placed on the top of the meter. The top hand will be used to unseat the meter by applying slow and steady downward force until the meter is released from the top meter jaws and rocks back into the bottom hand. The Installer will then pull the meter away from the meter base removing it from the bottom meter jaws. • The Installer will examine the inside of the meter panel for danger or irregularity. The Installer will examine wiring, connections, lugs, blade receivers and the meter block. • If the meter socket, block and contents appear to be in good condition, the Installer will approach the meter base with the new meter, confirming the new meter is the proper voltage, form and class for the installation • The Installer will place the meter in the front of the meter base slowly. The Installer will look around the side of the meter in an effort to properly align the bottom two blades of the meter with the blade receivers. The Installer will apply even pressure until the bottom two blades are inserted into the blade receivers. Once the bottom blades are in place the Installer will apply even pressure both inward and upward until the two top blades are secure. The Installer should not hit or strike the meter with any tool. • If a bypass or main breaker was opened during installation, the Installer will close them to energize the meter. • The Installer will then replace the meter cover and seal the	Full	Full

Meter Equipment Safety Best Practices	PG&E Compliance Historical	PG&E Compliance Current
installation with utility provided meter seals.		

5.5.2.4 Meter Deployment Findings

Meter Deployment Best Practices	PG&E Compliance	
	Historical	Current
Meter deployment for an AMI system should take into account the customer types and geographic areas where the Business Case benefits are the greatest. For instance, one utility may find significant pay backs by deploying its system first to transient customer accounts such as, apartments, college areas, and trailer parks to eliminate field service work involved with turn on and turn offs. Another utility may find that the largest benefit is to implement time of use and critical peak pricing rates to Commercial and Industrial customers. Either scenario is may be valid and drive the meter deployment strategy in different directions.	Full	Full
Communication Network Deployment		
AMI Communication Plan The AMI Supplier should create a network plan leveraging topology maps, density figures and RF propagation characteristics to determine the ideal location for the AMI Communication Network devices for optimal coverage of the meters. This plan will guide the deployment of network and metering devices. This network plan should be updated regularly as device installations are completed.	Partial RF Propagation studies not conducted – PG&E indicated not needed	Partial RF Propagation studies not conducted – PG&E indicated not needed
Provide Redundancy Wherever possible, the AMI network plan should provide for redundancy between collectors such that multiple collectors or concentrators will support any single AMI meter. The level of redundancy will depend on the meter density in the area, the priority of the customer base in the area, and the maximum number of possible hops, if employing a mesh network AMI system.	Full	Full
Deploy WAN/LAN Collectors Prior to Meter Deployment. By installing the communication backbone prior to meter deployment the majority of the Smart Meters will have immediate communication with the AMI Head End. This methodology ensures that meters can complete the provisioning process as quickly as possible and eliminates additional visits to the customer premises for manual meter reading. This methodology also allows for rapid discovery of communication holes where repeaters or additional collectors may need to be installed and allows for the quick transition of meter reading personnel.	Full	Partial PG&E deployed WAN/LAN collectors prior to meter deployment but felt it was more economically viable to install meters first.
Develop Methods and Procedures for Collector Site Selection	Full	Full

Meter Deployment Best Practices	PG&E Compliance	
	Historical	Current
Develop a comprehensive Methods and Procedures (M&P) document for site survey and selection process to standardize the field team activities. This M&P will help vendors and sub-contractors adhere to the policies and best practices outlined by the utility		
Use Pole Mounted Equipment AMI Communication Network devices for an RF network should be mounted between 15 and 20 feet above the ground to provide for optimal coverage as well as guard against unauthorized access. External antennas can be utilities to address locations with marginal coverage. External antenna options can help improve received signal strength and increase the range of AMI coverage	Full	Full
Site Surveys Installation sites for AMI Network Devices, as determined from the Network Plan, should be surveyed prior to scheduling the installation. The survey of the candidate site will determined whether the device can be safely and securely installed at the desired location (some distribution poles may be cluttered and provide for insufficient climbing space) and will identify any special permitting or access requirements. Depending upon the communication technology and AMI provider recommendations, wireless coverage measurements may be required to validate the communication potential of the site against the RF propagation predictions. Fade margins, signal strength requirements, etc. should be provided by the AMI vendor and utilized in these surveys. Ensure no possibility of physical obstruction and analyze foliage growth.	Full	Full
Meter Deployment		
In addition to following the practices delineated in the Meter Installation Standards document meter deployment practices should include the following		
Develop Meter Deployment Schedule Develop a meter deployment schedule that takes into consideration the billing cycles of the meters in the geographic area to be deployed as well as the AMI Communication Network deployment plan. Exchanging meters close to the bill date can create errors in billing. Ensure that the exchange schedule allows sufficient time for the meter exchanges to be processed into the customer billing system prior to billing and do not start until billing has completed for that route.	Full	Full

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Meter Deployment Best Practices	PG&E Compliance	
	Historical	Current
Develop Meter Deployment Communication Plan A Meter Deployment Communication Plan should be developed to ensure that all stakeholders are informed of the deployment schedule and activities. The Communication Plan should include the use of letters, bill inserts, door hangers, post cards, and mass print and communications media. Stakeholders should include regulatory agencies, local government, business associations and civic groups, customers impacted, and internal communications with employees and Contractors. The Communication Plan should also include regular communications to the local police and fire departments.	Full	Full
Provide Meter Rerouting Software As the meter exchange process increases across the utility a Meter Rerouting Software package is generally needed to properly transition meter reading resources and create new meter routes that ensure that skipped or delayed meter exchanges are read on the normal billing cycle.	Full	Full
Distribute Meter Warehouses and Exchange Centers Across the Service Territory. Locate the meter inventory warehouses and installation centers across the service territory to minimize installation crew travel time.	Full	Full
Perform Parallel Reads During Initial Implementation Performing manual meter reading on the communicating Smart Meters during the initial implementation or pilot phase provides verification that the AMI system is tracking with the manual reading system. This should be done for no more than one or two months to gain confidence in the AMI System and only on a small representative population of the customer base. The MDMS should be able to capture both the manual read and the AMI reads and automatically verify the data is consistent from both sources. When discrepancies are found the MDMS should automatically open a work order for an analyst to resolve the discrepancies.	Full	Full
Develop Route Acceptance Procedure A process map that defines the route closeout / acceptance procedures and clearly identifies the key steps that should lead to utility's acceptance at the route level should be jointly developed by the Utility and Contractor. Routes or areas that meet the agreed upon saturation, quality and readability	Full	Full

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Meter Deployment Best Practices	PG&E Compliance	
	Historical	Current
threshold should be delivered to Utility for inspection and acceptance. The MDMS should track the process through to complete route acceptance and generate a notice to the CIS that manual meter reading of the route is no longer required. The MDMS should orchestrate the process of route acceptance as part of the AMI meter provisioning.		
Automate Provisioning process A process map that defines the meter installation lifecycle including the provisioning process should be documented along with process monitoring tools that provide a view into the work-in-process at each stage of the lifecycle. The installation life cycle should include planning, scheduled, installation in process, installed, communicating, first readings validated, manual reads verified, route accepted and billing cut-over completed. The status should be tracked both by individual meter and by route. The MDMS should orchestrate this process and track the status of each meter through the process. The MDMS should automate the provision of meter configurations related to tariff or data to be collected. Any exceptions identified during the processing should trigger a work order for resolution. Comprehensive reporting of the numbers of exceptions and issues with the installation lifecycle should be used to ensure that issue and exception management processes are working and that the installation process is meeting quality and agreed service levels.	Full	Full
Installation Audit Process The installation process should be audited with a manual read at some point after the route acceptance and cutover to AMI billing. This process should verify that the meters inspected are at the right premise, that the AMI readings are consistent with the meter display and that no error codes or meter exceptions are displayed. Audit inspection should also check for signs of diversion.	Full	Full

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5.5.2.5 Meter Data Management Interfaces Findings

Meter Data Management Interfaces	PG&E Compliance	
Best Practices	Historical	Current
Meter Data Management System (MDMS) interfaces and integration are keys to a successful AMI implementation. Consideration should be given to the following:		
Data Strategy: Identify all the sources of data into the MDMS and all potential users of the data maintained within the MDMS. For each data user, identify the frequency and latency of the data request.	Full	Full
Users: Identify the users of the MDMS who will require direct interface via the user interface or ad hoc query.	Full	Full
Plan the technical architecture and application solutions with flexibility and adaptability in mind to choose a best-in-class architecture to accommodate inevitable changes.	Full	Full
Establish an integration standard to be followed whenever possible. Best practices recommend that this should be compliant with the IEC 61968-9 interoperability standards. Best practices recommend that this should be web services	Partial PG&E provided documentation that it was employing a set of interoperability standards for MDM Interfaces.	Partial PG&E provided documentation that it was employing a set of interoperability standards for MDM Interfaces.
Deploy a service-oriented architecture (SOA) to deal with integration challenges and provide a highly-adaptive architecture. If consistent with the overall IT standards and architecture, this should be consistent with a three tier Enterprise Service Bus (ESB) architecture with appropriate firewall and DMZ security features dictated by system access requirements. Batch integrations should be minimized in consideration for real-time interfaces and integrations	Full	Full
The MDMS should provide standard adapters to each AMI head end system, MV-90 and the Utility's manual meter reading system to ensure that the MDMS is receiving all meter data from all sources and can be the central repository for all meter data	Full	Full
Identify all non-billing sources of meter data, all unmetered service points and other meter data sources to ensure that all meter data can be centralized in the MDMS	Partial Compilation of non-billing sources of meter data and unmetered service points provide information and data around unbilled revenues and non technical losses	Partial Compilation of non-billing sources of meter data and unmetered service points provide information and data around unbilled revenues and non technical losses
MDM needs to support load balancing and leverage multi-threading capabilities in order to effectively take advantage of scalability provided by the inexpensive addition of application	Full	Full

Meter Data Management Interfaces	PG&E Compliance	
Best Practices	Historical	Current
servers.		
The system should be designed with the use of a meta-data layer, to enable the business users to add new database objects and attributes and to change relationships without the need for database table or structure changes	Full	Full
Develop an Information Technology Road Map indicating the priorities and integration timing of systems with which the MDM will need to interface.	Full	Full
As a general rule the following are systems that must be considered for interfaces with the MDM: • AMI • Manual Meter Reading • C&I Meter Reading (e.g. MV90 or equivalent) • Meter Asset Management System (MAMS) • Customer Information Systems and Billing • Customer Web Portal • Internal Meter Data Portal • Data Warehouse • Mobile Workforce Management including mobility • Outage Management • Load Management System (Demand Response Control) • Geospatial Information System (GIS) • Distribution Management System (DMS) • Settlement Systems • Load Research • Energy Forecasting	Full	Full
Implement MDMS before the deployment of AMI. This will provide great insight, monitoring, validation, presentation, and auditing capabilities for all AMI meter technologies being deployed. If MDMS cannot be implemented prior to the start of deployment, ensure that all pre-existing AMI meters are properly migrated to the MDMS.	Full	Full
To prepare for an AMI deployment, conduct a pilot program or phased implementation approach with a limited number of meters (e.g. 5,000 meters) to MDMS prove functional and operational viability and smooth integration across key systems	Full	Full
Correlate AMI meter events and alarms with VEE and CIS audits and checks for automated exception handling	Full	Full
Before the full project is commissioned, perform a full performance scalability test to prove operational functionality	Full	Full

5.5.2.6 Validating, Estimating, and Editing for Monthly and Interval Data Findings

Validating, Estimating, and Editing for Monthly and Interval Data Best Practices	PG&E Compliance	
	Historical	Current
At a minimum, VEE must be performed following the generally accepted validation tests of the California Interval Data VEE Rule Set (Revision 2) such as: • Missing Interval Check • Missing Intervals Due to Power Outage • Consecutive Zero Check <May not be used for residential accounts> • Maximum Demand Check • Negative Value Check • Static Value Check • Spike Check <May not be used for residential accounts> • Sum Check • Time Change Check • Meter operational integrity or health check flags and error code	Partial Maximum Demand check is not currently being validated; however this is only important on Demand billed customers (typically C&I).	Partial Maximum Demand check is not currently being validated; however this is only important on Demand billed customers (typically C&I).
The specific validation and estimation rules should be applied to different groups of customers or meters based on the applicability and criticality of those rules. As an example, residential customers do not require a Spike Check or a Watt/VAR validation, while a commercial customer does require a Spike Check and Watt/VAR validation	Full	Full
There needs to be a simple way to group customers together for VEE, and even the ability to include customers in different groupings for different purposes. Groupings and processes that should be addressed include: • Revenue Protection Analysis • Customer Load Profiles (Rate Analysis and Estimation Purposes) • Geographic Analysis (i.e., Loading on Substation, Distribution Circuit, Line Segment, Transformer, etc) • Settlements (Based upon different market rules)	Partial PG&E provided documentation indicating partial compliance with stated practice	Non-Compliant Historically this capability was deployed; however it was de-activated due to issues with the system.
There needs to be a automated process to group meters together that will use the same VEE rule set. VEE rules should be defined for the purpose of ensuring data integrity and not as a substitute for customer usage or behavior analysis. Validated data may be used separately for load research, customer segmentation analysis, rate design, settlements, energy forecasting and procurement and numerous other applications. Use of VEE processes to drive analytic functions inappropriately obscures the primary data integrity objective.	Full	Full
Meter data from AMI system must be properly validated to	Full	Full

Validating, Estimating, and Editing for Monthly and Interval Data Best Practices	PG&E Compliance	
	Historical	Current
insure accuracy and identify gaps, estimated where gaps or invalid data is identified and finally, manually reviewed and edited where automated estimation routines are not applicable. This is the purpose of meter data VEE. The purpose of interval data validation is: • Identify meter errors or conditions to ensure that later calculations are performed correctly • Identify data mapping and identification errors • Identify data recording or transmission errors • Identify service or usage exceptions • Identify missing intervals		
After full implementation the MDMS should replace the existing pre-bill functions within the CIS.	Partial Current plans are to enhance their billing system after full implementation.	Partial Current plans to enhance billing system after full implementation
MDMS should handle all meter reading data validation, high/low edits, and estimation. It should provide parameter based, user defined validation and estimation rule processing.	Full	Full
MDMS must provide an on-line method, with workflow, resolving validation errors rather than reports.	Partial Validation performed manually in some areas.	Partial Validation performed manually in some areas.
MDMS will perform all pre bill edit functions and be the "system of record" for energy usage. MDMS must be utilized for: • Register read and interval data validation; • billing cycle validation (pre-billing validation); • estimation process including: • automatically estimate meter data to fill in gaps in meter data brought in from integrated AMI systems; • flag estimated data as such; • capability to notify users and systems that meter data has been estimated; • estimation routines used to fill these gaps shall be customizable by the user; • allow the user to define and select the estimation routine needed for a particular meter or group of meters; • configurable to limit the number of intervals that can be estimated; • able to report the number of meters that were estimated and the amount of estimated data for each meter.	Full	Full

Validating, Estimating, and Editing for Monthly and Interval Data Best Practices	PG&E Compliance	
	Historical	Current
• Permit manual data editing by authorized users; • managing manual editing work processes and priorities; • maintain data versioning and the ability to recreate data from prior versions; • support standard versus configurable flags; • provide extensive audit logging and tracking records for added/edited/deleted data; • prioritization of editing rules; • acknowledgement triggers and messaging capability; • summarize interval data for billing determinants (e.g. peak, off-peak, and critical peak usage quantities for a given month that the billing system can then use to calculate the bill); • able to report on edited interval data, including original and new values, reason, process, and user. • Generate changed data notifications when data previously used for billing has been updated or changed.		
The system should allow the utility to set up or change data validation and estimation rules, grouping methods, and alarm/event notifications without modifying source program code and without any proprietary language skills	Full	Full
The VEE process must automatically perform most functions without costly manual intervention that creates opportunities for human errors. VEE processing should be performed as data is received so that exceptions can be identified well in advance of billing and to limit the duration of field metering problems.	Full	Full
Under most circumstances data should be automatically estimated. These include: • Missing intervals due to interrupted communications • Missing intervals due to power outage • Missing intervals surrounding a meter exchange	Full	Full
Estimation processes should support configurable rules for estimating based on historic usage patterns (profiles) and the selection of like day types for determining the usage profile for the estimate. When historic usage isn't available the process should be able to utilize a standard profile (class profile) that represents standard metered usage patterns for the group. Estimated interval data should be scaled to ensure that interval usage totals are consistent with the total usage represented by register reads for the same period. If no register reads are available estimated intervals should be flagged as un-scaled.	Partial Estimation routines are outside best practice tolerances.	Partial Estimation routines are outside best practice tolerances.
Circumstances requiring manual intervention include:	Full	Full

Validating, Estimating, and Editing for Monthly and Interval Data Best Practices	PG&E Compliance	
	Historical	Current
• Meters left in Test Mode • Meter exchanges without sufficient register readings or timestamps for the change • Maximum demand validation failures (indicate service connection issues) • Consecutive zeros or static values • Meters reporting health check failures		
Validation processes should also flag exception conditions that may indicate pending failure conditions even if the meter data is otherwise acceptable. Flagged conditions should be reported and acted on to ensure data degradation does not occur. Circumstances where data may be validated and flagged include: • Meter Time Change – excessive time changes indicate potential failures • Excessive missing intervals – generally a communications failure • Meter health check – data may be otherwise valid but meter failure is imminent • Group flicker counts by Substation, Distribution Circuit, Line Segment, or Transformer	Non-Compliant Meter conditions have lacked appropriate flags.	Partial PG&E has recently begun to flag meter conditions that may lead to metering issues and failure and seems to be coming into compliance with this stated practice.
The VEE process must recognize the importance of timing. Work flows should be scheduled and/or triggered by other events, such as data loading Data should be loaded throughout the day with VEE being done as it is loaded and perform sum checks and estimations with all available data.	Full	Full

5.5.2.7 Account Billing

Account billing must be both accurate and timely. Accuracy is obtained through quality meter reading data that has been validated or edited, and estimated if there are interval gaps and billing is based on usage values calculated from interval reads. Where there are multiple meter reading systems in place (such as during the implementation phase of an AMI system) there should be multiple levels of audits for accuracy.

These billing audits should be performed utilizing both pre-bill and post-bill audits within the Customer Information or Billing System (CIS) or though the Validation, Editing and Estimation (VEE) process for AMI captured reads being processed though the Meter Data Management System (MDM). During the implementation phase there should be redundant audits performed on AMI data through both MDM and CIS.

Account Billing Best Practices	PG&E Compliance	
	Historical	Current
Pre-Bill Audits Pre-bill audits should examine kWh usage data and at a minimum include:		
1. Use on Inactive Account: Consumption where no active contract or account exists	Full	Full
2. Zero Use on Active Account: Zero consumption for the entire billing period. Where the account is a multi-commodity (e.g. gas and electric) service, zero consumption on both commodities is a valid condition and only zero consumption on one of the commodities and not the other is an exception.	Non-Compliant PG&E had problems with meters registering zero consumption, resulting in inaccurate billing.	Partial Implemented controls to limit zero consumption related to non reading meters, although some meters still exist.
3. Complete Billing Determinants: All billing determinants as required by the rate are available and represent the same billing period (end on the same date and time).	Full	Full
4. TOU Verification: For TOU, or dynamic rates, the peak and off-peak consumption billing determinants should total to the Total consumption for this billing period.	Full	Full
5. Bill Period: The billing period should not be more than Max Billing Period (typically 33 to 35 days), nor less than Min Billing Period (typically 26 to 27 days).	Partial Bill periods extended beyond typical Max period	Partial Bill periods extended beyond typical Max period
6. Consecutive Estimates: The billing determinants should not be estimated for more than Max Estimates (typically 2) billing periods.	Non-Compliant Historical practice of estimating three months was not in compliance.	Full
7. High / Low check on meter reading (consumption for the billing period) +/- x% of monthly usage as compared to last billing period, same month last year, same month rate class profile.	Full	Full
8. Rated Load—The number of days in the billing	Full	Full

Account Billing Best Practices	PG&E Compliance Historical	PG&E Compliance Current
period multiplied by the current rating of the meter multiplied by 24 hours per day will provide a kWh usage level at which meter or electrical service is overloaded and may create either metering or safety issues.		
9. Service type and rate (gas vs. electric vs. water) mainly for multiple commodity utilities. Sometimes this is preformed as screen validation.	Full	Full
10. Account class and rate (residential vs. commercial vs. industrial). Sometimes this is preformed as screen validation.	Full	Full
11. Tariff Check: Verification that the rate and rider combinations are correct for this service point.	Full	Full
12. Billing Determinant Check: Verification that the meter supports all of the billing determinants required for the tariff.	Full	Full
Post-Bill Audits Post bill audits should examine the dollar amount of the bill		
1. +/- x% of total bill ($'s) as compared to last month, same month last year, same month rate class profile.	Non-Compliant Historical practice utilized a set dollar amount across rate class to flag a potentially high bill. The historical threshold was $1,700 above previous month's billing. The implication is that many high bills may be erroneously sent to Customers without adequate internal review	Non-Compliant Current practice is to use a set dollar amount across a rate class to flag a potentially high bill. The current practice is $300.00 above previous month's billing. The implication is that many high bills may be erroneously sent to Customers without adequate internal review
2. +/- x% of consumption based dollars on bill (this is to remove riders, service charges, etc) as compared to last month, same month last year, same month rate class profile.	Non-Compliant Historical practice utilized a set dollar amount. The implication is that many high bills may be erroneously sent to customers without adequate internal review	Non-Compliant Current practice is to use a set dollar amount across a rate class. The implication is that many high bills may be erroneously sent to customers without adequate internal review
The levels that trigger both Pre and Post Bill Audits should be set such that they do not cause a high level of false positives yet low enough that the majority of billing	Full	Full

Account Billing Best Practices	PG&E Compliance	
	Historical	Current
error issues are reviewed prior to mailing an incorrect bill.		
Timeliness		
As a general rule exceptions should be reviewed and corrected within three business days of billing to ensure an accurate bill is delivered in a timely manner	Full	Full
To further ensure billing timeliness the Meter Read Window (the number of days in which the meter may be read without creating proration issues for the specific bill cycle) should generally be three to five days. In the five day Meter Read Window scenario this would mean that a meter read obtained no more than two days prior to or after the scheduled bill cycle date would be acceptable	Full	Full
Any accounts not read by the end of the Meter Read Window should be estimated	Full	Full
Billing Estimation		
Whenever possible estimated bills should be avoided, however if they must be estimated the estimation algorithms should take into account as many variables as possible for the individual account. For those meters which are read by AMI and the usage is calculated from the interval data, the estimation should occur at the interval level (typically, in the MDM)	Full	Full

Those variables should include:
• Weather related data
  ○ Climate Zone
  ○ Number of Heating or Cooling Degree Days
• Premise Data
  ○ Square Footage
  ○ Heating Source
  ○ Whether or not there is a swimming pool or hot tub (if available)
• Account historical data
  ○ Previous month usage
  ○ Same month last year usage
• Rate Class kWh usage profiles
	Partial
	
	Utilization of premise basis not performed.
		Partial
		
		Utilization of premise basis not performed.

With AMI Meters and where interval data is used for billing the estimation of intervals must be factored into the determination of whether a bill is deemed estimated or not. While meter reading data for the billing period may be complete to the end date of the period there may be estimated intervals within the billing period. If more than x% of the intervals or y% of the energy usage for the period are estimated those billing determinants computed from interval data should be marked as estimated	Full	Full
KW or KVAR Demand billing determinants should not use estimated intervals.	Full	Full
Account estimation should not occur more than two consecutive months or more than 6 times per year. Once	Non-Compliant	Non-Compliant

Account Billing Best Practices	PG&E Compliance	
	Historical	Current
these parameters are reached a field service order should be issued to investigate the causes for estimation and potential resolutions to the issue.	Not an established procedure	Not an established procedure
Data Traceability		
The meter data used for billing must be traceable from the raw meter data collected through the AMI system to the actual billing determinant used to calculate the bill. As a best practice, this would be a single system where all meter data is retained, where any changes or edits to the data are performed and all data is versioned. If billing data is changed as part of the billing process in another system, then such data should be reflected back into the meter data repository to maintain a consistent and auditable system of record for meter data.	Full	Full

5.5.2.8 High Bill Complaint Troubleshooting

High Bill Complaint Troubleshooting Best Practices	PG&E Compliance	
	Historical	Current
High bill complaint trouble shooting should be instituted whenever a customer complaint has been received concerning excessive consumption or an unusually high billed amount. Information must be gathered from the following sources: • Customer • Customer Information System/Billing System • Field Order Service System • Meter Installation Work Force Management System • AMI Head End System/ Meter Data Management System	Non-Compliant Resolution practices based upon historical systems.	Full
In depth analysis of each of these sources must be performed to determine the causation of the high bill. Often times the causation may be inter-related to several factors that can be determined through these sources. Occasionally a field visit must be scheduled to determine other possible causes.	Non-Compliant Resolution practices based upon historical systems.	Partial Additional Smart Meter designated agents assigned to assist with resolution. Utilization of interval data in complaint analysis needed.
Information to be ascertained and questions to be reviewed are:		
Customer		

• How does the customer describe their issue?
• How did the issue first arise and when?
• When did the customer first contact the utility?
• When did the customer move into the current address?
• Have there been previous instances of the same issue?
• What is customers heating/cooling source?
  ○ What is the temperature setting?
  ○ Do the HVAC controls operate automatically?
  ○ Have there been any issues with these systems during the period in question?
• What is the connected load?
  ○ Are there high usage appliances such as pool pumps, spa, water heaters, space heaters, clothes dryers, etc?
  ○ Have any of any of these appliances exhibited any issues or problems during the billing period in question?
  ○ Are any of these high consumption
	Full	Full

High Bill Complaint Troubleshooting Best Practices	PG&E Compliance	
	Historical	Current
appliances on timers? ○ Has the water bill increased during the period in question? ○ Has the customer added or removed appliances during the period in question? • What is the daily consumption pattern? ○ What time do they sleep? ○ How many people are in the household? ○ Has that number changed? • Does the customer mention changes in the household or home equipment that could affect consumption? • What were the dates and times of changes in customer behavior?		
Customer Information System/Billing System		
Usage History		
• Is the usage for the period in question significantly higher or lower than the previous billing period? • Was there a meter change before or during the billing period in question? • Has usage pattern changed? • If so, when did usage pattern change? • How does usage pattern compare to same month for the past three years? • Has usage pattern ever been that high or low as the period in question for that customer? • Has usage pattern ever been that high or low as the period in question for that premise? • Are there corresponding increases in gas usage/decreases in electric usage or vice versa during the period in question? • Were there any weather events that could have affected usage? • Does the usage pattern coincide with the installation of the new meter? • Is the usage associated with the old meter (indication of mis-read during meter exchange process) or new meter (indication of problem with the AMI meter) suspect?	Full	Full
Billing History		
• When were bills generated? • Were any bills delayed? • Is there a large difference between the number of days in the previous billing period and the billing period in question? • Was the customer over/under billed based on an erroneous manual meter read?	Full	Full

High Bill Complaint Troubleshooting Best Practices	PG&E Compliance	
	Historical	Current
• Is that affecting the bill in question? • Is the number of days in the billing period consistent? • If the bill was estimated was it spread across the tiers properly? • Have tier changes affected the bill compared to last year?		
Rates		
• What is the end use code? • Does the customer have the proper baseline adjustment? • What is the Medical Baseline history and status? • Was the customer recently dropped from Medical Baseline? • Should we send a Medical application? • What is the CARE history and status? • Did the customer recently drop form CARE? • Does the customer qualify for CARE? • When did rates change for the customer? • If the rate changed, did it contribute to the customer's issue?	Full	Full
Field Order Service System		
• Was there a meter exchange? • What are the meter exchange details? • What were the meter faceplate details? • Is an image or verification of the removed meter read available? • Were there alterations or modifications to the meter or service? • Were there any additional employee observations?	Full	Full
Meter Data Management System		
• What is the service point status? • Has the Smart Meter been enabled, read, or billed? • When did the meter start communicating? • If meter stopped communicating, when? • Are there meter events? • What are the descriptions and dates? • Which reads were validated actual as opposed to estimated? • Are estimated reads in line with validated actual reads? • Which estimation rules were used? • Is there a relationship between meter event dates and usage or read status?	Full	Full

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High Bill Complaint Troubleshooting Best Practices	PG&E Compliance	
	Historical	Current
• Does AMI Head End data align with MDMS data? • Does read data align with customers stated usage patterns? • Are night time intervals higher than normal?		

5.6 Security Assessment

5.6.1 Summary of Security Assessment Findings

Structure concluded that PG&E has developed a cyber security framework that meets the objectives of the Smart Grid industry's OpenSG AMI-SEC Task Force "AMI System Security Requirements" that were reviewed as part of this evaluation.

5.6.2 Detail of Security Assessment Findings

Structure independently reviewed PG&E's cyber security framework as it applies to their Smart Meter system. Structure also evaluated PG&E's cyber security framework against industry best practice standards to identify deviations in current and historical business practices. Structure concluded that PG&E had developed a cyber security framework that met the objectives of the OpenSG AMI-SEC Task Force "AMI System Security Requirements" that were reviewed as part of this evaluation. An assessment of the implementation of the cyber security framework was not within Structure's agreed-upon scope of work. Based on this Assessment, Structure cannot ensure that the satisfied objectives were implemented at PG&E.

The following sections provide additional detail related to each component of the Structure's Security Assessment.

- Corporate Cyber Security Approach
- Confidentiality and Privacy
- Integrity
- Availability
- Identification and Authentication of Users
- Authorization of Users
- Accounting and Non-Repudiation
- Anomaly Detection Services
- Boundary Services and Interfaces
- Cryptographic Services
- Resource Management Services
- Development Rigor
- Organization Rigor
- Handling and Operating Rigor
- Accountability

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5.6.2.1 Corporate Cyber Security Approach

PG&E has implemented a cyber security framework based on ISO/IEC 27000 to address cyber security for all IT systems and solutions. This framework has been implemented for the whole enterprise and PG&E has worked to eliminate any possible business unit silos that may be following a different security framework. The framework and all PG&E cyber security policies are supported at high levels within the organization with defined consequences for failure to follow the policies.

The implemented security framework specifies that cyber security is addressed early on in all IT projects and is an area of focus for the development process. For example, one major part of the development process includes an IT security risk analysis that must be passed prior to the IT system going into production.

The framework also addresses interactions with outside vendors and contractors. When utilizing outside vendors for IT projects or services, these vendors are contractually held to negotiated cyber security standards.

PG&E's cyber security framework also requires that regularly scheduled and unscheduled audits are performed, using internal and external resources, for evaluating their performance in implementing the policies and procedures.

PG&E reports that they have been recognized, by an outside source, for its implementation of cyber security practices.

Finally, PG&E encourages participation of its employees in cyber security organizations and working groups and are currently active in several smart grid/AMI related cyber security initiatives.

5.6.2.2 Confidentiality and Privacy

PG&E has implemented several policies and procedures to insure the confidentiality and privacy of the data within the smart grid system. These policies and procedures require:

- Various levels of data encryption dependant on the sensitivity of the information
- Defined user roles and responsibilities with a documented authorization process
- Utilization of two factor authorization for defined levels of access
- Detailed logging of system and data events for audit purposes

5.6.2.3 Integrity

PG&E has implemented several cyber security controls to address system and data integrity. They have implemented several best-practices such as:

- Various methods of malware and antivirus protection
- System isolation techniques
- Advanced intrusion detection tools and techniques
- Monitoring of outside security alerts and advisories with defined procedures for evaluation
- Incident response plans
- Validation of data transmitted and received
- Change and Configuration Management processes
- Detailed logging of system and data events for audit purposes

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PG&E is also actively involved in evaluating emerging technologies to enhance their ability to maintain data and system integrity.

5.6.2.4 Availability

PG&E has implemented controls to address availability, including but not limited to:

- Usage of redundancy in hardware and applications where possible
- Usage of high-availability hardware components
- Deployment of monitoring tools at all layers of the system to analyze system performance and health
- Change Management process to insure that no change impacts the availability of the system
- Incident Response Plan that includes provisions to maintain the system during active attacks or responses to prior attacks
- Stated metrics around system availability which are reported on a regular basis to upper management.

5.6.2.5 Identification and Authentication of Users

PG&E has implemented controls to address Identification and Authentication of Users, including but not limited to:

- Require a multiple levels of approval for access being granted
- Usage of two-factor authentication for defined access methods
- Limit usage of system accounts
- Requirement for usage of unique users ids and passwords for normal access
- Process to disable inactive user identifiers
- Process for handling user terminations, voluntary and in-voluntary.
- Preservation of user identifications
- Active monitoring and logging of user system events
- Minimization of complexity of user provisioning system
- Deployment of multiple levels of security prior to ability being granted to issues privileged commands
- Where a system is issuing a command, mechanisms have been implemented to verify the identity of source systems
- Policies concerning complexity, reuse and aging of user account passwords

5.6.2.6 Authorization of Users

PG&E has implemented controls to address Authorization of Users, including but not limited to:

- Formalized users authorization process that requires multiple levels of approval
- Periodic reviews of all user accounts to validate need for continued access to specific systems
- Periodic review of user account role assignments
- Where feasible, tight physical security controls have been implemented

5.6.2.7 Accounting and Non-Repudiation

PG&E has implemented controls to address Accounting and Non-Repudiation, including but not limited to:

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- Logging of all user level events along with system-to-system events.
- Active monitoring of all logged data with exception reports being generated
- Process for review of all exception reports
- Procedures to restrict access to logged events to security personnel or system administrators.
- Contractual requirements with vendors to log all user events and system-to-system events.
- Vendors are contractually required to disclose any issues to PG&E

5.6.2.8 Anomaly Detection Services

PG&E has implemented controls to address Anomaly Detection Services, including but not limited to:

- Installation of various intrusion detection technologies for both cyber and physical
- Usage of internal and external real-time monitoring of system events and IDS outputs
- Usage of system specific rules to detect anomalies
- Incident Response Plan developed and tested
- Detailed Disaster Recovery/Business Continuity procedures
- Scheduled reviews of Disaster Recovery/Business Continuity procedures

5.6.2.9 Boundary Services and Interfaces

PG&E has implemented controls to address Boundary Services and Interfaces, including but not limited to:

- Various technologies at the smart grid system boundaries to control and monitor access
- All external interfaces are evaluated as to the risk to the smart grid systems
- Change and Configuration Management processes for changes to boundary security and interfaces
- Layered security at all system boundaries and interfaces

5.6.2.10 Cryptographic Services

PG&E has implemented controls to address Cryptographic Services, including but not limited to:

- A program to evaluate all transactions and apply appropriate encryption technologies
- A program to utilize standard encryption algorithms such as AES and Hashing for data integrity
- Utilize current threats to adjust encryption policies.
- Monitoring of advances in encryption and increases in threat matrix in regards to AMI infrastructure.
- Implementing PKI signed firmware updates for smart meter infrastructure.

5.6.2.11 Resource Management Services

PG&E has implemented controls to address Resource Management Services, including but not limited to:

- A hardware/software solution that minimizes any system resource constraints.
- Active monitoring of system resources and alerting for resource issues.
- Usage of standard vendor solutions for monitoring servers and applications, including databases.

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5.6.2.12 Development Rigor

PG&E has implemented controls to address Development Rigor, including but not limited to::

- A complete lifecycle development process with detailed phases and stake holder reviews.
- Formal process for standard scoring of all software/hardware solutions, including evaluations of cyber security.
- Detailed deliverables for all projects.
- Processes to catch un-authorized software/hardware purchases.
- Security testing of the end-to-end solution including penetration testing. This even applies for vendor developed systems.
- Detailed system configurations are developed during development phase for usage as a baseline for production systems.
- Implementation of hardening guidelines for all system deployed into production.
- Periodic training of all software developers in areas related to application/system security.
- Process to evaluate data access by or generated by a proposed system for security implications and design requirements.
- Detailed procedures for preventative and regular maintenance activities for systems.
- Process to follow project methodology for all major system upgrades.
- Policies that require a vulnerability assessment on a periodic basis for all systems.

5.6.2.13 Organization Rigor

PG&E has implemented controls to address Organization Rigor, including but not limited to:

- Policies requiring all new employees to receive a base level of cyber security training.
- Process for annual training of employees.
- Process for background checks with defined criteria for exclusion.
- Training, based on need, concerning physical security requirements.
- Policy for lifecycle management of corporate security policies. Requirement for annual reviews and approvals.
- Defined physical access controls for facilities based on cyber assets housed within.
- Protection of power supplies and provisions for backup power capacity.
- Termination policies and procedures for employees and contractors.
- Information protection policy that addresses restrictions of company information being removed from systems.

5.6.2.14 Handling and Operating Rigor

PG&E has implemented controls to address Handling and Operating Rigor, including but not limited to:

- Document management software.
- Procedures for storage of all project documentation in document management system.
- Incident response procedures with multiple levels of incidents and requirement to log all incidents into issue tracking system.
- Policies and procedures centered on data backups and data storage device destruction

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5.6.2.15 Accountability

PG&E has implemented controls to address Accountability, including but not limited to:

- Policies addressing the following:
  - Audit and Accountability
  - Control System Security
  - System and Communication
  - System and Services Acquisitions
  - Configuration Management
  - Personnel Security
  - Physical Security
  - Planning
  - Contractor and Outsourcing

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7 List of Abbreviations

This section identifies the common abbreviations used in this report, with their corresponding definitions.

Abbreviation	Definition
ADU	Average Daily Usage
AMI	Advanced Metering Infrastructure
ANSI	American National Standards Institute
CPUC	California Public Utilities Commission
CC&B	Customer Care & Billing
DASMMD	Direct Access Standards for Metering and Meter Data
EA	Ecologic Analytics
EPRI	Electric Power Research Institute
GE	General Electric
FL	Full Load
HAN	Home Area Network
L+G	Landis+Gyr
LL	Light Load
MDM	Meter Data Management; may also be Meter Data Management System
NIC	Network Interface Card
PF	Power Factor
PHEV	Plug-in Hybrid Electric Vehicle
PG&E	Pacific Gas and Electric Corporation
P.U.	Public Utilities
SSN	Silver Spring Networks
Structure	The Structure Group, or Structure Consulting, LLC
TOU	Time-of-Use
VEE	Validation, Editing, and Estimation

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8 List of Appendices

The following Appendices provide additional detail for each of the specified areas.

A. Laboratory Meter Testing Exhibitions
B. Field Meter Testing Exhibitions
C. California Climate Zone Map
D. Customer Notification Letters
E. End-to-End Customer Bill Analysis
F. Unauthorized Scenario 6 Meter Swaps Exhibitions
G. Shadow Meter Analysis

APPENDIX A

CPUC.500

Appendix A - Laboratory Meter Test Exhibitions

Prepared by: The Structure Group

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Structure™

Appendix A
Laboratory Meter Test Exhibitions

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1 Overview

Structure was tasked with performing laboratory testing on a representative sample of meters received from the factory prior to installation in the field.

The laboratory testing methodology to be performed on the meters included:

- Document the original location, customer/warehouse information, serial numbers, and other relevant information for each meter when removed from original location.
- Install the meters in a test board
  - Utilize calibrated phantom load
  - Utilize calibrated National Institute of Standards and Technology (NIST) traceable watt/VAR meter test standard
- Confirm that all meters are energized and functional.
- Reset all meters and zero-out all prior recordings.
- *Light Load & Full Load Test* - Apply a known load to the meters in the test system.
- *Demand Test* - Allow the meters to remain at a constant load for an extended period of time.
- For a percentage of the meters, periodically vary the load over a period and record the times when the variations occur.
- During the test period, interrogate the meters daily both locally and through the PG&E network.
- At the end of the test period, evaluate the interval data compared to the measurements on the calibrated NIST meter standard.
- A percentage of meters will undergo harsh environmental testing in the testing lab.
- Report findings

The procedures conducted for accuracy and environmental testing are found in this document, along with supporting exhibitions illustrating the equipment and standards used for laboratory testing.

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2 Accuracy Laboratory Testing

As with all the meters drawn from PG&E's inventory, Structure's first activity was to observe and record the metering performance of each selected meter when it was connected to a recently calibrated test standard supplying a known amount of full and light load. The records of these tests indicated whether or not the meter measured within the manufacturer's specifications (measured kWh equals ±0.2% of actual kWh) or within PG&E's standard for meters (measured kWh equals ±0.5% of actual kWh). All tests were performed by a certified metering specialist who certified each meter upon completion of a test.

The following steps were performed to conduct the accuracy testing in Structure's laboratory:

- Meters were sorted at the laboratory by manufacturer and meter form factor in order to facilitate an efficient testing process. Meters were visually inspected for damage prior to being accuracy tested. If any physical problems were detected that may cause a safety issue or other problem, the meter defect was noted and the meter would not be tested and a replacement would be requested.
- In order to properly validate the accuracy of the Watthour meters being tested, a validated reference standard was used as a basis for comparison. The reference standard was annually calibrated by a certified lab to a National Institute of Standards (NIST) traceable Watthour standard. The standard used in the laboratory testing was integral to the Probewell test set.
- Along with the reference standard, the Probewell test system current (amperage) source was used to supply the test current to the test meter socket. A separate stable voltage source was provided to the test meter socket to supply the voltage. The test system allowed the tester to control the current levels using a pre-defined set of controls from the Probewell test program.
- Once the meter was ready for testing, all power was removed from the test socket and the meter was installed in the socket by the tester. The reference standard and the meter under test (MUT) were electrically wired in tandem such that the voltages and currents were identical on both instruments. The Probewell test program was then initiated and the meter disc revolutions, represented by infrared pulses, were counted by the Probewell test set and compared to those recorded on the reference standard.
- The test was started manually by the operator; when the correct number of pulses was counted, the hand held controller displayed and held in memory the meter accuracy in percent registration. The accuracy test consisted of three basic tests:
    - Full Load (FL) test, conducted at the rated test current (TA) of the meter at unity power factor. The meter was placed at the full load rating for ten (10) infrared pulse output counts.
    - Power Factor (PF) test, conducted at the rated test current at a 50% power factor. The meter was placed at the full load rating for five (5) infrared pulse output counts.
    - Light Load (LL) test, conducted at 10% of the rated test current at unity power factor. The meter was placed at the LL rating for two (2) infrared pulse output counts.
- At the end of each of the three tests above, the meter accuracy, in percent registration, was then manually entered into the tracking database.
- The acceptance criterion for these meters was ±0.2% registration as per ANSI C12.20.

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3 Environmental Laboratory Testing

In accordance with ANSI Standard C12.1 test number 19, Effect of Variation of Ambient Temperature, a set of sixSmart Meters were subjected to a period of operation at high (+50°C [+122° F]), low (-20°C [-4° F]), and reference (+23 degrees Celsius, ±5° [+73.4 degrees Fahrenheit, ±5°]) temperatures, and were subsequently evaluated for accuracy with a calibrated test standard. The meters were placed into the environmental chamber for 24 hours and allowed to reach "equilibrium" at the test temperature. The temperature was then adjusted, and the test performed.

The equipment used in the environmental testing included:

- TransData SER - 2100 Watthour Meter Test Set
  - The standard test set that was used for the Environmental testing was the Transdata SER2130, serial number 401151. Unit was calibrated on 3/9/2010.
  - Correction factors for Full Load = 1.0000, Power Factor = 1.00010, Light load = 1.0000.
- TestEquity Model 115 Temperature Chamber

The profiles of the meters subjected to environmental testing were:

- General Electric, Form 2S, I-210+, with Silver Spring NIC.
- Landis+Gyr, Form 2S, Focus AXR – SD, with Silver Spring NIC.

Three environmental tests were conducted to establish a baseline and to test the meters at extreme high and low temperatures as specified in ANSI Standard C12.1, and simulating proximal high and low temperature ranges of the climate zones selected for testing. The temperatures tested at were:

- Reference Test at +23 degrees Celsius, ±5° (+73.4 degrees Fahrenheit, ±5°)
- +50 degrees Celsius (+122 degrees Fahrenheit) Test
- -20 degrees Celsius (-4 degrees Fahrenheit) Test

Each scenario was executed using a full load (FL), light load (LL), and a power factor (PF) test. The maximum deviation for the FL and LL tests was no greater than 0.3% from the reference performance at nominal temperature difference, and no greater than 0.5% for the PF test. Conditions, temperatures, and performance were used as specified in ANSI C12.20-2002, Table 18.

The following figures documented the types of environmental tests conducted in Structure's laboratory, and the procedural steps taken for each test.

Structure's Environmental Reference Test +23 degrees Celsius, ±5° (+73.4 degrees Fahrenheit, ±5°)	
Type of Test	Procedural Steps
Full Load (FL)	The first step in the environmental testing was to establish a reference performance test as a benchmark. The benchmark was established by placing a meter in a temperature chamber set at +23°C ±5° with the rated voltage (in this case, 240VAC) applied for a minimum of 2 hours. Rated test current was applied to the meter for no less than 1 hour prior to conducting the reference test. An accuracy test was conducted at rated current and unity power factor. The accuracy test result was recorded on the reference performance test page.
Power Factor (PF)	The loading device (meter test set) was switched to 50% PF at rated current. An accuracy test was conducted at rated current and 50% power factor. The accuracy test result was recorded on the reference performance test page.

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Structure's Environmental Reference Test +23 degrees Celsius, ±5° (+73.4 degrees Fahrenheit, ±5°)	
Type of Test	Procedural Steps
Light Load (LL)	The test current was adjusted to 10% of the meter's rated test current for no less than 1 hour prior to conducting the reference test. An accuracy test was conducted, and the accuracy test result was recorded on the reference performance test page.

Figure 1: Structure's Environmental Laboratory Reference Test

Structure's Environmental Test +50° Celsius (+122° Fahrenheit)	
Type of Test	Procedural Steps
Full Load (FL)	The temperature chamber was set to +50°C ±5° and stabilized for 24 hours. The rated voltage was applied for a minimum of 2 hours, and the rated test current was applied for no less than 1 hour prior to conducting accuracy tests. An accuracy test was conducted at the rated current and unity power factor. The results of the accuracy test were recorded.
Power Factor (PF)	The loading device (meter test set) was switched to 50% PF at rated current. An accuracy test was conducted at the rated current and 50% power factor. The results of the accuracy test were recorded.
Light Load (LL)	The test current was adjusted to 10% of the meter's rated test current for no less than 1 hour prior to conducting the reference test. The accuracy test was conducted, and the results of the accuracy test were recorded.

Figure 2: Structure's Environmental Laboratory Test: +50° Celsius (+122° Fahrenheit)

Structure's Environmental Test -20° Celsius (-4° Fahrenheit)	
Type of Test	Procedural Steps
Full Load (FL)	The temperature chamber was set to -20°C ±5° and allowed to stabilize for 24 hours. The rated voltage was applied for a minimum of 2 hours, and the rated test current was applied for no less than 1 hour prior to conducting accuracy tests. An accuracy test was conducted at the rated current and unity power factor. The accuracy test result was recorded.
Power Factor (PF)	The loading device (meter test set) was switched to 50% PF at rated current. An accuracy test was conducted at rated current and 50% power factor, and the accuracy test result was recorded.
Light Load (LL)	The test current was adjusted to 10% of the meter's rated test current for no less than 1 hour prior to conducting the reference test. The accuracy test was conducted, and the results of the accuracy test were recorded.

Figure 3: Structure's Environmental Laboratory Test: -20° Celsius (-4° Fahrenheit)

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4 End-to-End Laboratory Test Meter Board

For end-to-end lab testing, Structure constructed the meter board shown below to facilitate variable load conditions and side-by-side shadow metering. The top row of meters is comprised of the shadow meters; the bottom row of meters are the laboratory-based Smart Meters under test.



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4.1 Resistive Load

For shadow meter test constant #5, Structure installed a space heater to create constant resistive load.



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4.2 Variable Load

For the remaining shadow meter lab tests #1 to #4, Structure facilitated variable load conditions via the below hardware configuration.



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5 Communication Access Point

Structure requested installation by PG&E of the below Silver Spring Networks (SSN) access point (AP), to facilitate communication of meter usage data back to the PG&E data collection center. The access point was located near the Structure laboratory facility.



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6 Environmental Chamber

Structure utilized a Model 115 Temperature Chamber to perform Environmental lab test. The below section displays images of the environmental chamber utilized in the Structure lab facility, and provides detailed product specifications for the M115 environmental test equipment.

6.1 Environmental Test Chamber





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6.2 Model 115 Temperature Chamber Product Specifications

Temperature Range	-73°C to +175°C
Control Tolerance	±0.2°C (Measured at the control sensor after stabilization)
Uniformity	±0.5°C (Variations throughout the chamber after stabilization)
Heat Up Transition Time*	5°C/minute typical

Cool Down Transition Time*						
Start Temp	**End Temp**					
	+23°C	**0°C**	**-40°C**	**-55°C**	**-65°C**	**-73°C**
+23°C	-----	5 min	20 min	30 min	40 min	Ultimate
+85°C	16 min	25 min	45 min	57 min	69 min	Ultimate

Rate Of Change
To calculate rate of change for a particular condition, take the difference between the Start Temp and End Temp and divide by the Transition Time.
Cool Down Example: From +85°C to -40°C = 125°C / 45 min = 2.78°C/min.

***Note:** Transition times are measured after a 1 hour soak at the respective start temperature with an empty chamber, as indicated on the temperature controller, 23°C ambient.

Live Load Capacity				
+23°C	**0°C**	**-40°C**	**-55°C**	**-65°C**
300 Watts	255 Watts	160 Watts	110 Watts	80 Watts

Refrigeration and Heating System	
High Stage Refrigerant	R-404A (Dupont HP-62)
Low Stage Refrigerant	R-508B (Dupont SUVA-95)
Compressors	1/2 HP x 1/3 HP Copeland hermetic compressors in a cascade configuration.
Condenser	Air Cooled
Heat of Rejection	4,000 BTUH (maximum rated chamber load at maximum cooling rate from high temperature soak)
Heater Power	600 Watts

Instrumentation	
Temperature Controller	256 step, 40 profile, ramp and soak programmable memory. RS-232/485 interface.
Limit Controller	Independent high and low temperature limits. Triggers an audible alarm and shuts down the chamber.

Power Requirements

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Input Voltage	120 V nominal (110 to 126 VAC), 60 Hz, 1 PH Max Current Draw 15 A, Recommended Minimum Service 20 A Model 115-EX export version available with 230V, 50Hz, 8A input
Power Cord and Plug	6' Power cord supplied with a molded NEMA 5-20P plug. Plugs into a standard NEMA 5-20R receptacle. Use of an extension cord is not recommended. Model 115-EX export version is supplied with power cord for destination country.

Physical Characteristics and Safety	
Inside Dimensions	16" W x 12" H x 14" D (1.55 Cubic feet) 406 mm W x 305 mm H x 353 mm D (44 liters)
Outside Dimensions	**Benchtop Model 115B** 24" W x 44" H x 26" D (nominal) 610 mm W x 1118 mm H x 660 mm D **Floor Model 115F** 24" W x 61" H x 26" D (nominal) 610 mm W x 1549 mm H x 660 mm D
Minimum Installed Clearance	6" from the left and right side 12" from the rear
Window Viewing Area	8" W x 6" H
Access Ports	3" (2.83" inside diameter) supplied on all new Model 115 chambers. Port on left and right side (two total) Supplied with silicone foam port plugs
Weight	**Benchtop Model 115B** Chamber Weight: 275 pounds Shipping Weight: 320 pounds **Floor Model 115F** Chamber Weight: 300 pounds Shipping Weight: 345 pounds
Sound Level	52 dBA in cooling mode (A-weighted, measured 36" from the front surface, 63" from the floor, in a free-standing environment)
CE Mark	Export version, Model 115-EX is CE Marked

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7 ANSI Standards

7.1 ANSI C12.20

ANSI C12.20 is an ANSI standard that describes an American National Standard for Electricity Meters - accuracy and performance.

The C12.20 standard established the physical aspects and performance criteria for a meter's accuracy class. It supersedes certain details in C12.1 and C12.10.

The existing ANSI accuracy classes for electric meters are:

- Class .5 - having ± 0.5% accuracy
- Class .2 - having ± 0.2% accuracy

Contents:

1. Current classes and test amperes
2. Typical form designations
3. List of tests
4. Starting load test
5. Load performance test
6. Effect of variation of power factor for single-element meters
7. Effect of variation of power factor for two-element meters
8. Effect of variation of power factor for three-element meters
9. Effect of variation of voltage
10. Effect of variation of voltage for meters of a wide range voltage rating
11. Effects of variation of frequency
12. Equality of current circuits for multi-element meters
13. Temperature-rise test specifications
14. Effect of internal heating for current classes 2, 10, and 20
15. Effect of internal heating for current classes 100, 200, and 320
16. Effect of tilt
17. Effect of external magnetic field
18. Effect of variation of ambient temperature
19. Effect of temporary overloads on accuracy
20. 20 Effect of current surge in ground conductor

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7.1.1 ANSI C12.20 – Test Number 19: Effect of Variation of Ambient Temperature

ANSI C12.20-2002

5.5.3.2 Test number 15: Insulation

Refer to subclause 4.7.3.1 of ANSI C12.1-2001.

5.5.3.3 Test number 16: Voltage interruptions test

Refer to subclause 4.7.3.2 of ANSI C12.1-2001.

5.5.3.4 Test number 17: Effect of high voltage line surges

Refer to subclause 4.7.3.3 of ANSI C12.1-2001.

5.5.3.5 Test number 18: Effect of external magnetic field

Refer to subclause 4.7.3.4 of ANSI C12.1-2001 except that Table 17 (below) is to be used in place of Table 21 in C12.1-2001.

Table 17 – Effect of external magnetic field

Condition	Current in Amperes						Position of Conductor From ANSI C12.1-2001	Maximum Deviation in Percent From Reference Performance
	Current Class							
	2	10	20	100	200	320		
Reference performance for conditions (1), (2), and (3)	0.025	0.25	0.25	1.5	3	5	---	Reference
Condition (1)	0.025	0.25	0.25	1.5	3	5	Condition (1) in Paragraph 4.7.3.4	±1.0
Condition (2)	0.025	0.25	0.25	1.5	3	5	Condition (2) in Paragraph 4.7.3.4	±1.0
Condition (3)	0.025	0.25	0.25	1.5	3	5	Condition (3) in Paragraph 4.7.3.4	±1.0

5.5.3.6 Test number 19: Effect of variation of ambient temperature

This test shall be applied to a minimum of three meters. The meters shall be placed in a space with a temperature of 23°C ± 5°C and allowed to stand for no less than 2 hours with the voltage circuits of the meters energized. Reference performance at each of the loads specified in Table 16 shall be obtained after operating the meters for 1 hour at the specified load. The meters shall then be operated and tested at each of the following conditions:

a) Conditions (1) through (6): These tests shall be conducted by placing the meter in a space with a temperature of 50°C ± 5°C. After energizing the voltage circuits of the meters for no less than 2 hours, the appropriate test currents at the power factors listed for conditions (1) through (6) of Table 16 shall be sequentially applied to the meters. Each condition shall be maintained for a period of at least 1 hour before performing tests to determine the deviation from reference performance.

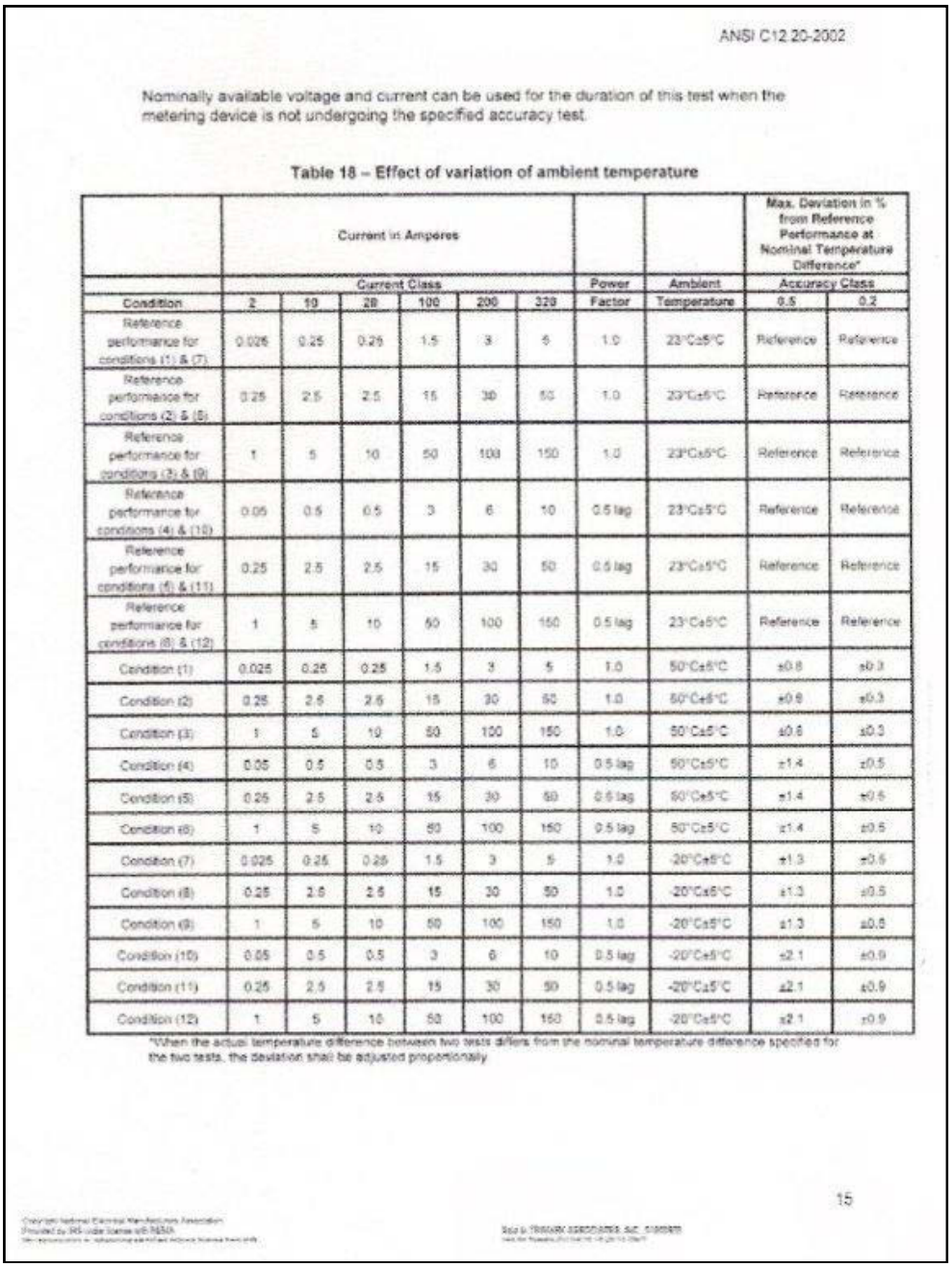
b) Conditions (7) through (12): Repeat conditions (1) through (6), respectively, but place meters in a space with a temperature of -20°C ± 5°C.

The effect of variation of temperature upon the performance of the meters shall not exceed that specified in Table 18.

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7.1.2 ANSI C12.20 Table 18 – Effect of Variation of Ambient Temperature



ANSI C12.20-2002

Nominally available voltage and current can be used for the duration of this test when the metering device is not undergoing the specified accuracy test.

Table 18 – Effect of variation of ambient temperature

	Current in Amperes								Max. Deviation in % from Reference Performance at Nominal Temperature Difference*	
	Current Class						Power	Ambient	Accuracy Class	
Condition	2	10	20	100	200	320	Factor	Temperature	0.5	0.2
Reference performance for conditions (1) & (7)	0.025	0.25	0.25	1.5	3	5	1.0	23°C±5°C	Reference	Reference
Reference performance for conditions (2) & (8)	0.25	2.5	2.5	15	30	50	1.0	23°C±5°C	Reference	Reference
Reference performance for conditions (3) & (9)	1	5	10	50	100	150	1.0	23°C±5°C	Reference	Reference
Reference performance for conditions (4) & (10)	0.05	0.5	0.5	3	6	10	0.5 lag	23°C±5°C	Reference	Reference
Reference performance for conditions (5) & (11)	0.25	2.5	2.5	15	30	50	0.5 lag	23°C±5°C	Reference	Reference
Reference performance for conditions (6) & (12)	1	5	10	50	100	150	0.5 lag	23°C±5°C	Reference	Reference
Condition (1)	0.025	0.25	0.25	1.5	3	5	1.0	50°C±5°C	±0.6	±0.3
Condition (2)	0.25	2.5	2.5	15	30	50	1.0	50°C±5°C	±0.6	±0.3
Condition (3)	1	5	10	50	100	150	1.0	50°C±5°C	±0.6	±0.3
Condition (4)	0.05	0.5	0.5	3	6	10	0.5 lag	50°C±5°C	±1.4	±0.5
Condition (5)	0.25	2.5	2.5	15	30	50	0.5 lag	50°C±5°C	±1.4	±0.5
Condition (6)	1	5	10	50	100	150	0.5 lag	50°C±5°C	±1.4	±0.5
Condition (7)	0.025	0.25	0.25	1.5	3	5	1.0	-20°C±5°C	±1.3	±0.5
Condition (8)	0.25	2.5	2.5	15	30	50	1.0	-20°C±5°C	±1.3	±0.5
Condition (9)	1	5	10	50	100	150	1.0	-20°C±5°C	±1.3	±0.5
Condition (10)	0.05	0.5	0.5	3	6	10	0.5 lag	-20°C±5°C	±2.1	±0.9
Condition (11)	0.25	2.5	2.5	15	30	50	0.5 lag	-20°C±5°C	±2.1	±0.9
Condition (12)	1	5	10	50	100	150	0.5 lag	-20°C±5°C	±2.1	±0.9

*When the actual temperature difference between two tests differs from the nominal temperature difference specified for the two tests, the deviation shall be adjusted proportionally.

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7.2 ANSI C12.1

ANSI C12.1 is the American National Standard for Code for Electricity Metering

Scope and References
This Code establishes acceptable performance criteria for new types of AC watthour meters, demand meters, demand registers, pulse devices, and auxiliary devices. It describes acceptable in-service performance levels for meters and devices used in revenue metering. It also includes information on related subjects, such as recommended measurement standards, installation requirements, test methods, and test schedules. This Code for Electricity Metering is designed as a reference for those concerned with the art of electricity metering, such as utilities, manufacturers, and regulatory bodies.

Contents: Acceptable performance of new types of electricity metering devices and associated equipment

1. General
    a. Acceptable metering devices
    b. Adequacy of testing laboratory
    c. Retesting of new meter type
    d. Test documentation
    e. Test device
    f. Tests performed in series
    g. Handling of failed device
    h. Restart testing
    i. Reporting of test metering devices
2. Types of metering devices
    a. Basic type
    b. Variations within the basic type
    c. Type designation
    d. Acceptance of basic types in whole or part
    e. Minor variations
    f. Special types
3. Specifications for design and construction
    a. Sealing
    b. Enclosures
    c. Terminals and markings
    d. Construction and workmanship
    e. Provision for adjustment
4. Selection of metering devices for approval tests
    a. Samples to be representative of the basic type
    b. Number to be tested
5. Conditions of test
    a. Tests to be applied
    b. Configuration
    c. Metering devices for special services
    d. Metering devices of non-standard classes
    e. Metering devices with wide voltage range
6. Rules governing the acceptance of types
    a. Tolerances
    b. Determination of Failure and Rejection

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7. Performance requirements
    a. Test conditions
    b. Accuracy Tests—Internal Influences
    c. Accuracy tests – external influences performance verification
8. Standards for in-service performance
    a. Watthour meters and electronic registers
        i. Purpose
        ii. Accuracy requirements
        iii. Tests
        iv. Performance tests
        v. Determination of average percentage registration
    b. Demand registers and pulse recorders
        i. Accuracy requirements
    c. Instrument transformers (magnetic
        i. Pre-installation tests, (section 5. shall apply)
        ii. Instrument transformers removed from service
        iii. Performance tests
    d. Coupling-capacitor voltage transformers
        i. Performance tests

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7.2.1 ANSI C12.1 Test No. 19 and Table 22 – Effect of Variation of Ambient Temperature

[redacted]

4.7.3.5 Test No. 19: Effect of variation of ambient temperature

The test shall be applied to three metering devices. The metering devices shall be placed in a space having a temperature of 23°C ±5°C and allowed to stand for not less than 2 hours with the voltage circuits of the metering devices energized. Reference performance at each of the loads specified in Table 22 shall be obtained after operating the metering devices for 1 hour at the specified load. The metering devices shall then be operated and tested at each of the following conditions:

– Conditions (1) through (6). These tests shall be made with the metering device placed in a space having a temperature of 50°C ± 5°C. After energizing the voltage circuits of the metering devices for a period of not less than 2 hours, the appropriate test currents at the power factors listed for conditions (1) through (6) of Table 22 shall be sequentially applied to the metering devices. Each condition shall be maintained for a period of at least 1 hour before tests are made to determine the deviation from reference performance.

Available nominal voltage and current can be used for the duration of this test except when the metering device is undergoing the specified accuracy test.

– Conditions (7) through (12). Repeat conditions (1) through (6), respectively, except that metering devices shall be placed in a space having a temperature of -20°C ±5°C. The effect of variation of temperature upon the performance of the metering devices shall not exceed the maximum deviation specified in Table 22. Available nominal voltage and current can be used for the duration of this test except when the metering device is undergoing the specified accuracy test.

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The chart below depicts the effect of variable temperature on max registration deviation percentages.

ANSI C12.1-2008

[redacted]

Table 22 – Effect of Variation of Ambient Temperature

Condition	Current Class					Power Factor	Ambient Temperature	Max. Deviation In % From Reference Performance At Nominal Temperature Difference*
	10	20	100	200	320			
	Current In Amperes							
Reference performance for conditions (1) and (7)	0.25	0.25	1.5	3	5	1.0	23°C±5°C	Reference
Reference performance for conditions (2) and (8)	2.5	2.5	15	30	50	1.0	23°C±5°C	Reference
Reference performance for conditions (3) and (9)	5	10	50	100	150	1.0	23°C±5°C	Reference
Reference performance for conditions (4) and (10)	0.5	0.5	3	6	10	0.5 lag	23°C±5°C	Reference
Reference Performance for conditions (5) and (11)	2.5	2.5	15	30	50	0.5 lag	23°C±5°C	Reference
Reference Performance for conditions (6) and (12)	5	10	50	100	150	0.5 lag	23°C±5°C	Reference
Condition (1)	0.25	0.25	1.5	3	5	1.0	50°C±5°C	±2.0
Condition (2)	2.5	2.5	15	30	50	1.0	50°C±5°C	±1.0
Condition (3)	5	10	50	100	150	1.0	50°C±5°C	±1.0
Condition (4)	0.5	0.5	3	6	10	0.5 lag	50°C±5°C	±3.0
Condition (5)	2.5	2.5	15	30	50	0.5 lag	50°C±5°C	±2.0
Condition (6)	5	10	50	100	150	0.5 lag	50°C±5°C	±2.0
Condition (7)	0.25	0.25	1.5	3	5	1.0	-20°C±5°C	±3.0
Condition (8)	2.5	2.5	15	30	50	1.0	-20°C±5°C	±2.0
Condition (9)	5	10	50	100	150	1.0	-20°C±5°C	±2.0
Condition (10)	0.5	0.5	3	6	10	0.5 lag	-20°C±5°C	±4.0
Condition (11)	2.5	2.5	15	30	50	0.5 lag	-20°C±5°C	±3.0
Condition (12)	5	10	50	100	150	0.5 lag	-20°C±5°C	±3.0

* When the actual temperature difference between two tests differs from the nominal temperature difference specified for the two tests, the deviation shall be adjusted proportionally.

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APPENDIX B

CPUC.500

Appendix B - Field Meter Testing Exhibitions

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Appendix B
Field Meter Testing Exhibitions

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1 Overview

Structure determined the processes required to test meters safely, completely, and accurately at Customer premises in cooperation with but without interference from PG&E, the media, or other interested parties, while also ensuring that the Customer understood the test procedure and intent. These processes were documented in the form of procedural documents and aids, and supplied to and reviewed with each of Structure's field testers.

The field meter specialists' activities encompassed performing the following activities:

- Download the most recent full Meter Testing Database to the Structure specialists' laptop prior to commencing a day's route
- Meet with PG&E technician at Customer premise
- Notify Customer of testing procedure
- Handle any Customer or media requests for comments or information, per established procedures
- Verify as-found conditions to the Meter Testing Database and document any variances within the Meter Testing Database
- Photograph customer premise
- Photograph as-found meter (with visible register display)
- Test meter and document results in the Meter Testing Database
- Photograph as-left meter
- If necessary, complete a Meter Review-Replacement Required (MRRR) form indicating that the test was unable to be completed, and provide PG&E with a copy of the form
- Repeat all but the first step in the daily test regimen until the day's route has been completed
- At the end of the day:
    - Export a copy of all photos with encoded GPS coordinates taken during the day from the camera to a secure thumb drive.
    - Export test results from laptop to the secure FTP site, for incorporation in the master Meter Testing Database.

Additionally, Structure project leads conducted regular calls with the Structure field meter technicians to facilitate communications and address issues related to the field work.

The following sections display visual documentation of Structure field test procedures. Photographs were captured with GPS-equipped high-resolution digital cameras.

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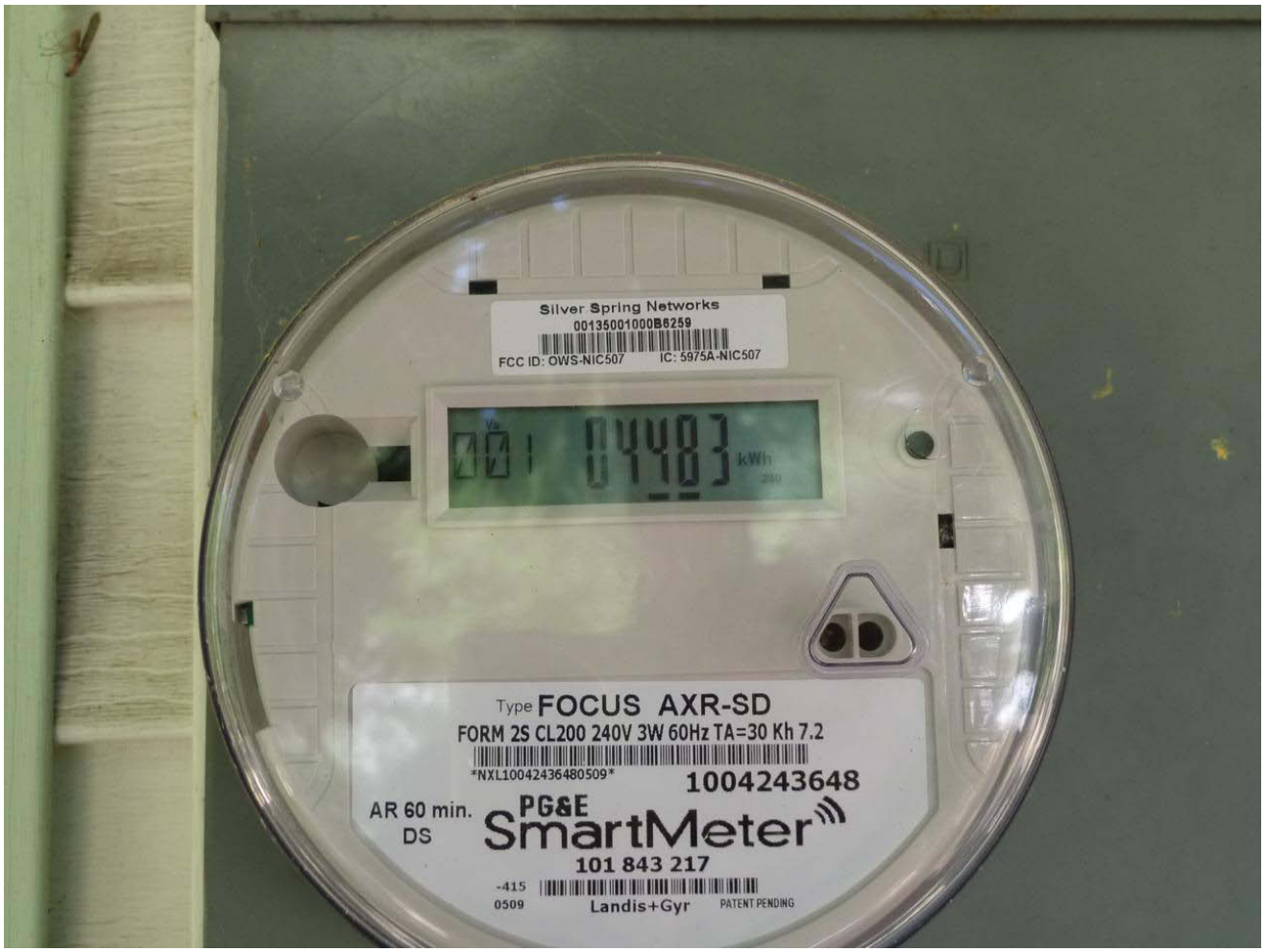
2 Photos from a Smart Meter Field Test

2.1 Front of House



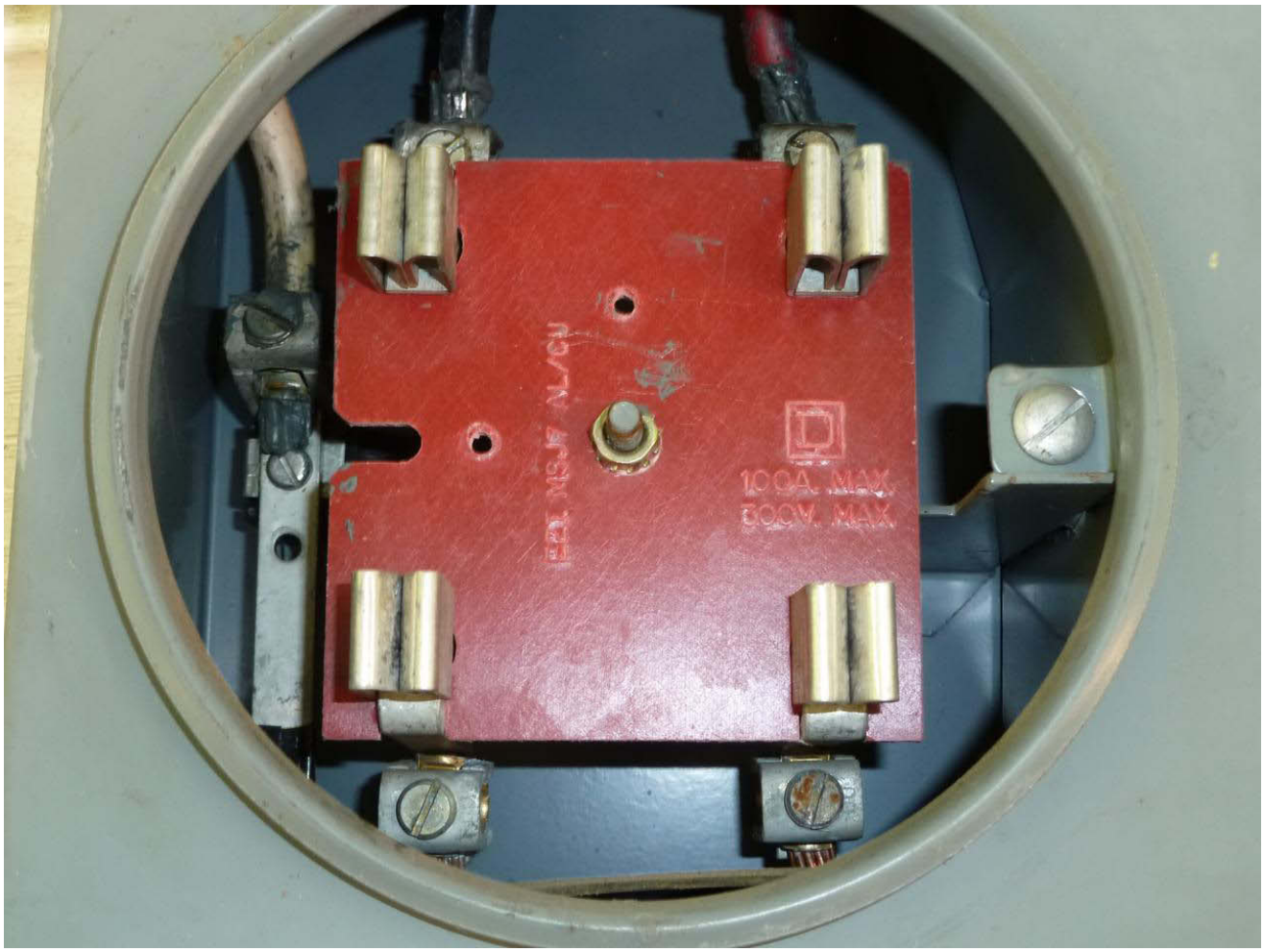
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2.2 As-Found PG&E Smart Meter



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2.3 Removed Meter



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2.4 As-Left PG&E Smart Meter



3 Photos from an Electromechanical Meter Test

3.1 Front of House



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3.2 As-Found PG&E Electromechanical Meter

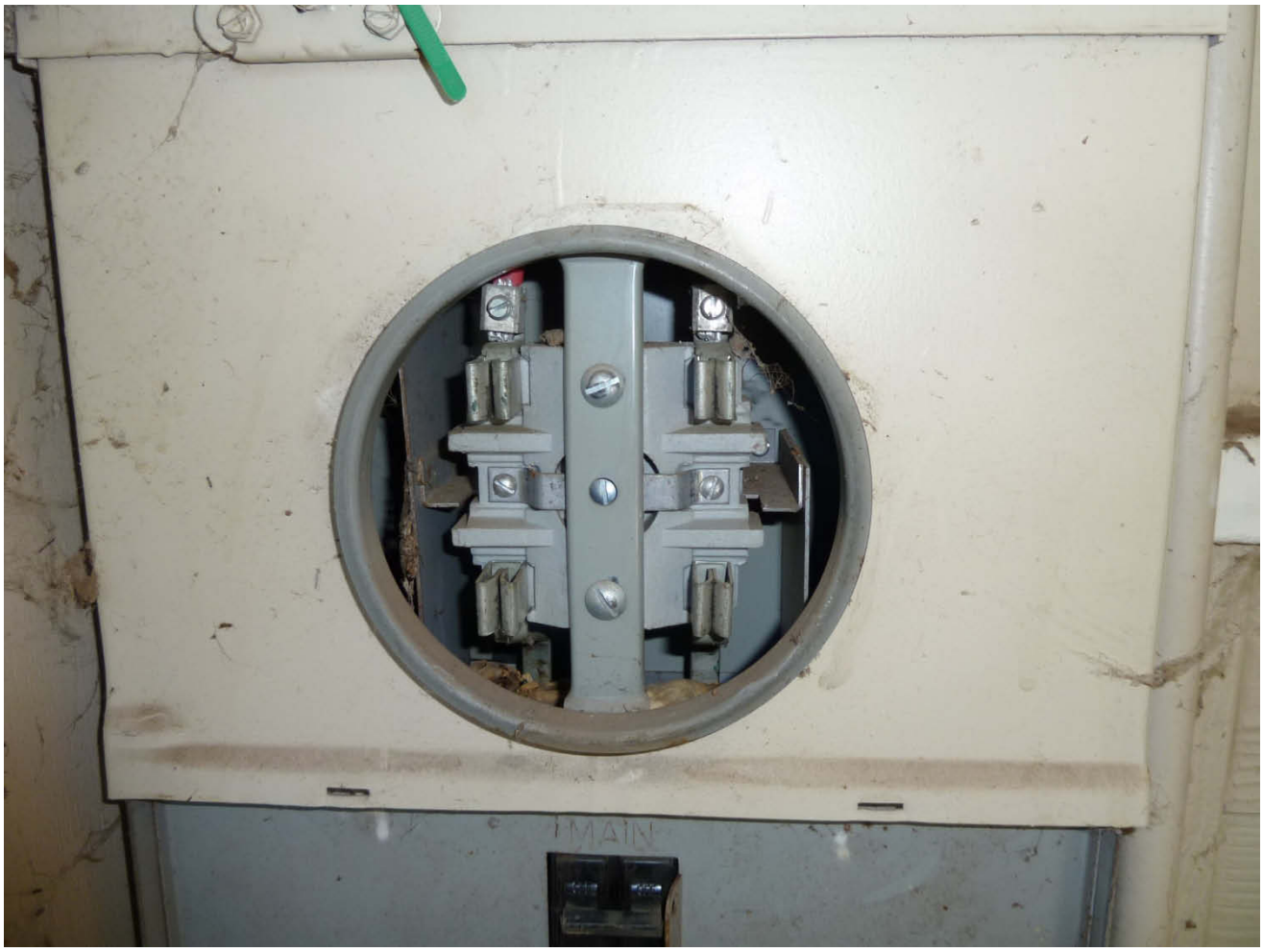


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3.3 Electromechanical Meter Test



3.4 Empty Socket



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3.5 Replaced Smart Meter with Structure and PG&E Seal



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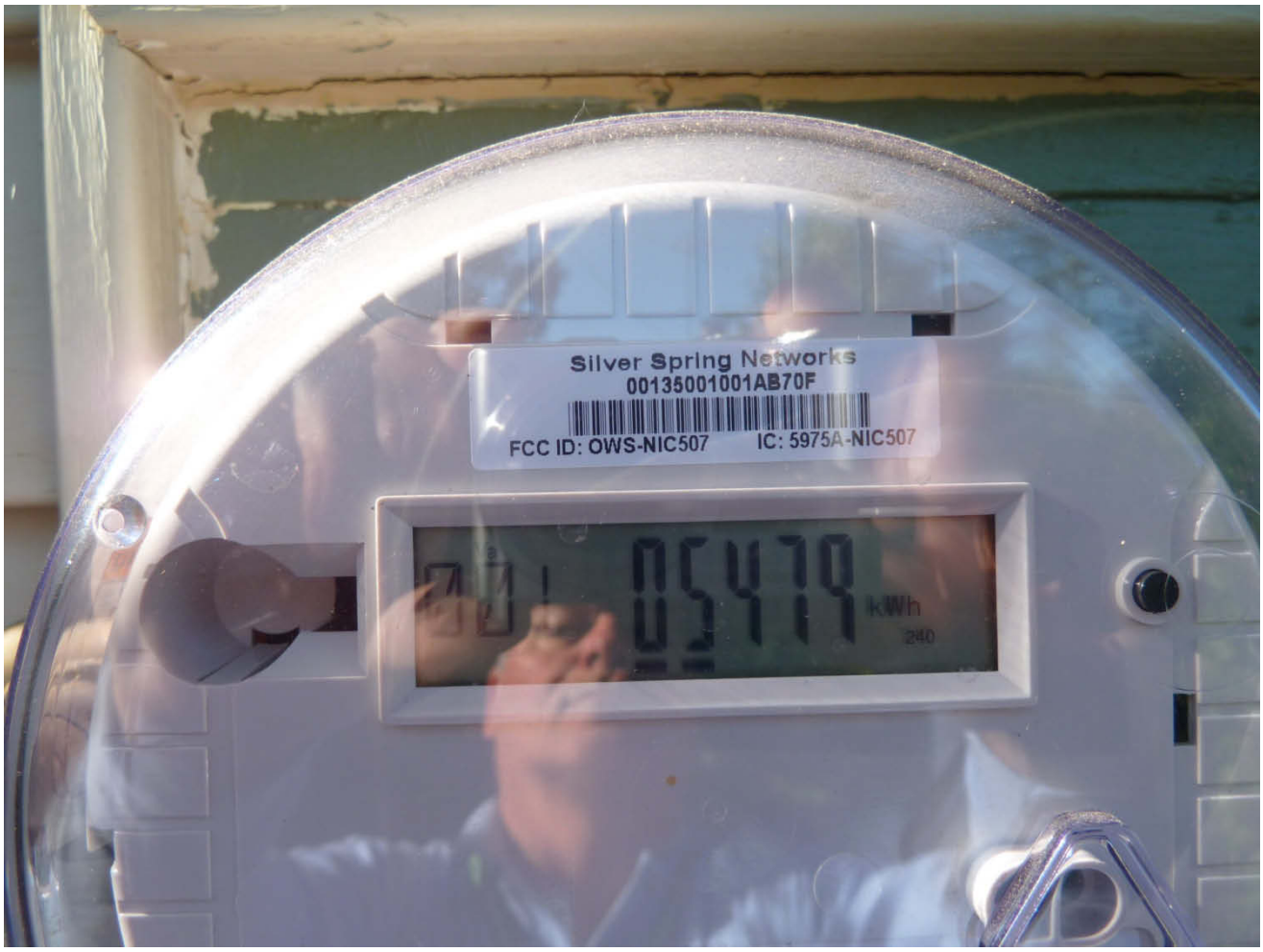
4 Photos from a Shadow Meter Test

4.1 Front of House



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4.2 As-Found PG&E Smart Meter



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4.3 Side-by-Side Shadow Meter Socket



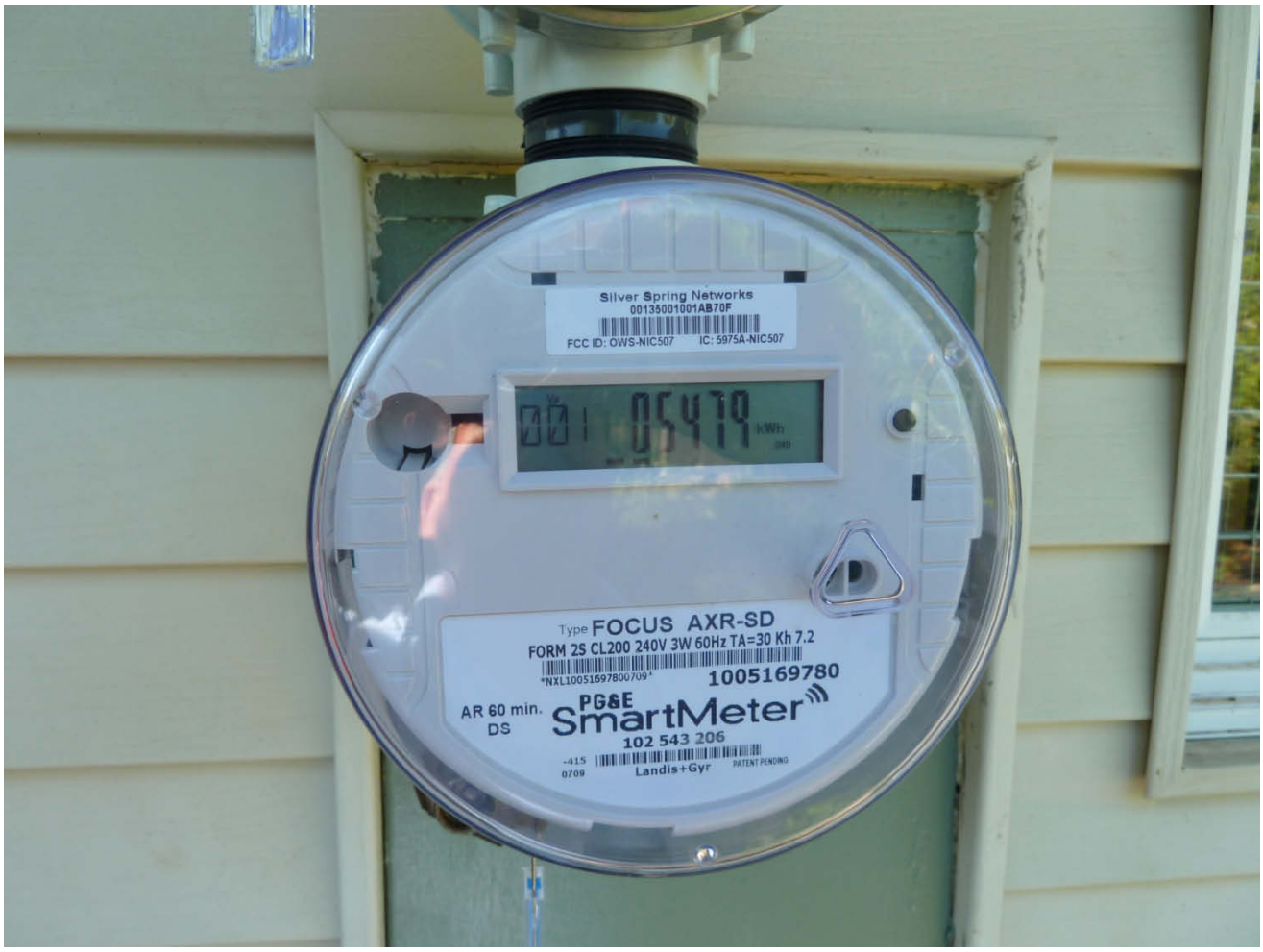
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4.4 As-Left Elster Shadow Meter



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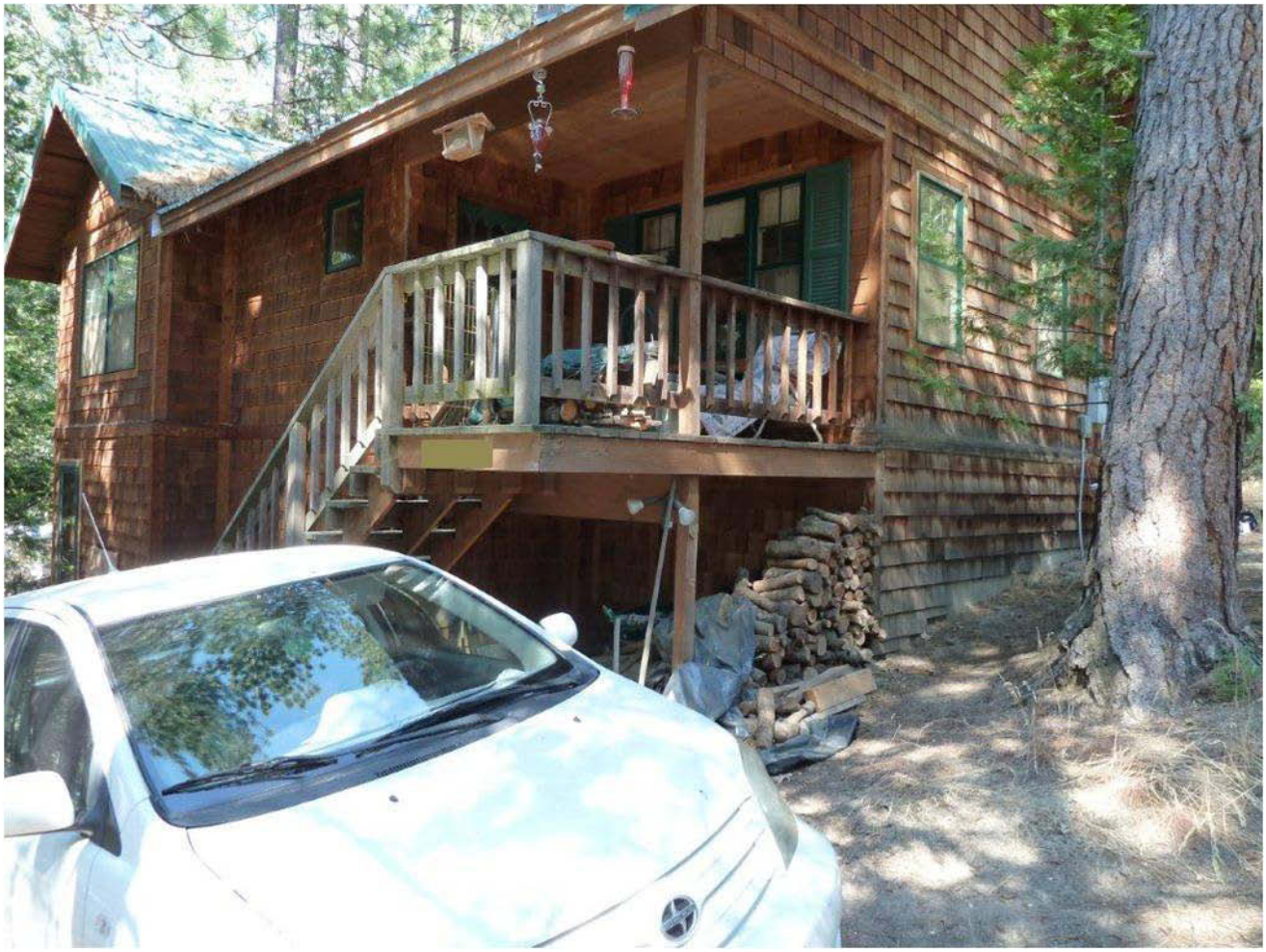
4.5 As-Left PG&E Smart Meter



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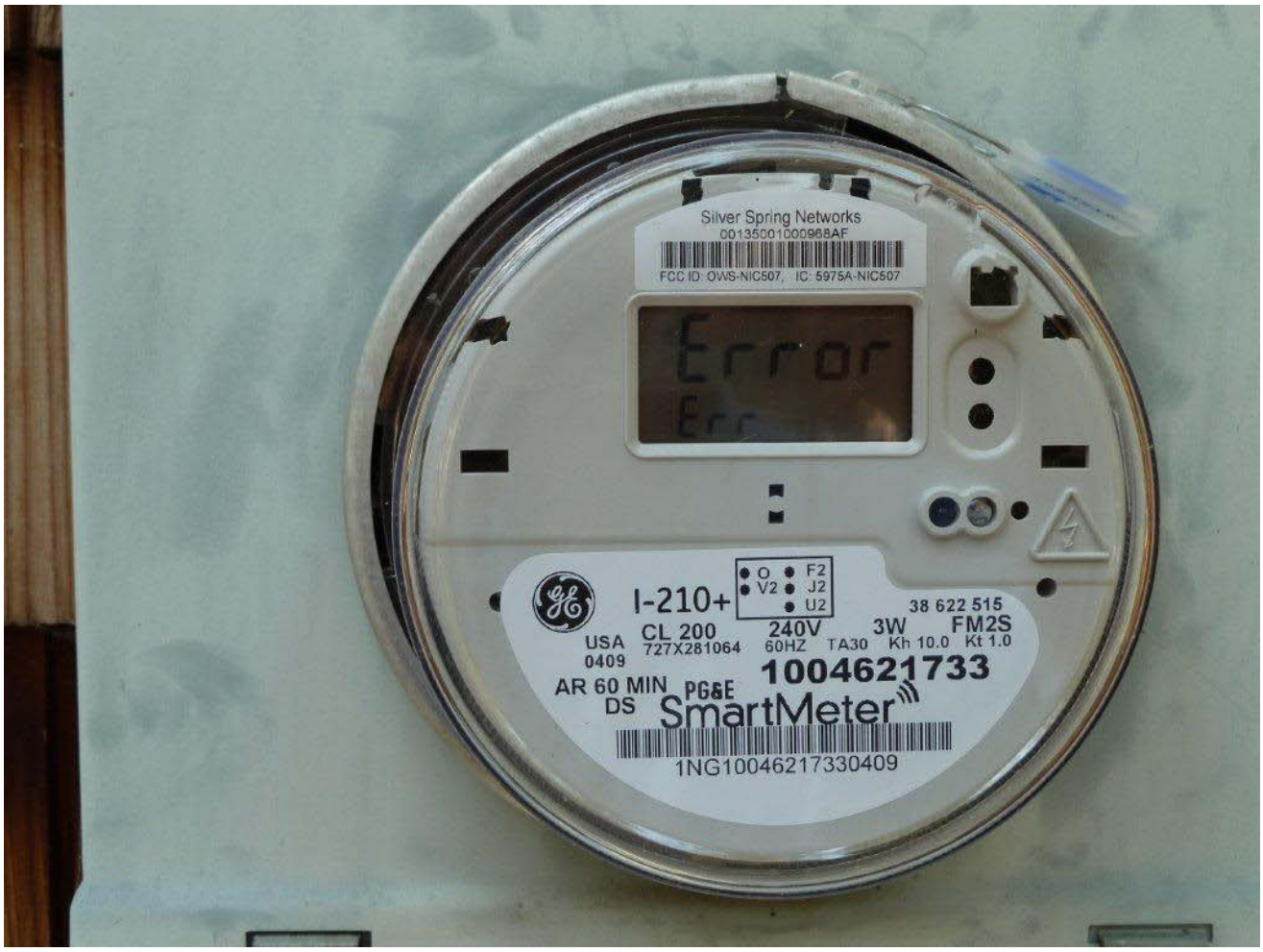
5 Bad Meter In Auberry

5.1 Front of House



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5.2 Smart Meter “ERROR”



APPENDIX C

CPUC.500

Appendix C –

California Climate Zone Designations

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Appendix C
California Climate Zone Map

1 Overview

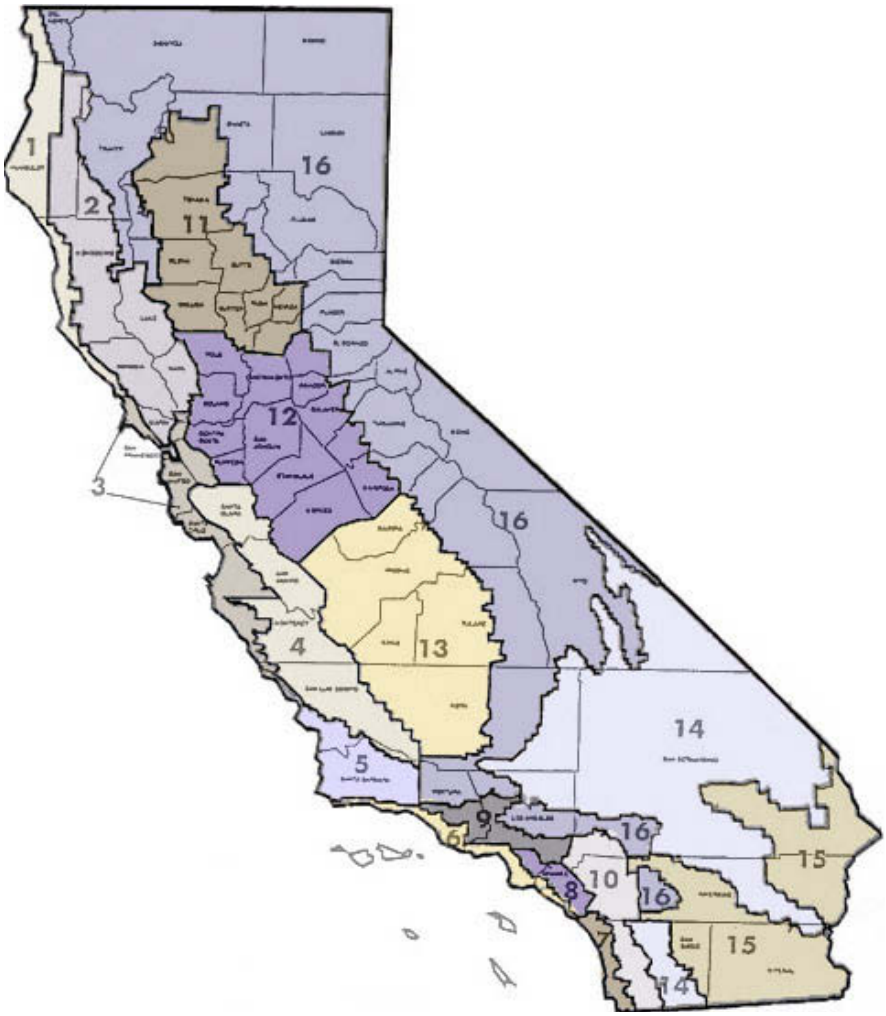
Selection of over 500 PG&E Customers for the Scenario 4 Non-High Bill Complaint Smart Meter Field Test involved a multi-step process:

1. Down-select 5.2million PG&E customers into non-high bill complaint customers (2.4 million).
2. Define the 2.4 million customer population by climate zones or “cells”.
3. Define the 2.4 million customer population by metering hardware installed at the customer premise.
4. Select a statistically random population, stratified by climate zone, meter manufacturer, meter type, meter read communication technology and meter form for field testing.
5. Coordinate test schedule and execute field test.

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2 California Climate Zone Map

Parsing PG&E's total installed electric meter database of over 5.2 million meters to obtain those locations where a Smart Meter had been installed. The resulting 2.4 million Smart Meter population was then parsed to determine the number of Smart Meters installed in each climate zone or "cell". The below climate zone map was used to facilitate the statistical sampling of representative smart meter accounts.



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3 Climate Zone Selection Matrix

Structure identified 2,556 zip codes within the PG&E territory and divided each to the above climate zones. Structure utilized a zip code by climate zone matrix to identify the entire 2.4 million non-high bill complaint smart meter population by climate zone. Further stratification was then performed by meter manufacturer, communication technology and meter form.

The combination of 9 climate zones, 2 communication technologies, 2 meter manufacturers, and 2 meter reading methodologies resulted in a 54 cell matrix to be utilized for statistical sample size determination. Cells with fewer than 3,000 actual meter locations were excluded from the test matrix, reducing the test matrix to 30 cells. Structure's stratification of the Scenario 4 meter population is illustrated in the following Figure.

Structure's Stratification of the Meter Population for Field Meter Test Scenario 4							
Cells	**DCSI**		**SSN**		**Manual Read**		**Totals**
	L+G	**GE**	**L+G**	**GE**	**L+G**	**GE**	
Zone 1	464	0	0	0	224	2,966	
Zone 2	2	0	20,178	11,818	32,312	43,243	**107,553**
Zone 3	17	0	199,320	281,514	94,013	131,917	**706,781**
Zone 4	145	43	14,029	18,810	54,581	87,392	**175,000**
Zone 5	124	0	0	272	0	0	
Zone 11	18	2	38,809	50,501	872	15,819	**106,021**
Zone 12	19	0	266,710	333,345	53,059	81,762	**734,895**
Zone 13	108,815	2,621	214,012	234,729	26,790	33,446	**620,413**
Zone 16	4	0	505	428	1,847	1,937	**4,721**
	109,608	2,666	753,563	931,417	263,698	398,482	**2,455,384**

Figure 1: Structure's Stratification of the Meter Population for Field Meter Test Scenario 4

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4 Climate Zone Selection Matrix

Structure combined each of the 9 climate zones with a sub-zone assignment to identify meter manufacturer, communication technology, and billing. Structure utilized the sub-zones outlined below as the final step in selecting Customers for the Scenario 4 non-high bill complaint field meter test.

Climate Zone	Sample Cell	Manufacturer	GE						L&G						Grand Total
		Read Technology	DCSI			SSN			DCSI			SSN			
		AMI Enabled	SM Billed	SM Enabled	SM Read	SM Billed	SM Enabled	SM Read	SM Billed	SM Enabled	SM Read	SM Billed	SM Enabled	SM Read	
2	2MG						31								31
	2ML												31		31
	2SG							31							31
	2SL											1		30	31
3	3MG						31								31
	3ML												31		31
	3SG							31							31
	3SL													31	31
4	4MG						31								31
	4ML												31		31
	4SG					1		30							31
	4SL													31	31
11	11MG						31								31
	11ML									3			28		31
	11SG					1		30							31
	11SL											1		30	31
12	12MG						31								31
	12ML												31		31
	12SG							31							31
	12SL											1		30	31
13	13AG			1	30										31
	13AL								2		29				31
	13MG						31								31
	13ML												31		31
	13SG							21			1	1	1	7	31
	13SL											1		30	31
16	16MG						31								31
	16ML												31		31
	16SG							31							31
	16SL											4		27	31
Grand Total				**1**	**30**	**2**	**217**	**205**	**2**	**3**	**30**	**9**	**215**	**216**	**930**

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APPENDIX D

CPUC.500

Appendix D - Customer Notification Letters

Prepared by: The Structure Group

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Appendix D
Customer Notification Letters

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1 Overview

As part of this CPUC-ordered evaluation, Structure tested and verified PG&E's Smart Meters for a statistically representative electric residential meter population. Customer Notification Letters were sent to Customers selected for testing, and were the first direct Customer notification of Structure's CPUC- authorized independent evaluation of PG&E's Smart Meter installations. Each letter was customized with a brief notification of the scenario-specific test to be performed at the Customer's premise. The letters were followed by a phone call with similar information, as referenced in "CPUC.150 – Customer Communications Procedure" and "CPUC.500 - PG&E AMI Assessment Report."

An overview of the field tests performed is provided in Figure 1. The letters for each field test Scenario follow in the document, in the general order of the executed field tests.

Scenario	Description	Synopsis	# of Meters
Scenario 3	Mechanical Meter Test & Smart Meter Field Replacement	The procedure for replacing self-contained, residential mechanical meters with new lab-tested warehouse Smart Meters entailed performing the following sequential events at the Customer's premise.	50
Scenario 4	Non-High Bill Complaint Smart Meter Field Test	The procedure for field-testing currently installed non-high bill complaint Smart Meters at the Customer's premise.	500
Scenario 5	High Bill Complaint Smart Meter Field Test	The procedure for field-testing currently installed high-bill complaint Smart Meters at the Customer's premise.	50
Scenario 6	High Bill Complaint Shadow Meter Field Test	Testing of the Shadow Meters involved comparing the reads of a Shadow Meter with the Customer's usage as recorded in their existing Smart Meter. Reads were taken in parallel over a billing period, and reflected the kWh accumulated in the shadow meter vs. the kWh accumulated in the Smart Meter over the same period of time.	20
Scenario 7	Non-High Bill Complaint Mechanical Meter Field Test	The procedure for testing self-contained, residential mechanical meters; and PG&E's potential replacement of them with PG&E Smart Meters.	100
Scenario 8	High Bill Complaint PG&E Installed Shadow Meter Test Verification	Structure verified the PG&E accuracy testing process and procedures according to standards and monitor the read accuracy of both the Smart Meter and the shadow meter. Structure verified, oversaw, and documented the PG&E installation process and procedures of the Shadow meters including the testing of the existing Smart Meter, testing of electromechanical meter being utilized by PG&E as the shadow meter, along with the weekly analysis of reads.	30

Figure 1: Field Meter Testing Scenarios

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2 First Issue of Customer Notification Letter for Scenario 3: Mechanical Meter Test & Smart Meter Field Replacement

STATE OF CALIFORNIA — ARNOLD SCHWARZENEGGER, *Governor*

PUBLIC UTILITIES COMMISSION
505 VAN NESS AVENUE
SAN FRANCISCO, CA 94102-3298

May 13, 2010

Notice of CPUC Authorized Independent Evaluation

<Address Line 1>
<Address Line 2>
<Address Line 3>

Re: Account ID <Account Number>

Dear <Customer Name>:

The California Public Utilities Commission (CPUC), a state agency that regulates California investor-owned utilities, has selected The Structure Group (Structure), a consulting firm located in Texas, to conduct an independent evaluation of Pacific Gas and Electric Company (PG&E) smart meters. As you may know, PG&E, as authorized by the CPUC, is currently replacing the old analog mechanical meters with new digital smart meters throughout its service territory.

As part of this CPUC-ordered evaluation, Structure is testing and verifying PG&E's smart meters for a statistically representative electric residential meter population. In the next several weeks, Structure, in coordination with the CPUC, will test your electric meter, oversee the installation by PG&E of a new, independently-tested smart meter, and retest the smart meter post-installation. The Structure team will be accompanied by PG&E technicians on-site to ensure safe handling of equipment; however, Structure will be in control of the overall process and testing. The Structure team will also be carrying badges identifying them as CPUC Contractors.

Here's what you can expect:

- Upon arrival, Structure will knock on your door before the work begins.
- If no one is present, Structure will leave a note on your door after installation or testing is complete.
- You do not need to be home for Structure to perform the work as long as the Structure team has unobstructed access to the meters.
- Your meter testing/upgrade will take place during regular business hours.
- Installation of the equipment is simple and quick. Your electric service may be interrupted for a brief period, so you may need to reset digital clocks on your appliances or equipment. We appreciate your patience during this process.

Additionally, you may receive a phone call from Structure regarding your prospective involvement in the evaluation. Be assured that Structure is authorized to act on behalf of the CPUC and will maintain the highest level of confidentiality, as required by law, and is working to minimize the impact to your service.

Should you have any questions regarding this test, please contact Structure at 415-678-8601 or 1-888-406-1782 between the hours of 8am to 4pm.

Sincerely,

Natalie Walsh, Program Manager
Energy Division
California Public Utilities Commission

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The Structure Group, LLC.

3 Second Issue of Customer Notification Letter for Scenario 3: Mechanical Meter Test & Smart Meter Field Replacement

STATE OF CALIFORNIA — ARNOLD SCHWARZENEGGER, Governor

PUBLIC UTILITIES COMMISSION

505 VAN NESS AVENUE
SAN FRANCISCO, CA 94102-3298

Notice of CPUC Authorized Independent Evaluation

«Current_Date»

«Primary_Customer_Contact_Name»
«Mailing_Address_1»
«Mailing_City», «Mailing_State» «Mailing_Postal»

Re: Account ID «Account_ID»

Dear «Primary_Customer_Contact_Name»:

The California Public Utilities Commission (CPUC), a state agency that regulates California investor-owned utilities, has selected The Structure Group (Structure), a consulting firm located in Texas, to conduct an independent evaluation of Pacific Gas and Electric Company (PG&E) smart meters. As you may know, PG&E, as authorized by the CPUC, is currently replacing the old analog mechanical meters with new digital smart meters throughout its service territory.

As part of this CPUC-ordered evaluation, Structure is testing and verifying PG&E's smart meters for a statistically representative electric residential meter population. In the next several weeks, Structure, in coordination with the CPUC, will «Scenario_3» The Structure team will be accompanied by PG&E technicians on-site to ensure safe handling of equipment; however, Structure will be in control of the overall process and testing. The Structure team will also be carrying badges identifying them as CPUC Contractors.

Here's what you can expect:

- Upon arrival, Structure will knock on your door before the work begins.
- If no one is present, Structure will leave a note on your door after installation or testing is complete.
- You do not need to be home for Structure to perform the work as long as the Structure team has unobstructed access to the meters.
- Your meter testing/upgrade will take place during regular business hours.
- Installation of the equipment is simple and quick. Your electric service may be interrupted for a brief period, so you may need to reset digital clocks on your appliances or equipment. We appreciate your patience during this process.

Additionally, you may receive a phone call from Structure regarding your prospective involvement in the evaluation. Be assured that Structure is authorized to act on behalf of the CPUC and will maintain the highest level of confidentiality, as required by law, and is working to minimize the impact to your service.

Should you have any questions regarding this test, please contact Structure at 415-678-8601 or 1-888-406-1782 between the hours of 8am to 4pm.

Sincerely,

Natalie Walsh, Program Manager
Energy Division
California Public Utilities Commission

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4 Issuances of Customer Notification Letter for Scenario 4: Non-High Bill Complaint Smart Meter Field Test; and Scenario 5: High Bill Complaint Smart Meter Field Test

STATE OF CALIFORNIA ARNOLD SCHWARZENEGGER, *Governor*

PUBLIC UTILITIES COMMISSION
505 VAN NESS AVENUE
SAN FRANCISCO, CA 94102-3298

Notice of CPUC Authorized Independent Evaluation

«Current_Date»

«Primary_Customer_Contact_Name»
«Mailing_Address_1»
«Mailing_City», «Mailing_State» «Mailing_Postal»

Re: Account ID «Account_ID»

Dear «Primary_Customer_Contact_Name»:

The California Public Utilities Commission (CPUC), a state agency that regulates California investor-owned utilities, has selected The Structure Group (Structure), a consulting firm located in Texas, to conduct an independent evaluation of Pacific Gas and Electric Company (PG&E) smart meters. As you may know, PG&E, as authorized by the CPUC, is currently replacing the old analog mechanical meters with new digital smart meters throughout its service territory.

As part of this CPUC-ordered evaluation, Structure is testing and verifying PG&E's smart meters for a statistically representative electric residential meter population. In the next several weeks, Structure, in coordination with the CPUC, may test your existing smart meter. The Structure team will be accompanied by PG&E technicians on-site to ensure safe handling of equipment; however, Structure will be in control of the overall process and testing. The Structure team will also be carrying badges identifying them as CPUC Contractors.

Here's what you can expect:

- Notification by Structure of the anticipated replacement/testing date.
- Upon arrival, Structure will knock on your door before the work begins.
- If no one is present, Structure will leave a note on your door after installation or testing is complete.
- You do not need to be home for Structure to perform the work as long as the Structure team has unobstructed access to the meters.
- Your meter testing will take place during regular business hours.
- The test is simple and quick. Your electric service may be interrupted for a brief period, so you may need to reset digital clocks on your appliances or equipment. We appreciate your patience during this process.

If you operate life support or other sensitive medical equipment in your home please call Structure at 415-678-8601 or 1-888-406-1782 from Monday to Friday between the hours of 8am to 4pm PST.

Additionally, you may receive a phone call from Structure regarding your prospective involvement in the evaluation. Be assured that Structure is authorized to act on behalf of the CPUC and will maintain the highest level of confidentiality, as required by law, and is working to minimize the impact to your service.

Should you have any questions regarding this test, please contact Structure at 415-678-8601 or 1-888-406-1782 from Monday to Friday between the hours of 8am to 4pm PST.

Sincerely,

Natalie Walsh, Program Manager
Energy Division
California Public Utilities Commission

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5 First Issue of Customer Notification Letter for Scenario 6: High Bill Complaint Shadow Meter Field Test

STATE OF CALIFORNIA ARNOLD SCHWARZENEGGER, *Governor*

PUBLIC UTILITIES COMMISSION
505 VAN NESS AVENUE
SAN FRANCISCO, CA 94102-3298

Notice of CPUC Authorized Independent Evaluation

June 9, 2010

<Address Line 1>
<Address Line 2>
<Address Line 3>

Re: Account ID <Account Number>

Dear <Customer Name>:

The California Public Utilities Commission (CPUC), a state agency that regulates California investor-owned utilities, has selected The Structure Group (Structure), a consulting firm located in Texas, to conduct an independent evaluation of Pacific Gas and Electric Company (PG&E) smart meters. As you may know, PG&E, as authorized by the CPUC, is currently replacing the old analog mechanical meters with new digital smart meters throughout its service territory.

As part of this CPUC-ordered evaluation, Structure is testing and verifying PG&E's smart meters for a statistically representative electric residential meter population. In the next several weeks, Structure, in coordination with the CPUC, may test your existing smart meter, oversee the installation of a side-by-side, independently-tested lab-calibrated meter, and re-test the smart meter post-installation for comparison purposes. The Structure team will be accompanied by PG&E technicians on-site to ensure safe handling of equipment; however, Structure will be in control of the overall process and testing. The Structure team will also be carrying badges identifying them as CPUC Contractors.

Here's what you can expect:

- Notification by Structure of the anticipated replacement/testing date.
- Upon arrival, Structure will knock on your door before the work begins.
- If no one is present, Structure will leave a note on your door after installation or testing is complete.
- You do not need to be home for Structure to perform the work as long as the Structure team has unobstructed access to the meters.
- Your meter testing/upgrade will take place during regular business hours.
- Installation of the equipment is simple and quick. Your electric service may be interrupted for a brief period, so you may need to reset digital clocks on your appliances or equipment. We appreciate your patience during this process.

Additionally, you may receive a phone call from Structure regarding your prospective involvement in the evaluation. Be assured that Structure is authorized to act on behalf of the CPUC and will maintain the highest level of confidentiality, as required by law, and is working to minimize the impact to your service.

Should you have any questions regarding this test, please contact Structure at 415-678-8601 or 1-888-406-1782 from Monday through Friday between the hours of 8am to 4pm PST.

Sincerely,

Natalie Walsh, Program Manager
Energy Division
California Public Utilities Commission

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6 Second Issue of Customer Notification Letter for Scenario 6: High Bill Complaint Shadow Meter Field Test

STATE OF CALIFORNIA ARNOLD SCHWARZENEGGER, *Governor*

PUBLIC UTILITIES COMMISSION
505 VAN NESS AVENUE
SAN FRANCISCO, CA 94102-3298

Notice of CPUC Authorized Independent Evaluation

June 18. 2010

<Address Line 1>
<Address Line 2>
<Address Line 3>

Re: Account ID <Account Number>

Dear <Customer Name>:

The California Public Utilities Commission (CPUC), a state agency that regulates California investor-owned utilities, has selected The Structure Group (Structure), a consulting firm located in Texas, to conduct an independent evaluation of Pacific Gas and Electric Company (PG&E) smart meters. As you may know, PG&E, as authorized by the CPUC, is currently replacing the old analog mechanical meters with new digital smart meters throughout its service territory.

As part of this CPUC-ordered evaluation, Structure is testing and verifying PG&E's smart meters for a statistically representative electric residential meter population. From mid to late June, Structure, in coordination with the CPUC, may test your existing meter, oversee the installation of a side-by-side, independently-tested lab-calibrated meter, and re-test the smart meter post-installation for comparison purposes. The Structure team will be accompanied by PG&E technicians on-site to ensure safe handling of equipment; however, Structure will be in control of the overall process and testing. The Structure team will also be carrying badges identifying them as CPUC Contractors.

Here's what you can expect:

- Notification by Structure of the anticipated replacement/testing date.
- Upon arrival, Structure will knock on your door before the work begins.
- If no one is present, Structure will leave a note on your door after installation or testing is complete.
- You do not need to be home for Structure to perform the work as long as the Structure team has unobstructed access to the meters.
- Your meter testing/upgrade will take place during regular business hours.
- Installation of the equipment is simple and quick. Your electric service may be interrupted for a brief period, so you may need to reset digital clocks on your appliances or equipment. We appreciate your patience during this process.

Additionally, you may receive a phone call from Structure regarding your prospective involvement in the evaluation. Be assured that Structure is authorized to act on behalf of the CPUC and will maintain the highest level of confidentiality, as required by law, and is working to minimize the impact to your service.

Should you have any questions regarding this test, please contact Structure at 415-678-8601 or 1-888-406-1782 from Monday through Friday between the hours of 8am to 4pm PST.

Sincerely,

Natalie Walsh, Program Manager
Energy Division
California Public Utilities Commission

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7 Third Issue of Customer Notification Letter for Scenario 6: High Bill Complaint Shadow Meter Field Test

STATE OF CALIFORNIA ARNOLD SCHWARZENEGGER, *Governor*

PUBLIC UTILITIES COMMISSION
505 VAN NESS AVENUE
SAN FRANCISCO, CA 94102-3298

Notice of CPUC Authorized Independent Evaluation

June 25, 2010

<Address Line 1>
<Address Line 2>
<Address Line 3>

Re: Account ID <Account Number>

Dear <Customer Name>:

The California Public Utilities Commission (CPUC), a state agency that regulates California investor-owned utilities, has selected The Structure Group (Structure), a consulting firm located in Texas, to conduct an independent evaluation of Pacific Gas and Electric Company (PG&E) smart meters. As you may know, PG&E, as authorized by the CPUC, is currently replacing the old analog mechanical meters with new digital smart meters throughout its service territory.

As part of this CPUC-ordered evaluation, Structure is testing and verifying PG&E's smart meters for a statistically representative electric residential meter population. Within the next 30 days, Structure, in coordination with the CPUC, may test your existing meter, oversee the installation of a side-by-side, independently-tested lab-calibrated meter, and re-test the smart meter post-installation for comparison purposes. The Structure team will be accompanied by PG&E technicians on-site to ensure safe handling of equipment; however, Structure will be in control of the overall process and testing. The Structure team will also be carrying badges identifying them as CPUC Contractors.

Here's what you can expect:

- Notification by Structure of the anticipated replacement/testing date.
- Upon arrival, Structure will knock on your door before the work begins.
- If no one is present, Structure will leave a note on your door after installation or testing is complete.
- You do not need to be home for Structure to perform the work as long as the Structure team has unobstructed access to the meters.
- Your meter testing/upgrade will take place during regular business hours.
- Installation of the equipment is simple and quick. Your electric service may be interrupted for a brief period, so you may need to reset digital clocks on your appliances or equipment. We appreciate your patience during this process.

Additionally, you may receive a phone call from Structure regarding your prospective involvement in the evaluation. Be assured that Structure is authorized to act on behalf of the CPUC and will maintain the highest level of confidentiality, as required by law, and is working to minimize the impact to your service.

Should you have any questions regarding this test, please contact Structure at 415-678-8601 or 1-888-406-1782 from Monday through Friday between the hours of 8am to 4pm PST.

Sincerely,

Natalie Walsh, Program Manager
Energy Division
California Public Utilities Commission

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8 First Issue of Customer Notification Letter for Scenario 7: Non-High Bill Complaint Mechanical Meter Field Test

STATE OF CALIFORNIA ARNOLD SCHWARZENEGGER, *Governor*

PUBLIC UTILITIES COMMISSION
505 VAN NESS AVENUE
SAN FRANCISCO, CA 94102-3298

Notice of CPUC Authorized Independent Evaluation

May 27, 2010

<Address Line 1>
<Address Line 2>
<Address Line 3>

Re: Account ID <Account Number>

Dear <Customer Name>:

The California Public Utilities Commission (CPUC), a state agency that regulates California investor-owned utilities, has selected The Structure Group (Structure), a consulting firm located in Texas, to conduct an independent evaluation of Pacific Gas and Electric Company (PG&E) smart meters. As you may know, PG&E, as authorized by the CPUC, is currently replacing the old analog mechanical meters with new digital smart meters throughout its service territory.

As part of this CPUC-ordered evaluation, Structure is testing and verifying PG&E's smart meters for a statistically representative electric residential meter population. In the next several weeks, Structure, in coordination with the CPUC, may test your electric meter. At that time, PG&E may also install a PG&E smart meter. The Structure team will be accompanied by PG&E technicians on-site to ensure safe handling of equipment; however, Structure will be in control of the overall process and testing of the electric meter. The Structure team will also be carrying badges identifying them as CPUC Contractors.

Here's what you can expect:

- Upon arrival, Structure will knock on your door before the work begins.
- If no one is present, Structure will leave a note on your door after testing is complete.
- You do not need to be home for Structure to perform the work as long as the Structure team has unobstructed access to the meters.
- Your meter testing/upgrade will take place during regular business hours.
- Testing/potential installation of the equipment is simple and quick. Your electric service may be interrupted for a brief period, so you may need to reset digital clocks on your appliances or equipment. We appreciate your patience during this process.

Additionally, you may receive a phone call from Structure regarding your prospective involvement in the evaluation. Be assured that Structure is authorized to act on behalf of the CPUC and will maintain the highest level of confidentiality, as required by law, and is working to minimize the impact to your service.

Should you have any questions regarding this test, please contact Structure at 415-678-8601 or 1-888-406-1782 from Monday through Friday between the hours of 8am to 4pm PST.

Sincerely,

Natalie Walsh, Program Manager
Energy Division
California Public Utilities Commission

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9 Second Issue of Customer Notification Letter for Scenario 7: Non-High Bill Complaint Mechanical Meter Field Test

STATE OF CALIFORNIA ARNOLD SCHWARZENEGGER, *Governor*

PUBLIC UTILITIES COMMISSION
505 VAN NESS AVENUE
SAN FRANCISCO, CA 94102-3298

Notice of CPUC Authorized Independent Evaluation

June 22, 2010

<Address Line 1>
<Address Line 2>
<Address Line 3>

Re: Account ID <Account Number>

Dear <Customer Name>:

The California Public Utilities Commission (CPUC), a state agency that regulates California investor-owned utilities, has selected The Structure Group (Structure), a consulting firm located in Texas, to conduct an independent evaluation of Pacific Gas and Electric Company (PG&E) smart meters. As you may know, PG&E, as authorized by the CPUC, is currently replacing the old analog mechanical meters with new digital smart meters throughout its service territory.

As part of this CPUC-ordered evaluation, Structure is testing and verifying PG&E's smart meters for a statistically representative electric residential meter population. If your premise has been selected, Structure, in coordination with the CPUC, may test your electric meter during mid to late June. At that time, PG&E may also install a PG&E smart meter. The Structure team will be accompanied by PG&E technicians on-site to ensure safe handling of equipment; however, Structure will be in control of the overall process and testing of the electric meter. The Structure team will also be carrying badges identifying them as CPUC Contractors.

Here's what you can expect:

- Upon arrival, Structure will knock on your door before the work begins.
- If no one is present, Structure will leave a note on your door after testing is complete.
- You do not need to be home for Structure to perform the work as long as the Structure team has unobstructed access to the meters.
- Your meter testing/upgrade will take place during regular business hours.
- Testing/potential installation of the equipment is simple and quick. Your electric service may be interrupted for a brief period, so you may need to reset digital clocks on your appliances or equipment. We appreciate your patience during this process.

Additionally, you may receive a phone call from Structure regarding your prospective involvement in the evaluation. Be assured that Structure is authorized to act on behalf of the CPUC and will maintain the highest level of confidentiality, as required by law, and is working to minimize the impact to your service.

Should you have any questions regarding this test, please contact Structure at 415-678-8601 or 1-888-406-1782 from Monday through Friday between the hours of 8am to 4pm PST.

Sincerely,

Natalie Walsh, Program Manager
Energy Division
California Public Utilities Commission

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10 Issuances of Customer Notification Letter for Scenario 8: High Bill Complaint PG&E Installed Shadow Meter Test Verification

STATE OF CALIFORNIA ARNOLD SCHWARZENEGGER, *Governor*

PUBLIC UTILITIES COMMISSION
505 VAN NESS AVENUE
SAN FRANCISCO, CA 94102-3298

Notice of CPUC Authorized Independent Evaluation

«Current_Date»

«Primary_Customer_Contact_Name»
«Mailing_Address_1»
«Mailing_City», «Mailing_State» «Mailing_Postal»

Re: Account ID «Account_ID»

Dear «Primary_Customer_Contact_Name»:

The California Public Utilities Commission (CPUC), a state agency that regulates California investor-owned utilities, has selected The Structure Group (Structure), a consulting firm located in Texas, to conduct an independent evaluation of Pacific Gas and Electric Company (PG&E) smart meters. As you may know, PG&E, as authorized by the CPUC, is currently replacing the old analog mechanical meters with new digital smart meters throughout its service territory.

As part of this CPUC-ordered evaluation, Structure is testing and verifying PG&E's smart meters for a statistically representative electric residential meter population. In the next several weeks, Structure, in coordination with the CPUC, may oversee PG&E's test of your existing meter and installation of a side-by-side meter. The Structure team will be accompanied by PG&E technicians on-site to ensure safe handling of equipment. The Structure team will be carrying badges identifying them as CPUC Contractors.

Here's what you can expect:

- Notification by Structure of the anticipated replacement/testing date.
- Upon arrival, a meter technician will knock on your door before the work begins.
- If no one is present, the technician will leave a note on your door after installation or testing is complete.
- You do not need to be home as long as there is unobstructed access to the meter.
- Your meter testing will take place during regular business hours.
- The test is simple and quick. Your electric service may be interrupted for a brief period, so you may need to reset digital clocks on your appliances or equipment. We appreciate your patience during this process.

If you operate life support or other sensitive medical equipment in your home please call Structure at 415-678-8601 or 1-888-406-1782 from Monday to Friday between the hours of 8am to 4pm PST.

Additionally, you may receive a phone call from Structure regarding your prospective involvement in the evaluation. Be assured that Structure is authorized to act on behalf of the CPUC and will maintain the highest level of confidentiality, as required by law, and is working to minimize the impact to your service.

Should you have any questions regarding this test, please contact Structure at 415-678-8601 or 1-888-406-1782 from Monday to Friday between the hours of 8am to 4pm PST.

Sincerely,

Natalie Walsh, Program Manager
Energy Division
California Public Utilities Commission

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APPENDIX E

CPUC.500

Appendix E -

End-to-End Customer Bill Analysis

Prepared by: The Structure Group

Copyright 2010. Confidential and Proprietary to
The Structure Group, LLC.

Structure™

Appendix E
End-to-End Customer Bill Analysis

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1 Overview

"End-to-End" testing in this report refers to the flow of meter usage and event data from the Customer premise, through the AMI and Billing systems, to the Customer's receipt of the printed bill. In addition to meter data and bill analysis, the end-to-end system test involved side-by-side "shadow metering." All end-to-end PG&E Smart Meters were installed with a dual-meter socket, and "shadowed" by a laboratory-tested and calibrated non-AMI solid-state meter. Details on Structure's shadow metering procedure and individual shadow meter configurations were documented for each of the end-to-end test cases.

Structure utilized meters from the Shadow Meter Field Testing scenario and a subset of laboratory-tested meters to verify end-to-end processing of meter usage to the Customers' bill including the application of the appropriate tariff rates on the bill. The end-to-end testing was performed during the same test period and time period as the Shadow Meter Testing and included one billing cycle.

Structure's objective for the end-to-end laboratory test was to replicate PG&E's standard process for collecting and handling Smart Meter data. To achieve this objective, Structure requested PG&E to create "proxy accounts" for each laboratory scenario. Five proxy accounts were created in PG&E's live Customer billing system. Each account was bound to the same system configuration guidelines and Validation Estimation Editing (VEE) rules as the typical residential PG&E Smart Meter Customer.

End-to-end laboratory testing scenarios were driven by simulating specific metering conditions and tracking the results over a complete billing period. Laboratory testing was designed to test how PG&E's AMI system collected, validated, estimated, stored, and billed meter usage and event data under adverse conditions.

1.1 Billing Accuracy Assessment

End-to-end shadow meter system test commenced in the Lab environment on May 28, 2010 and collected registered meter data through June 30, 2010. As per changes to PG&E rate structure kilowatt price tier allocation, effective 6/1/2010, the five end-to-end shadow meter accounts were billed through a split rate structure. The 4 Field end-to-end shadow meter tests were not subjected to the rate change, as field shadow meters were installed subsequent to 6/1. The Figure below presents a summary of these changes.

PG&E BASELINE ALLOCATION CHANGE EFFECTIVE DATE				
3/1/2010 to 5/31/2010			6/1/2010 to Present	
Tier Allocation	$/KWH		Tier Allocation	$/KWH
Tier 1 (Baseline)	$0.11877		Tier 1 (Baseline)	$0.11877
Tier 2	$0.13502		Tier 2	$0.13502
Tier 3	$0.28562		Tier 3	$0.29062
Tier 4	$0.42482		Tier 4	$0.40029
Tier 5	$0.49778		Tier 5	$0.40029

Figure 1: PG&E Baseline Allocation Change Effective Date

Printed bills delivered by PG&E for five lab end-to-end accounts broke-out registered usage into two separate periods. 5/28/2010 to 5/31/2010 and 6/1/2010 to 6/27/2010. This segmentation was in line with Structure expectations for billing through a Customer rate change. Manual calculations performed by Structure for each

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printed bill concluded that PG&E bill-print calculations were accurate. Moreover, the PG&E bill accurately parsed customer usage into the appropriate Tier groupings and presented accurate totalized KWH amounts.

In addition to manual review of printed PG&E bills, Structure utilized raw meter read data collected by the Meter Data Management System and meter reads registered by the shadow meter and compared these KWH values to the usage figures presented on the bill. This comparison identified no significant discrepancies between the meter data source and the physical bill delivered to the customer.

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2 End-to-End Laboratory Shadow Test #1 Bill Information: "John Structure"

END-TO-END LABORATORY SHADOW TEST #1		
Customer Name	John Structure	
Premise ID	N/A	
SP ID	2312175400	
Account ID	5235000629	
Smart Meter	GE I-210+	
Network	SSN	
Meter Form	2S	
City	Walnut Creek	
Bill Code	Basic	
Rate	E1	
Baseline ADU	12.1 KWH	
Bill From Date	5/28/2010	
Bill To Date	6/24/2010	
Bill Cycle Length	28	
Tier Allocation	**PRINTED BILL**	
	Bill Segment 1	**Bill Segment 2**
Tier 1 (Baseline)	48.4000	290.4000
Tier 2	14.5200	87.1200
Tier 3	33.8800	203.2800
Tier 4	48.4000	290.4000
Tier 5	100.2286	601.3714
Tax/Other	$0.05	$0.32
KWH USAGE	1,718.00	
MANUAL BILL CALCULATION	$ 550.51	
ACTUAL BILL AMOUNT	$ 550.51	

Figure 2: End-to-End Laboratory Shadow Test #1 Bill Information

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3 End-to-End Laboratory Shadow Test #2 Bill Information: "Mark Structure"

END-TO-END LABORATORY SHADOW TEST #2		
Customer Name	Mark Structure	
Premise ID	N/A	
SP ID	2312175412	
Account ID	1949334877	
Smart Meter	L+G	
Network	SSN	
Meter Form	2S	
City	Walnut Creek	
Bill Code	Basic	
Rate	E1	
Baseline	12.1 KWH	
Bill From Date	5/28/2010	
Bill To Date	6/27/2010	
Bill Cycle Length	31	
Tier Allocation	**PRINTED BILL**	
	Bill Segment 1	**Bill Segment 2**
Tier 1 (Baseline)	48.4000	326.7000
Tier 2	14.5200	98.0100
Tier 3	33.8800	228.6900
Tier 4	48.4000	326.7000
Tier 5	86.4129	583.2871
Tax/Other	$0.05	$0.34
USAGE	1,795.00	
MANUAL BILL CALC	$ 564.11	
ACTUAL BILL AMOUNT	$ 564.11	

Figure 3: End-to-End Laboratory Shadow Test #2 Bill Information

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4 End-to-End Laboratory Shadow Test #3 Bill Information: "Kristen Structure"

Note: Rounding Error on Bill, should be $531.80 (actual = $531.7974276287).

END-TO-END LABORATORY SHADOW TEST #3		
Customer Name	Kristen Structure	
Premise ID	N/A	
SP ID	2312175433	
Account ID	2101332265	
Smart Meter	GE I-210+	
Network	SSN	
Meter Form	2S	
City	Walnut Creek	
Bill Code	Basic	
Rate	E1	
Baseline	12.1 KWH	
Bill From Date	5/28/2010	
Bill To Date	6/23/2010	
Bill Cycle Length	27	
Tier Allocation	**PRINTED BILL**	
	Bill Segment 1	**Bill Segment 2**
Tier 1 (Baseline)	48.4000	278.3000
Tier 2	14.5200	83.4900
Tier 3	33.8800	194.8100
Tier 4	48.4000	278.3000
Tier 5	100.4296	577.4704
Tax/Other	$0.05	$0.31
USAGE	1,658.00	
MANUAL BILL CALC	$	531.80
ACTUAL BILL AMOUNT	$	531.79

Figure 4: End-to-End Laboratory Shadow Test #3 Bill Information

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5 End-to-End Laboratory Shadow Test #4 Bill Information: "Stacey Structure"

END-TO-END LABORATORY SHADOW TEST #4		
Customer Name	Stacey Structure	
Premise ID	N/A	
SP ID	2312175466	
Account ID	1239442971	
Smart Meter	L+G FOCUS	
Network	SSN	
Meter Form	2S	
City	Walnut Creek	
Bill Code	Basic	
Rate	E1	
Baseline	12.1 KWH	
Bill From Date	5/28/2010	
Bill To Date	6/24/2010	
Bill Cycle Length	28	
Tier Allocation	**PRINTED BILL**	
	Bill Segment 1	**Bill Segment 2**
Tier 1 (Baseline)	48.4000	290.4000
Tier 2	14.5200	87.1200
Tier 3	33.8800	203.2800
Tier 4	48.4000	290.4000
Tier 5	95.6571	573.9429
Tax/Other	$0.05	$0.32
USAGE	1,686.00	
MANUAL BILL CALC	$ 537.25	
ACTUAL BILL AMOUNT	$ 537.25	

Figure 5: End-to-End Laboratory Shadow Test #4 Bill Information

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6 End-to-End Laboratory Shadow Test #5 Bill Information: "Kent Structure"

END-TO-END LABORATORY SHADOW TEST #5		
Customer Name	Kent Structure	
Premise ID	N/A	
SP ID	2312175472	
Account ID	862927841	
Smart Meter	GE I-210+	
Network	SSN	
Meter Form	1S	
City	Walnut Creek	
Bill Code	Basic	
Rate	E1 CARE	
Baseline	12.1 KWH	
Bill From Date	5/28/2010	
Bill To Date	6/24/2010	
Bill Cycle Length	28	
Tier Allocation	**PRINTED BILL**	
	Bill Segment 1	**Bill Segment 2**
Tier 1 (Baseline)	48.4000	290.4000
Tier 2	14.5200	87.1200
Tier 3	33.8800	203.2800
Tier 4	46.2000	277.2000
Tier 5	0.0000	0.0000
Tax/Other	$0.03	$0.19
USAGE	1,001.00	
MANUAL BILL CALC	$	91.72
ACTUAL BILL AMOUNT	$	91.72

Figure 6: End-to-End Laboratory Shadow Test #5 Bill Information

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7 End-to-End Field Shadow Test #1 (Shadow Meter #6) Bill Information

END-TO-END FIELD SHADOW TEST #1		
Customer Name	[redacted]	
Premise ID		
SP ID		
Account ID		
Smart Meter	L+G	
Network	DCSI	
Meter Form	2S	
City	Bakersfield	
Bill Code	Basic	
Rate	E1	
Baseline ADU	19.4 KWH	
Bill From Date	6/4/2010	
Bill To Date	7/2/2010	
Bill Cycle Length	29	
	Bill Segment 1	**Bill Segment 2**
Tier 1 (Baseline)	523.8000	38.8000
Tier 2	157.1400	11.6400
Tier 3	366.6600	27.1600
Tier 4	523.8000	38.8000
Tier 5	449.8759	33.3241
Tax/Other	$0.44	$0.03
KWH USAGE	2,171.00	
MANUAL BILL CALCULATION	$	623.15
ACTUAL BILL AMOUNT	$	623.15

HISTORICAL BILL ANALYSIS		
Bill From Date	5/5/2010	
Bill To Date	6/3/2010	
Bill Cycle Length	30	
	MDM Usage	**Printed Bill**
USAGE	1261	1261
USAGE CHARGE(+tax)	$250.51	$250.51
DELTA	0	0
Bill From Date	4/6/2010	
Bill To Date	5/4/2010	
Bill Cycle Length	29	
	MDM Usage	**Printed Bill**
USAGE	989	989
USAGE CHARGE (+tax)	$245.14	$245.14
DELTA	0	0
Bill From Date	3/5/2010	
Bill To Date	4/5/2010	
Bill Cycle Length	32	
	MDM Usage	**Printed Bill**
USAGE	1012	1012
USAGE CHARGE (+tax)	$251.23	$251.23
DELTA	0	0

Figure 7: End-to-End Field Shadow Test #1 (Shadow Meter #6) Bill Information

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8 End-to-End Field Shadow Test #2 (Shadow Meter #7) Bill Information

END-TO-END FIELD SHADOW TEST #2		
Customer Name	[redacted]	
Premise ID		
SP ID		
Account ID		
Smart Meter	L+G	
Network	DCSI	
Meter Form	2S	
City	Bakersfield	
Bill Code	Basic	
Rate	E1	
Baseline ADU	19.4 KWH	
Bill From Date	6/4/2010	
Bill To Date	7/2/2010	
Bill Cycle Length	29	
	Bill Segment 1	**Bill Segment 2**
Tier 1 (Baseline)	523.8000	38.8000
Tier 2	157.1400	11.6400
Tier 3	366.6600	27.1600
Tier 4	255.8483	18.9517
Tier 5		
Tax/Other	$3.21	$0.24
KWH USAGE	1,400.00	
MANUAL BILL CALCULATION	$	317.51
ACTUAL BILL AMOUNT	$	317.51

Figure 8: End-to-End Field Shadow Test #2 (Shadow Meter #7) Bill Information

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9 End-to-End Field Shadow Test #3 (Shadow Meter #8) Bill Information

END-TO-END FIELD SHADOW TEST #3		
Customer Name	[redacted]	
Premise ID		
SP ID		
Account ID		
Smart Meter	L+G FOCUS	
Network	SSN	
Meter Form	2S	
City	Rocklin	
Bill Code	Basic	
Rate	E1	
Baseline ADU	16.5 KWH	
Bill From Date	6/24/2010	
Bill To Date	7/23/2010	
Bill Cycle Length	30	
	Bill Segment 1	**Bill Segment 2**
Tier 1 (Baseline)	115.5000	379.5000
Tier 2	34.6500	113.8500
Tier 3	80.8500	265.6500
Tier 4	63.7000	209.3000
Tier 5		
Tax/Other	$0.06	$0.21
KWH USAGE	1,263.00	
MANUAL BILL CALCULATION	$	289.09
ACTUAL BILL AMOUNT	$	289.09

Figure 9: End-to-End Field Shadow Test #3 (Shadow Meter #8) Bill Information

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10 End-to-End Field Shadow Test #4 (Shadow Meter #9) Bill Information

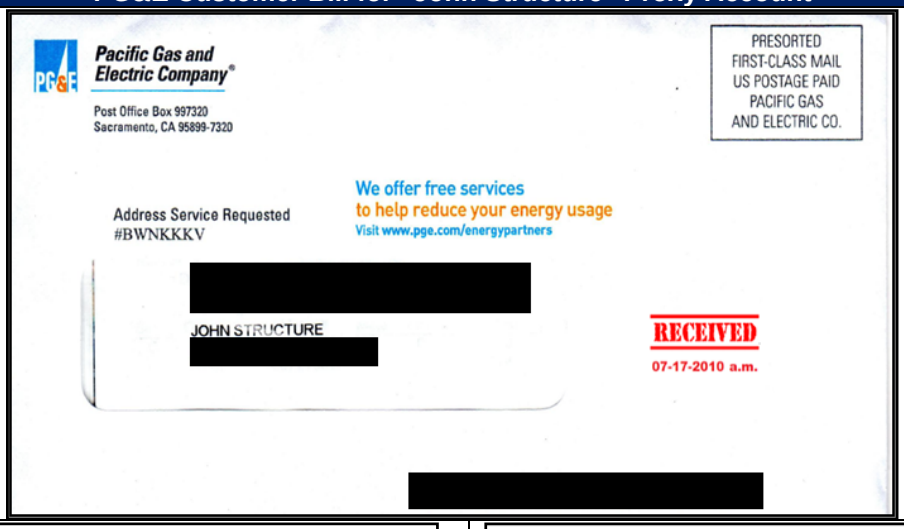
END-TO-END FIELD SHADOW TEST #4		
Customer Name	[redacted]	
Premise ID		
SP ID		
Account ID		
Smart Meter	L+G FOCUS	
Network	SSN	
Meter Form	2S	
City	Walnut Creek	
Bill Code	Basic	
Rate	CARE - E1	
Baseline ADU	12.2 KWH	
Bill From Date	6/11/2010	
Bill To Date	7/12/2010	
Bill Cycle Length	32	
	Bill Segment 1	**Bill Segment 2**
Tier 1 (Baseline)	244.0000	146.4000
Tier 2	73.2000	43.9200
Tier 3	13.4250	8.0550
Tier 4		
Tier 5		
Tax/Other	$0.07	$0.04
KWH USAGE	529.00	
MANUAL BILL CALCULATION	$	45.82
ACTUAL BILL AMOUNT	$	45.82

Figure 10: End-to-End Field Shadow Test #4 (Shadow Meter #9) Bill Information

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11 End-to-End Test Case 1: "John Structure" Proxy Account Bills

PG&E Customer Bill for "John Structure" Proxy Account



Pacific Gas and Electric Company®
Post Office Box 997320
Sacramento, CA 95899-7320

PRESORTED
FIRST-CLASS MAIL
US POSTAGE PAID
PACIFIC GAS
AND ELECTRIC CO.

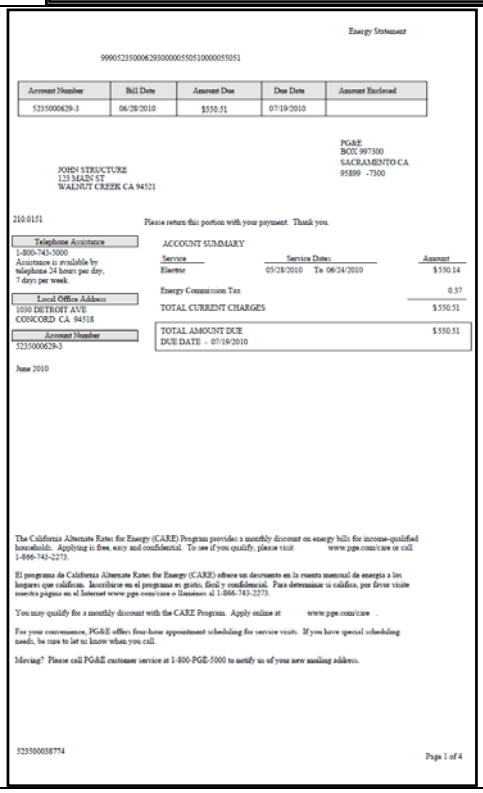
We offer free services
to help reduce your energy usage
Visit www.pge.com/energypartners

Address Service Requested
#BWNKKKV

[redacted]
JOHN STRUCTURE
[redacted]

RECEIVED
07-17-2010 a.m.

[redacted]



Energy Statement

Account Number	Bill Date	Amount Due	Due Date	Amount Enclosed
5235000629-3	06/28/2010	$550.51	07/19/2010	

PG&E
BOX 997300
SACRAMENTO CA
95899 -7300

JOHN STRUCTURE
123 MAIN ST
WALNUT CREEK CA 94521

210:0151

Please return this portion with your payment. Thank you.

Telephone Assistance
1-800-743-5000
Assistance is available by telephone 24 hours per day, 7 days per week.

Local Office Address
1030 DETROIT AVE
CONCORD CA 94518

Account Number
5235000629-3

ACCOUNT SUMMARY

Service	Service Dates	Amount
Electric	05/28/2010 To 06/24/2010	$550.14
Energy Commission Tax		0.37
TOTAL CURRENT CHARGES		$550.51
TOTAL AMOUNT DUE DUE DATE - 07/19/2010		$550.51

June 2010

The California Alternate Rates for Energy (CARE) Program provides a monthly discount on energy bills for income-qualified households. Applying is free, easy and confidential. To see if you qualify, please visit www.pge.com/care or call 1-866-743-2273.

El programa de California Alternate Rates for Energy (CARE) ofrece un descuento en la cuenta mensual de energía a los hogares que califican. Inscribirse es el programa es gratis, fácil y confidencial. Para determinar si califica, por favor visite nuestra página en el Internet www.pge.com/care o llámenos al 1-866-743-2273.

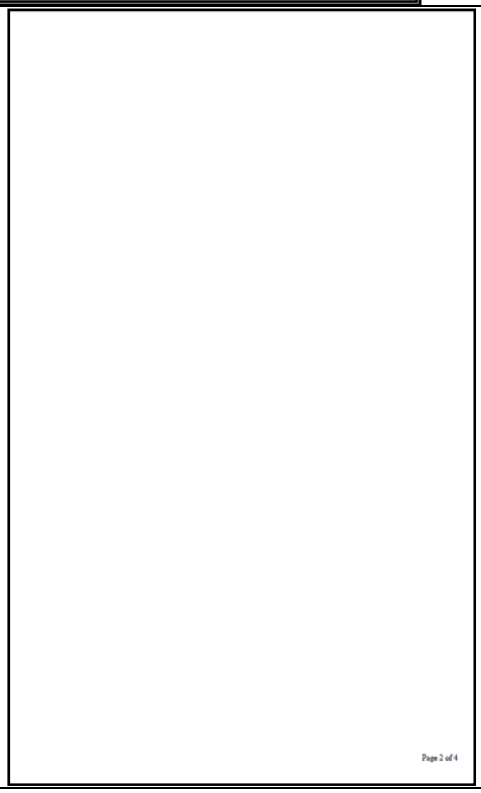
You may qualify for a monthly discount with the CARE Program. Apply online at www.pge.com/care .

For your convenience, PG&E offers four-hour appointment scheduling for service visits. If you have special scheduling needs, be sure to let us know when you call.

Moving? Please call PG&E customer service at 1-800-PGE-5000 to notify us of your new mailing address.

5235000038774

Page 1 of 4

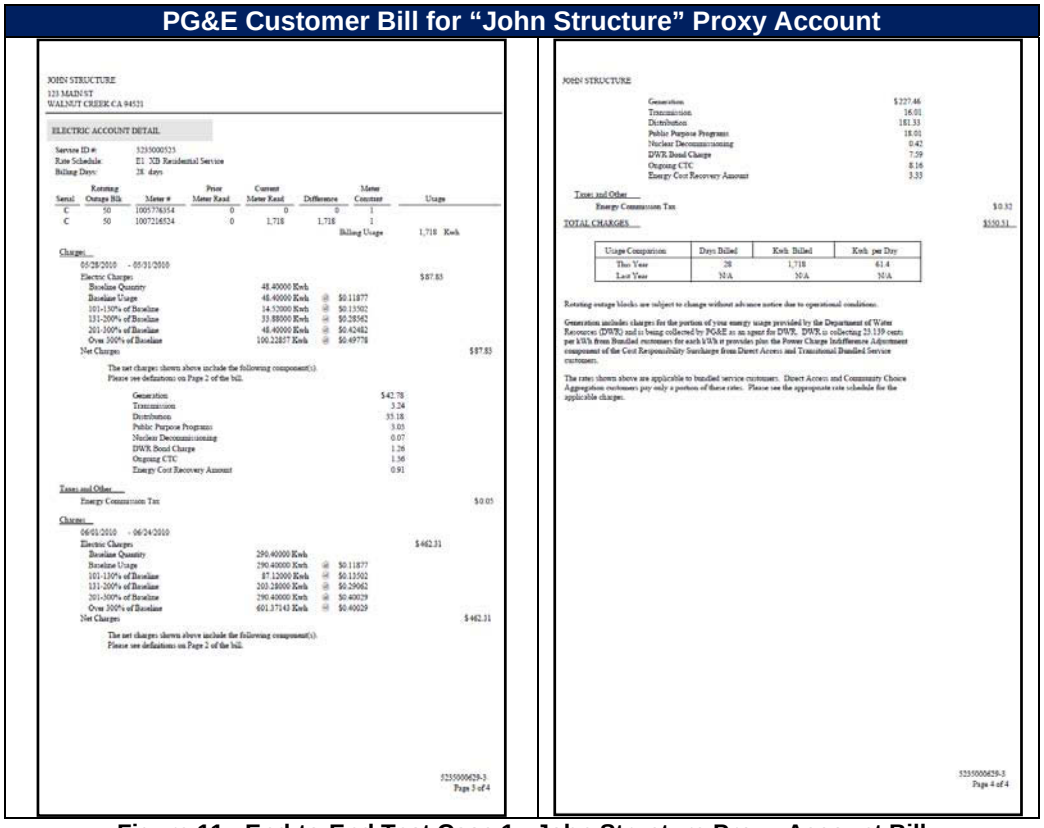


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Structure™

Appendix E
End-to-End Customer Bill Analysis

PG&E Customer Bill for "John Structure" Proxy Account



JOHN STRUCTURE
123 MAIN ST
WALNUT CREEK CA 94521

ELECTRIC ACCOUNT DETAIL

Service ID #: 5253000525
Rate Schedule: E1 XB Residential Service
Billing Days: 28 days

Serial	Rotating Outage Blk	Meter #	Prior Meter Read	Current Meter Read	Difference	Meter Constant	Usage
C	50	1005778354	0	0	0	1	
C	50	1007216524	0	1,718	1,718	1	
						Billing Usage	1,718 Kwh

Charges
05/28/2010 - 05/31/2010
Electric Charges: $87.83

Baseline Quantity	48.40000 Kwh		
Baseline Usage	48.40000 Kwh	@	$0.11877
101-130% of Baseline	14.52000 Kwh	@	$0.13502
131-200% of Baseline	33.88000 Kwh	@	$0.28562
201-300% of Baseline	48.40000 Kwh	@	$0.42482
Over 300% of Baseline	100.22857 Kwh	@	$0.49778

Net Charges $87.83

The net charges shown above include the following component(s).
Please see definitions on Page 2 of the bill.

Generation	$42.78
Transmission	3.24
Distribution	35.18
Public Purpose Programs	3.03
Nuclear Decommissioning	0.07
DWR Bond Charge	1.26
Ongoing CTC	1.36
Energy Cost Recovery Amount	0.91

Taxes and Other
Energy Commission Tax $0.05

Charges
06/01/2010 - 06/24/2010
Electric Charges: $462.31

Baseline Quantity	290.40000 Kwh		
Baseline Usage	290.40000 Kwh	@	$0.11877
101-130% of Baseline	87.12000 Kwh	@	$0.13502
131-200% of Baseline	203.28000 Kwh	@	$0.29062
201-300% of Baseline	290.40000 Kwh	@	$0.40029
Over 300% of Baseline	601.37143 Kwh	@	$0.40029

Net Charges $462.31

The net charges shown above include the following component(s).
Please see definitions on Page 2 of the bill.

5253000525-3
Page 3 of 4

JOHN STRUCTURE

Generation	$227.46
Transmission	16.01
Distribution	181.33
Public Purpose Programs	18.01
Nuclear Decommissioning	0.42
DWR Bond Charge	7.59
Ongoing CTC	8.16
Energy Cost Recovery Amount	3.33

Taxes and Other
Energy Commission Tax $0.32

TOTAL CHARGES $550.31

Usage Comparison	Days Billed	Kwh Billed	Kwh per Day
This Year	28	1,718	61.4
Last Year	N/A	N/A	N/A

Rotating outage blocks are subject to change without advance notice due to operational conditions.

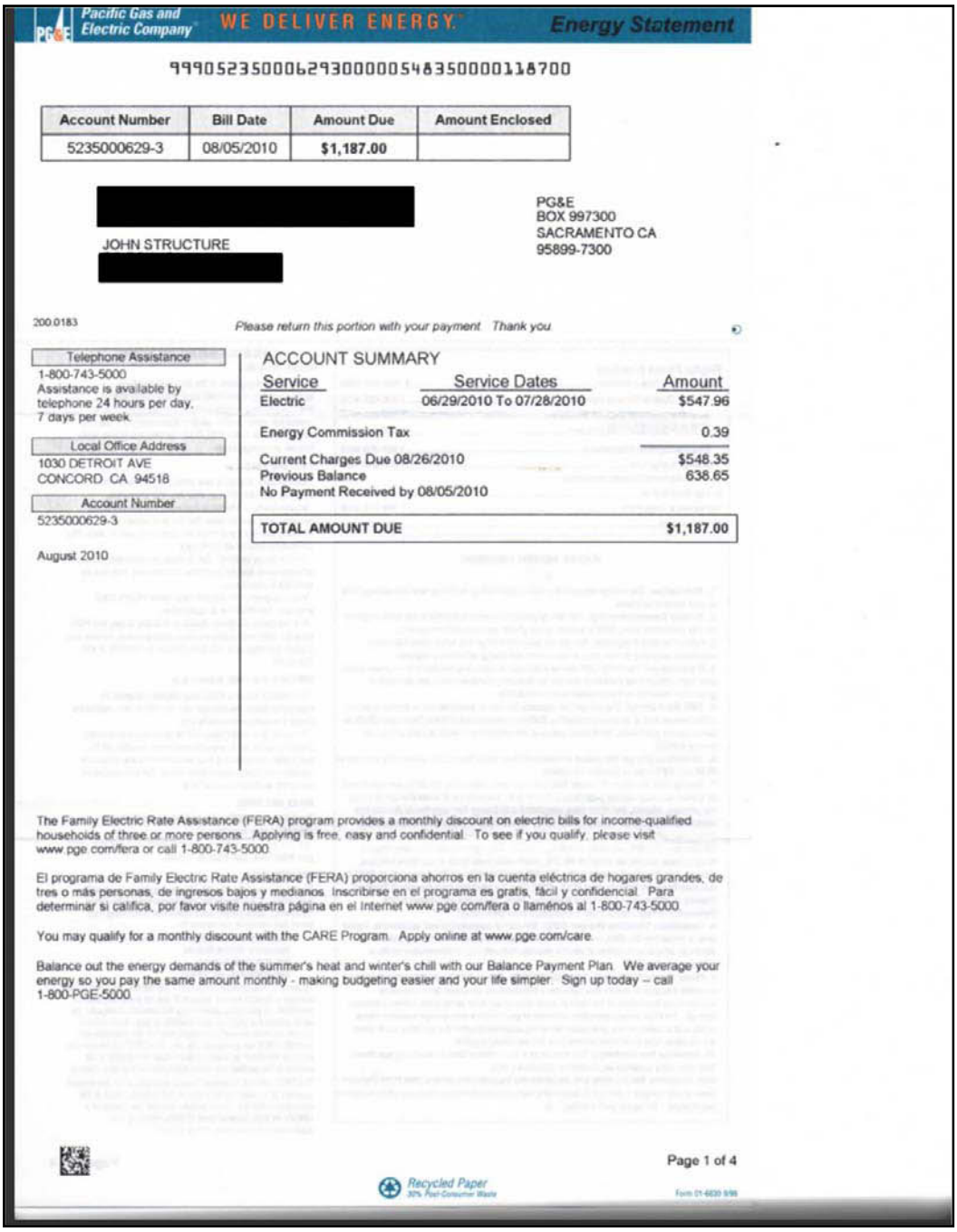
Generation includes charges for the portion of your energy usage provided by the Department of Water Resources (DWR) and is being collected by PG&E as an agent for DWR. DWR is collecting 23.139 cents per kWh from Bundled customers for each kWh it provides plus the Power Charge Indifference Adjustment component of the Cost Responsibility Surcharge from Direct Access and Transitional Bundled Service customers.

The rates shown above are applicable to bundled service customers. Direct Access and Community Choice Aggregation customers pay only a portion of these rates. Please see the appropriate rate schedule for the applicable charges.

5253000525-3
Page 4 of 4

Figure 11: End-to-End Test Case 1: John Structure Proxy Account Bill

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Pacific Gas and Electric Company WE DELIVER ENERGY. Energy Statement

99905235000629300000548350000118700

Account Number	Bill Date	Amount Due	Amount Enclosed
5235000629-3	08/05/2010	$1,187.00	

[redacted]

JOHN STRUCTURE

[redacted]

PG&E
BOX 997300
SACRAMENTO CA
95899-7300

200.0183

Please return this portion with your payment. Thank you.

Telephone Assistance
1-800-743-5000
Assistance is available by telephone 24 hours per day, 7 days per week.

Local Office Address
1030 DETROIT AVE
CONCORD CA 94518

Account Number
5235000629-3

August 2010

ACCOUNT SUMMARY

Service	Service Dates	Amount
Electric	06/29/2010 To 07/28/2010	$547.96
Energy Commission Tax		0.39
Current Charges Due 08/26/2010		$548.35
Previous Balance		638.65
No Payment Received by 08/05/2010		
TOTAL AMOUNT DUE		**$1,187.00**

The Family Electric Rate Assistance (FERA) program provides a monthly discount on electric bills for income-qualified households of three or more persons. Applying is free, easy and confidential. To see if you qualify, please visit www.pge.com/fera or call 1-800-743-5000.

El programa de Family Electric Rate Assistance (FERA) proporciona ahorros en la cuenta eléctrica de hogares grandes, de tres o más personas, de ingresos bajos y medianos. Inscribirse en el programa es gratis, fácil y confidencial. Para determinar si califica, por favor visite nuestra página en el Internet www.pge.com/fera o llaménos al 1-800-743-5000.

You may qualify for a monthly discount with the CARE Program. Apply online at www.pge.com/care.

Balance out the energy demands of the summer's heat and winter's chill with our Balance Payment Plan. We average your energy so you pay the same amount monthly - making budgeting easier and your life simpler. Sign up today – call 1-800-PGE-5000.

Page 1 of 4

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Appendix E
End-to-End Customer Bill Analysis

Helpful Phone Numbers

Customer Services – English	**1-800-743-5000**
TDD/TTY (Speech/Hearing-Impaired)	1-800-652-4712
Servicio al Cliente en **Español** (Spanish)	1-800-660-6789
華語客戶服務電話號碼 (Chinese)	1-800-893-9555
Tiếng Việt Nam (Vietnamese)	1-800-298-8438
Smarter Energy Line (Residential Energy Efficiency Information)	1-800-933-9555
Energy Theft Hotline	1-800-854-6250
To Request A Claim Form	1-800-743-5000
PG&E's website	www.pge.com

ELECTRIC INDUSTRY DEFINITIONS

1. **Distribution:** The charge recovers the cost of distributing electricity over low-voltage lines to your home or business.
2. **Nuclear Decommissioning:** The non-by passable charge that collects the funds required for site restoration when PG&E's nuclear power plants are removed from service.
3. **Public Purpose Programs:** The non-by passable charge that funds state-mandated assistance programs for low-income customers and energy-efficiency programs.
4. **Transmission:** The charge that recovers the cost of conveying electricity from power plants over high-voltage lines (including charges for Reliability Services which are the costs of generation required for transmission system reliability).
5. **DWR Bond Charge:** The charge that recovers the cost of bonds issued to finance a portion of the historic cost of power purchased by California Department of Water Resources (DWR) to serve electric customers. DWR bond revenues are collected on behalf of DWR and do not belong to PG&E.
6. **Generation Charge:** The charge that recovers the cost of the electric commodity incurred by PG&E and DWR to serve bundled customers.
7. **Energy Cost Recovery Amount:** These charges are approved by the CPUC and authorized by California Public Utilities Code Section 848 et seq. The purpose of these charges is to pay the principal, interest, and other costs associated with Energy Recovery Bonds (Bonds) that were issued by a Special Purpose Entity (SPE). One of these charges is the Dedicated Rate Component (DRC), which is $0.00532 per kWh. The right to receive DRC revenues has been transferred to the SPE and does not belong to PG&E. This right is called Recovery Property. PG&E collects the DRC on behalf of the SPE, which uses these funds to pay Bond principal, interest, and other Bond-related costs. The SPE transferred the net Bond proceeds to PG&E to purchase Recovery Property from PG&E. PG&E used the proceeds from the sale of Recovery Property to refinance its bankruptcy Regulatory Asset, which was established by the Commission to help finance PG&E's emergence from bankruptcy.
8. **Competition Transition Charges (CTC):** The cost of purchased power agreements, signed prior to December 20, 1995, in excess of a CPUC approved proxy of the market price of electricity as well as a portion of electric industry restructuring implementation costs as authorized by the CPUC.
9. **Power Charge Indifference Adjustment (PCIA):** The portion of your bill (either a charge or credit) intended to ensure that customers that purchase electricity from non-utility suppliers pay their share of the costs of generation acquired to serve them, unless otherwise exempt. The PCIA vintage describes the costs of generation a non-exempt customer needs to pay and is based on the generation resources acquired to serve the customer as of when the customer took generation service from the non-utility supplier.
10. **Franchise Fee Surcharge:** This surcharge is for franchise fees for electricity purchased from non-utility suppliers as provided in Schedule E-FFS.

Note: Customers that purchase both electricity and transportation service from PG&E (Bundled Service) pay charges 1 through 8; Customers that purchase electricity from non-utility suppliers pay charges 1 through 5, plus 7 through 10.

THIS BILL IS NOW DUE AND PAYABLE

PAYING YOUR BILL

By Mail: Send payment in the enclosed envelope.
In Person: Pay at any PG&E local office or pay station.
Unpaid Bill: May require a deposit as outlined below to reestablish credit and/or result in disconnection of service.
Pay By Phone: 1-866-735-7742. Certain restrictions apply
Online: at www.pge.com

PAST-DUE BILLS

- Residential – The bill is due when you receive it and becomes past due 19 days after the date presented.
- Nonresidential – The bill is due when you receive it and becomes past due 15 days after the date presented.
- Closing bills are considered past due if not paid 15 days after the mailing date for all customers.
- Unable to pay on time? Call to discuss reasonable payment arrangements, special programs and agencies that may be available to assist you.
- You may qualify for reduced rates under PG&E's CARE program. Call PG&E for an application.
- If a residential customer claims an inability to pay and PG&E does not offer reasonable payment arrangements, he/she may contact the CPUC at 1-800-649-7570 or by TDD/TTY at 415-703-2032.

DEPOSITS (Per PG&E Rules 6 & 7)

- To establish service, PG&E may require a deposit for residential (twice the average monthly bill) or non-residential (twice the maximum monthly bill)
- A deposit to re-establish credit or to increase an existing deposit may be up to twice the maximum monthly bill for residential accounts and may be up to twice the maximum monthly gas charge and electric charge for non-residential accounts, as determined by PG&E.

RULES AND RATES

The full text of PG&E's rules and rates is available for inspection upon request.
Optional rates are available to many customers and may lower your PG&E bills. Call PG&E for details.

DISPUTED BILLS

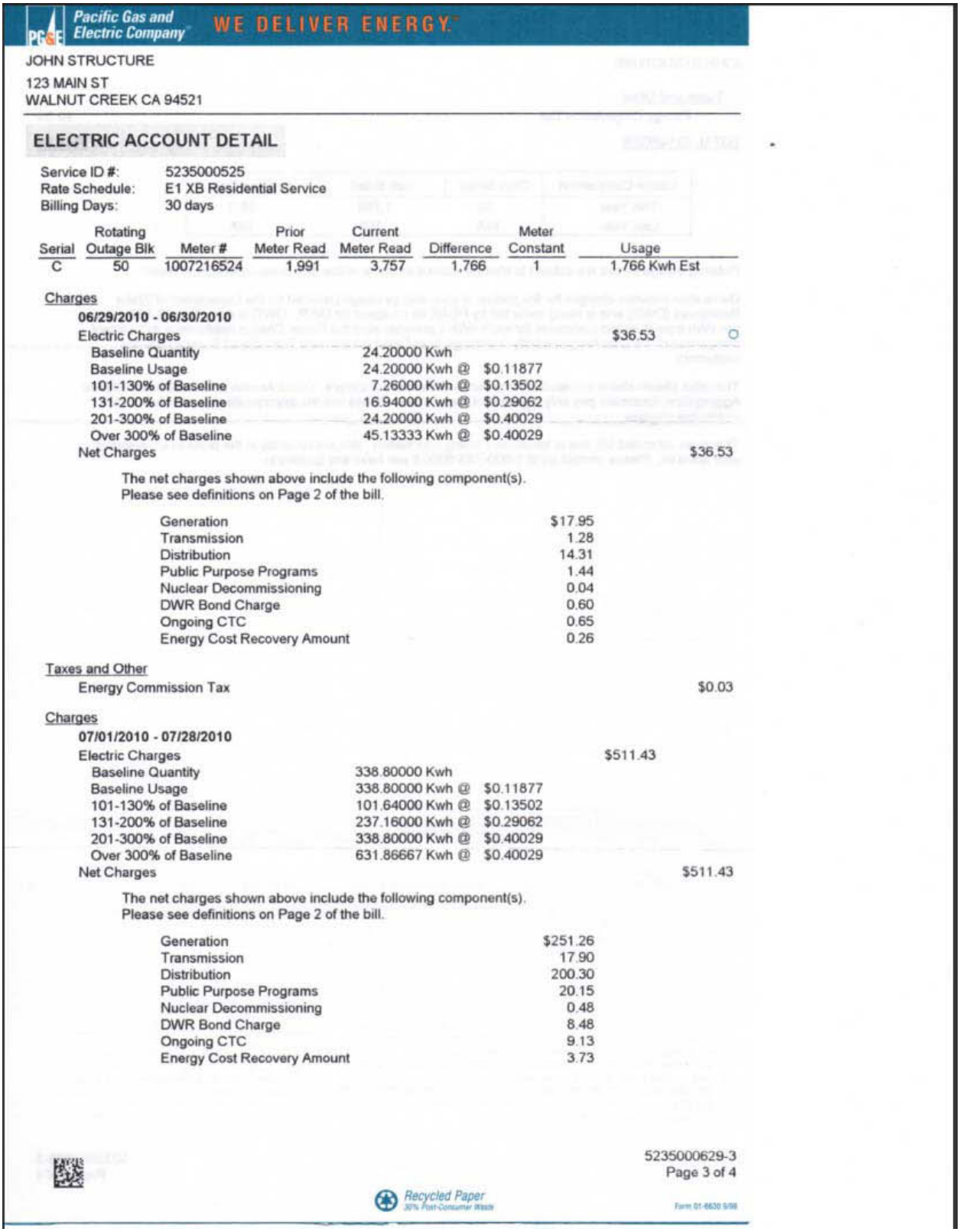
Should you question this bill, please request an explanation from PG&E. If you thereafter believe you have been billed incorrectly, send the bill and a statement supporting your belief that the bill is not correct to:

California Public Utilities Commission (CPUC)
Consumer Affairs Branch
505 Van Ness Avenue
San Francisco, CA 94102

To avoid having service turned off if the bill has not been paid, enclose a deposit for the amount of the bill made payable to the CPUC. If you are unable to pay the amount in dispute, you must inform the CPUC of your inability to pay. Your service cannot be discontinued for nonpayment of the disputed bill until the CPUC completes its review. The CPUC will review the basis of the billed amount, communicate the results of its review to the parties and make disbursements of any deposit. The CPUC will not, however, accept deposits when the dispute appears to be over matters that do not directly relate to the accuracy of the bill. Such matters include the quality of a utility's service, general level of rates, pending rate applications and sources of fuel or power.

Page 2 of 4

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The Structure Group, LLC.



Pacific Gas and Electric Company WE DELIVER ENERGY.

JOHN STRUCTURE
123 MAIN ST
WALNUT CREEK CA 94521

ELECTRIC ACCOUNT DETAIL

Service ID #: 5235000525
Rate Schedule: E1 XB Residential Service
Billing Days: 30 days

Serial	Rotating Outage Blk	Meter #	Prior Meter Read	Current Meter Read	Difference	Meter Constant	Usage
C	50	1007216524	1,991	3,757	1,766	1	1,766 Kwh Est

Charges

06/29/2010 - 06/30/2010

Electric Charges			$36.53
Baseline Quantity	24.20000 Kwh		
Baseline Usage	24.20000 Kwh @	$0.11877	
101-130% of Baseline	7.26000 Kwh @	$0.13502	
131-200% of Baseline	16.94000 Kwh @	$0.29062	
201-300% of Baseline	24.20000 Kwh @	$0.40029	
Over 300% of Baseline	45.13333 Kwh @	$0.40029	
Net Charges			$36.53

The net charges shown above include the following component(s).
Please see definitions on Page 2 of the bill.

Generation	$17.95
Transmission	1.28
Distribution	14.31
Public Purpose Programs	1.44
Nuclear Decommissioning	0.04
DWR Bond Charge	0.60
Ongoing CTC	0.65
Energy Cost Recovery Amount	0.26

Taxes and Other

Energy Commission Tax	$0.03

Charges

07/01/2010 - 07/28/2010

Electric Charges			$511.43
Baseline Quantity	338.80000 Kwh		
Baseline Usage	338.80000 Kwh @	$0.11877	
101-130% of Baseline	101.64000 Kwh @	$0.13502	
131-200% of Baseline	237.16000 Kwh @	$0.29062	
201-300% of Baseline	338.80000 Kwh @	$0.40029	
Over 300% of Baseline	631.86667 Kwh @	$0.40029	
Net Charges			$511.43

The net charges shown above include the following component(s).
Please see definitions on Page 2 of the bill.

Generation	$251.26
Transmission	17.90
Distribution	200.30
Public Purpose Programs	20.15
Nuclear Decommissioning	0.48
DWR Bond Charge	8.48
Ongoing CTC	9.13
Energy Cost Recovery Amount	3.73

5235000629-3
Page 3 of 4

Recycled Paper 30% Post-Consumer Waste

Form 01-6630 5/98

JOHN STRUCTURE

Taxes and Other

Energy Commission Tax	$0.36
TOTAL CHARGES	**$548.35**

Usage Comparison	Days Billed	Kwh Billed	Kwh per Day
This Year	30	1,766	58.9
Last Year	N/A	N/A	N/A

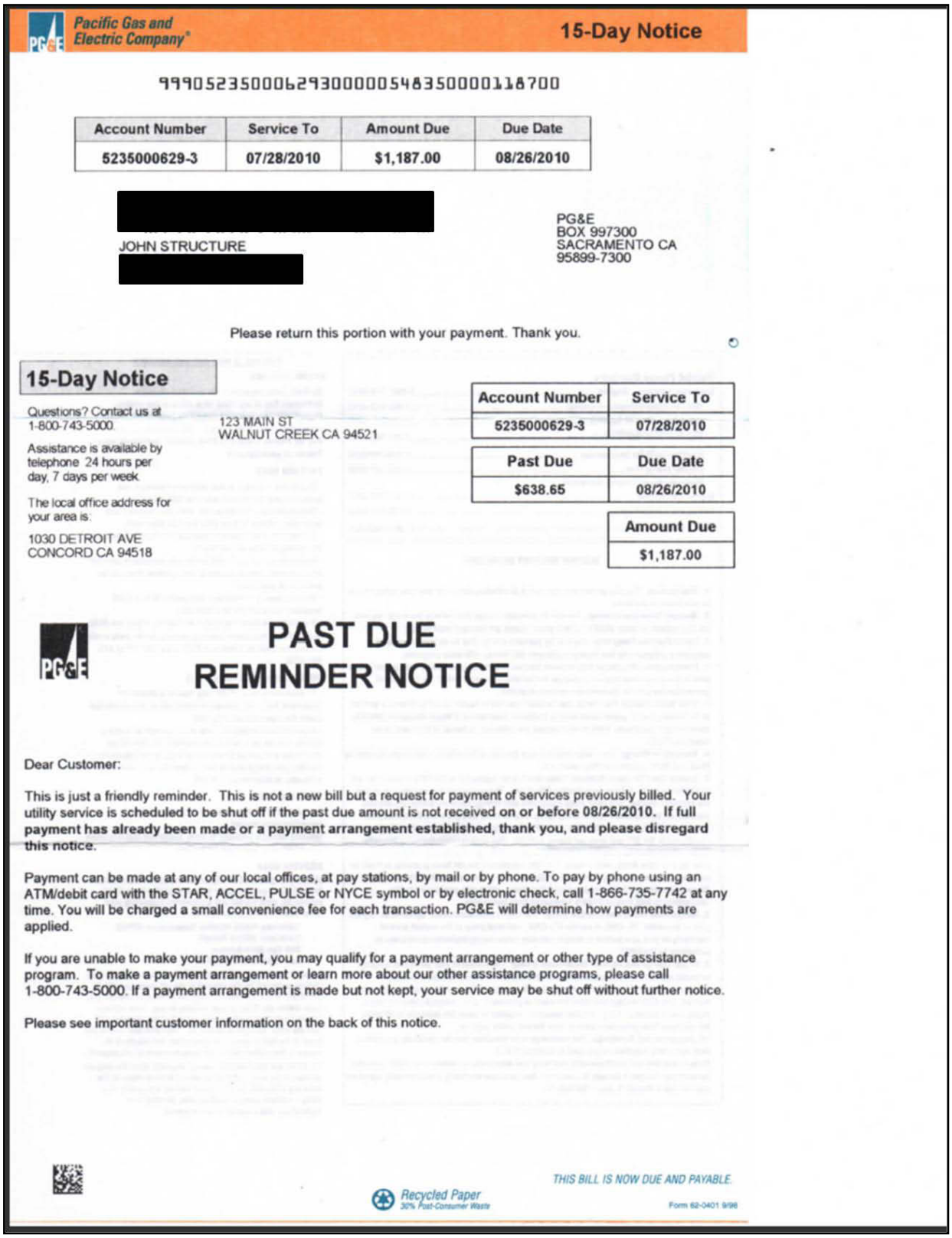
Rotating outage blocks are subject to change without advance notice due to operational conditions.

Generation includes charges for the portion of your energy usage provided by the Department of Water Resources (DWR) and is being collected by PG&E as an agent for DWR. DWR is collecting 23.139 cents per kWh from Bundled customers for each kWh it provides plus the Power Charge Indifference Adjustment component of the Cost Responsibility Surcharge from Direct Access and Transitional Bundled Service customers.

The rates shown above are applicable to bundled service customers. Direct Access and Community Choice Aggregation customers pay only a portion of these rates. Please see the appropriate rate schedule for the applicable charges.

This is an estimated bill due to insufficient billing information. We are currently in the process of reviewing your account. Please contact us at 1-800-743-5000 if you have any questions.

5235000629-3
Page 4 of 4



Pacific Gas and Electric Company®

15-Day Notice

99905235000629300000548350000118700

Account Number	Service To	Amount Due	Due Date
5235000629-3	07/28/2010	$1,187.00	08/26/2010

[redacted]

JOHN STRUCTURE

[redacted]

PG&E
BOX 997300
SACRAMENTO CA
95899-7300

Please return this portion with your payment. Thank you.

15-Day Notice

Questions? Contact us at 1-800-743-5000.

Assistance is available by telephone 24 hours per day, 7 days per week.

The local office address for your area is:

1030 DETROIT AVE
CONCORD CA 94518

123 MAIN ST
WALNUT CREEK CA 94521

Account Number	Service To
5235000629-3	07/28/2010

Past Due	Due Date
$638.65	08/26/2010

Amount Due
$1,187.00

PAST DUE REMINDER NOTICE

Dear Customer:

This is just a friendly reminder. This is not a new bill but a request for payment of services previously billed. Your utility service is scheduled to be shut off if the past due amount is not received on or before **08/26/2010. If full payment has already been made or a payment arrangement established, thank you, and please disregard this notice.**

Payment can be made at any of our local offices, at pay stations, by mail or by phone. To pay by phone using an ATM/debit card with the STAR, ACCEL, PULSE or NYCE symbol or by electronic check, call 1-866-735-7742 at any time. You will be charged a small convenience fee for each transaction. PG&E will determine how payments are applied.

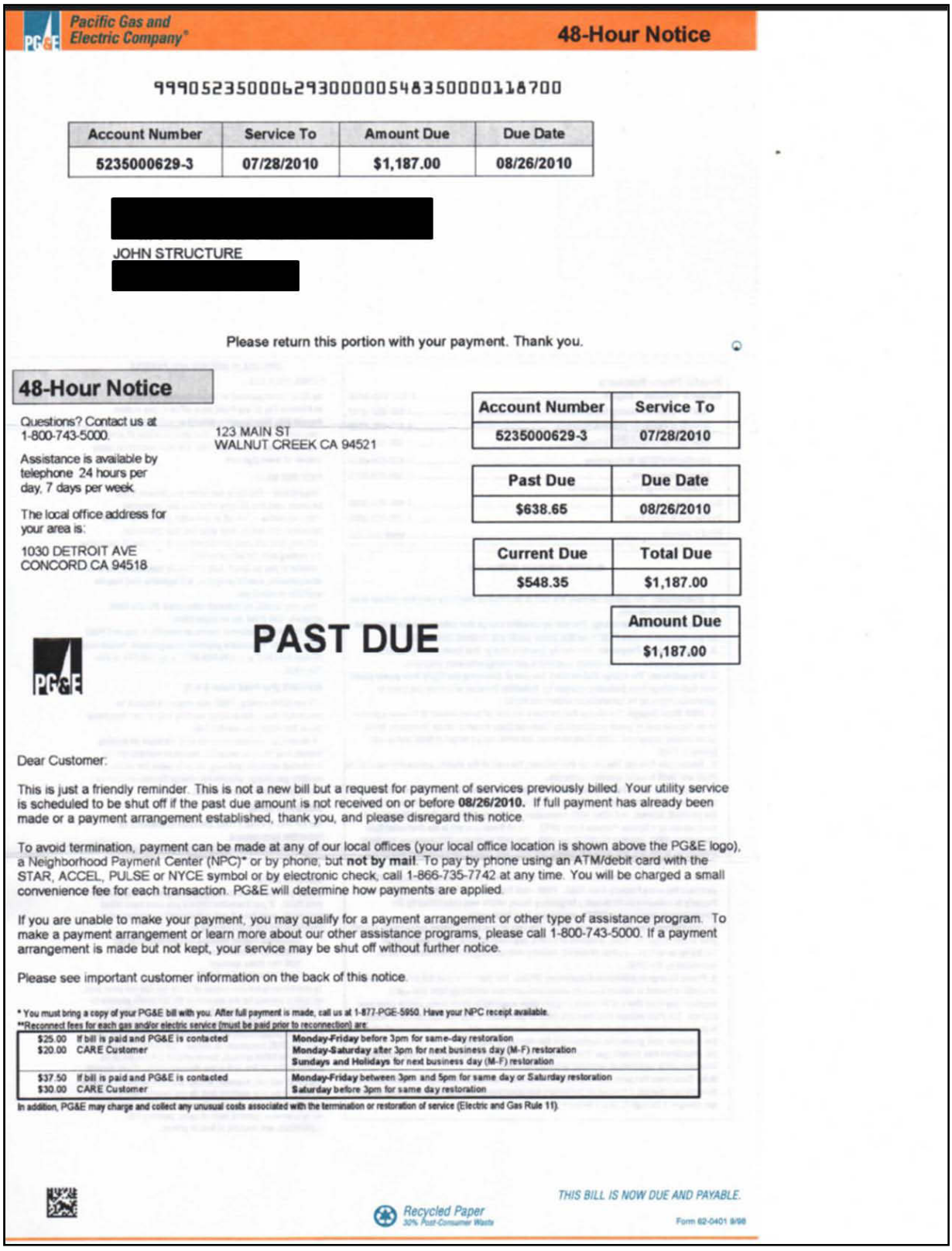
If you are unable to make your payment, you may qualify for a payment arrangement or other type of assistance program. To make a payment arrangement or learn more about our other assistance programs, please call 1-800-743-5000. If a payment arrangement is made but not kept, your service may be shut off without further notice.

Please see important customer information on the back of this notice.

Recycled Paper 30% Post-Consumer Waste

THIS BILL IS NOW DUE AND PAYABLE.

Form 62-0401 9/98



Pacific Gas and Electric Company®

48-Hour Notice

99905235000629300000054835000011870 0

Account Number	Service To	Amount Due	Due Date
5235000629-3	07/28/2010	$1,187.00	08/26/2010

[redacted]

JOHN STRUCTURE

[redacted]

Please return this portion with your payment. Thank you.

48-Hour Notice

Questions? Contact us at 1-800-743-5000.

Assistance is available by telephone 24 hours per day, 7 days per week.

The local office address for your area is:

1030 DETROIT AVE
CONCORD CA 94518

123 MAIN ST
WALNUT CREEK CA 94521

Account Number	Service To
5235000629-3	07/28/2010

Past Due	Due Date
$638.65	08/26/2010

Current Due	Total Due
$548.35	$1,187.00

Amount Due
$1,187.00

PAST DUE

Dear Customer:

This is just a friendly reminder. This is not a new bill but a request for payment of services previously billed. Your utility service is scheduled to be shut off if the past due amount is not received on or before **08/26/2010.** If full payment has already been made or a payment arrangement established, thank you, and please disregard this notice.

To avoid termination, payment can be made at any of our local offices (your local office location is shown above the PG&E logo), a Neighborhood Payment Center (NPC)* or by phone, but **not by mail**. To pay by phone using an ATM/debit card with the STAR, ACCEL, PULSE or NYCE symbol or by electronic check, call 1-866-735-7742 at any time. You will be charged a small convenience fee for each transaction. PG&E will determine how payments are applied.

If you are unable to make your payment, you may qualify for a payment arrangement or other type of assistance program. To make a payment arrangement or learn more about our other assistance programs, please call 1-800-743-5000. If a payment arrangement is made but not kept, your service may be shut off without further notice.

Please see important customer information on the back of this notice.

* You must bring a copy of your PG&E bill with you. After full payment is made, call us at 1-877-PGE-5950. Have your NPC receipt available.
**Reconnect fees for each gas and/or electric service (must be paid prior to reconnection) are:

$25.00 If bill is paid and PG&E is contacted $20.00 CARE Customer	**Monday-Friday** before 3pm for same-day restoration **Monday-Saturday** after 3pm for next business day (M-F) restoration **Sundays and Holidays** for next business day (M-F) restoration
$37.50 If bill is paid and PG&E is contacted $30.00 CARE Customer	**Monday-Friday** between 3pm and 5pm for same day or Saturday restoration **Saturday** before 3pm for same day restoration

In addition, PG&E may charge and collect any unusual costs associated with the termination or restoration of service (Electric and Gas Rule 11).

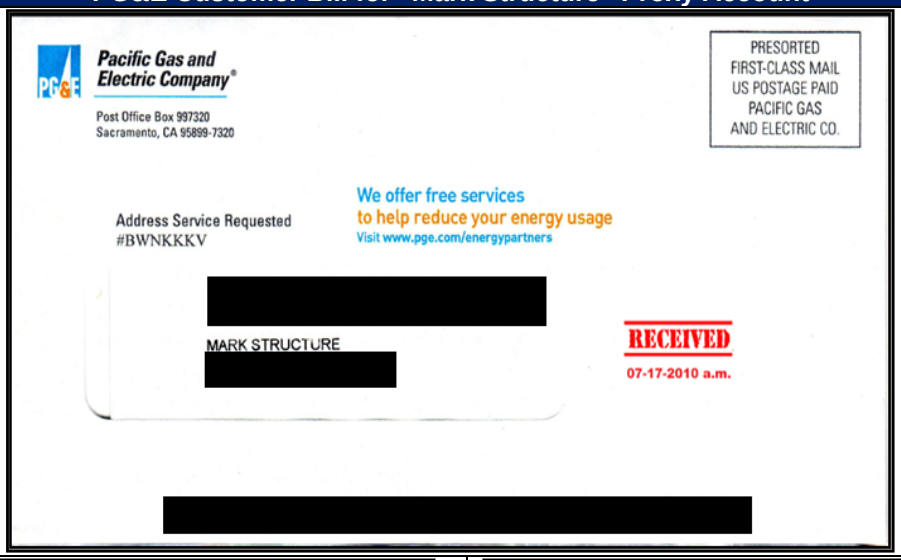
THIS BILL IS NOW DUE AND PAYABLE.

Recycled Paper 30% Post-Consumer Waste

Form 62-0401 9/98

12 End-to-End Test Case 2: "Mark Structure" Proxy Account Bills

PG&E Customer Bill for "Mark Structure" Proxy Account



Pacific Gas and Electric Company®
Post Office Box 997320
Sacramento, CA 95899-7320

PRESORTED
FIRST-CLASS MAIL
US POSTAGE PAID
PACIFIC GAS
AND ELECTRIC CO.

Address Service Requested
#BWNKKKV

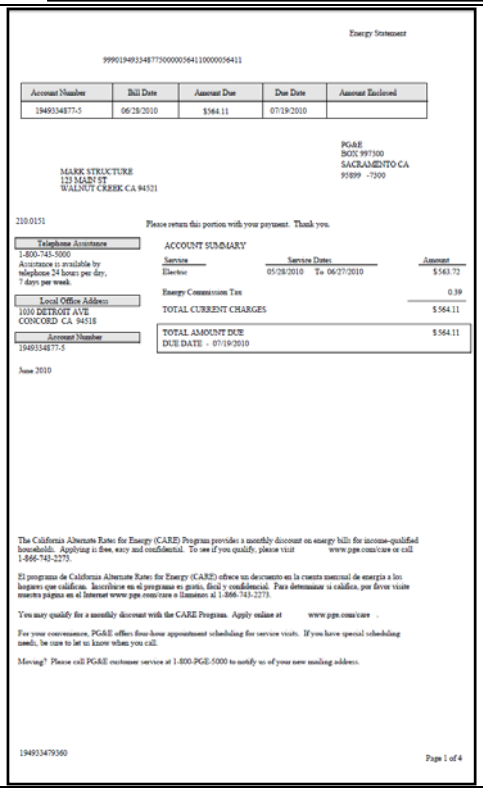
We offer free services
to help reduce your energy usage
Visit www.pge.com/energypartners

[redacted]

MARK STRUCTURE
[redacted]

RECEIVED
07-17-2010 a.m.

[redacted]



Energy Statement

9999194933487750000056411000005641 1

Account Number	Bill Date	Amount Due	Due Date	Amount Enclosed
1949334877-5	06/28/2010	$564.11	07/19/2010	

MARK STRUCTURE
123 MAIN ST
WALNUT CREEK CA 94521

PG&E
BOX 997300
SACRAMENTO CA
95899 -7300

210.0151

Please return this portion with your payment. Thank you.

Telephone Assistance
1-800-743-5000
Assistance is available by telephone 24 hours per day, 7 days per week

Local Office Address
1010 DETROIT AVE
CONCORD CA 94518

Account Number
1949334877-5

ACCOUNT SUMMARY

Service	Service Dates	Amount
Electric	05/28/2010 To 06/27/2010	$563.72
Energy Commission Tax		0.39
TOTAL CURRENT CHARGES		$564.11
TOTAL AMOUNT DUE DUE DATE - 07/19/2010		$564.11

June 2010

The California Alternate Rates for Energy (CARE) Program provides a monthly discount on energy bills for income-qualified households. Applying is free, easy and confidential. To see if you qualify, please visit www.pge.com/care or call 1-866-743-2273.

El programa de California Alternate Rates for Energy (CARE) ofrece un descuento en la cuenta mensual de energía a los hogares que califican. Inscribirse en el programa es gratis, fácil y confidencial. Para determinar si califica, por favor visite nuestra página en el Internet www.pge.com/care o llámenos al 1-866-743-2273.

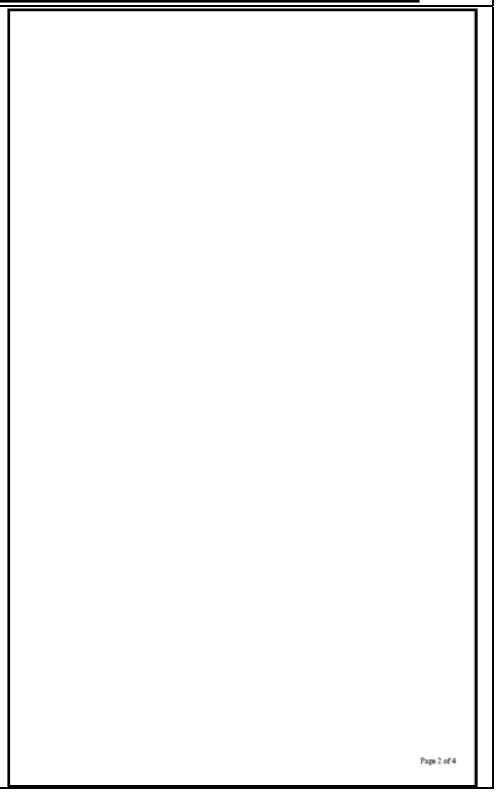
You may qualify for a monthly discount with the CARE Program. Apply online at www.pge.com/care .

For your convenience, PG&E offers four-hour appointment scheduling for service visits. If you have special scheduling needs, be sure to let us know when you call.

Moving? Please call PG&E customer service at 1-800-PGE-5000 to notify us of your new mailing address.

1949334879360

Page 1 of 4

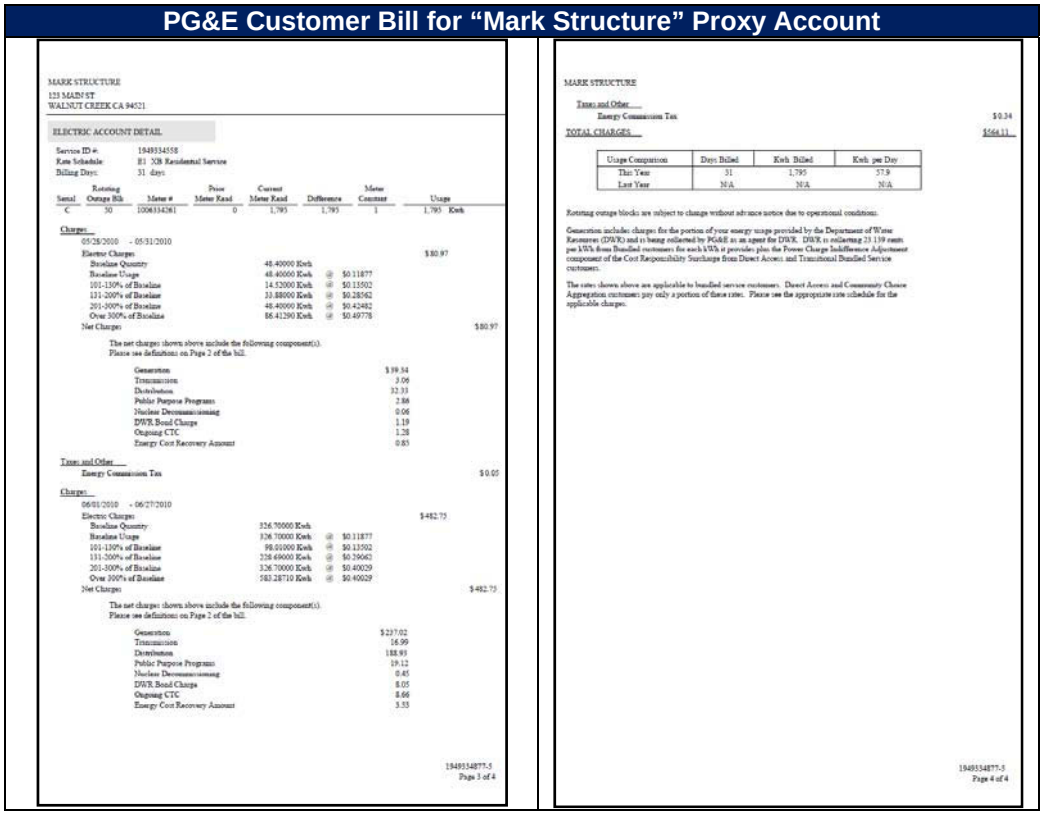


Page 2 of 4

Structure™

Appendix E
End-to-End Customer Bill Analysis

PG&E Customer Bill for "Mark Structure" Proxy Account



MARK STRUCTURE
123 MAIN ST
WALNUT CREEK CA 94521

ELECTRIC ACCOUNT DETAIL

Service ID #: 1949534558
Rate Schedule: E1 XB Residential Service
Billing Days: 31 days

Serial	Rotating Outage Blk	Meter #	Prior Meter Read	Current Meter Read	Difference	Meter Constant	Usage
C	30	1006134281	0	1,795	1,795	1	1,795 Kwh

Charges
05/28/2010 - 05/31/2010
Electric Charges $80.97
Baseline Quantity 48.40000 Kwh
Baseline Usage 48.40000 Kwh @ $0.11877
101-130% of Baseline 14.52000 Kwh @ $0.13502
131-200% of Baseline 33.88000 Kwh @ $0.28562
201-300% of Baseline 48.40000 Kwh @ $0.42482
Over 300% of Baseline 86.41290 Kwh @ $0.49778
Net Charges $80.97

The net charges shown above include the following component(s).
Please see definitions on Page 2 of the bill.

Generation	$39.54
Transmission	3.06
Distribution	32.33
Public Purpose Programs	2.86
Nuclear Decommissioning	0.06
DWR Bond Charge	1.19
Ongoing CTC	1.28
Energy Cost Recovery Amount	0.85

Taxes and Other
Energy Commission Tax $0.05

Charges
06/01/2010 - 06/27/2010
Electric Charges $482.75
Baseline Quantity 326.70000 Kwh
Baseline Usage 326.70000 Kwh @ $0.11877
101-130% of Baseline 98.01000 Kwh @ $0.13502
131-200% of Baseline 228.69000 Kwh @ $0.28062
201-300% of Baseline 326.70000 Kwh @ $0.40029
Over 300% of Baseline 583.28710 Kwh @ $0.40029
Net Charges $482.75

The net charges shown above include the following component(s).
Please see definitions on Page 2 of the bill.

Generation	$237.02
Transmission	16.99
Distribution	188.93
Public Purpose Programs	19.12
Nuclear Decommissioning	0.45
DWR Bond Charge	8.05
Ongoing CTC	8.66
Energy Cost Recovery Amount	3.53

1949534877-5
Page 3 of 4

MARK STRUCTURE

Taxes and Other
Energy Commission Tax $0.34
TOTAL CHARGES $564.11

Usage Comparison	Days Billed	Kwh Billed	Kwh per Day
This Year	31	1,795	57.9
Last Year	N/A	N/A	N/A

Rotating outage blocks are subject to change without advance notice due to operational conditions.

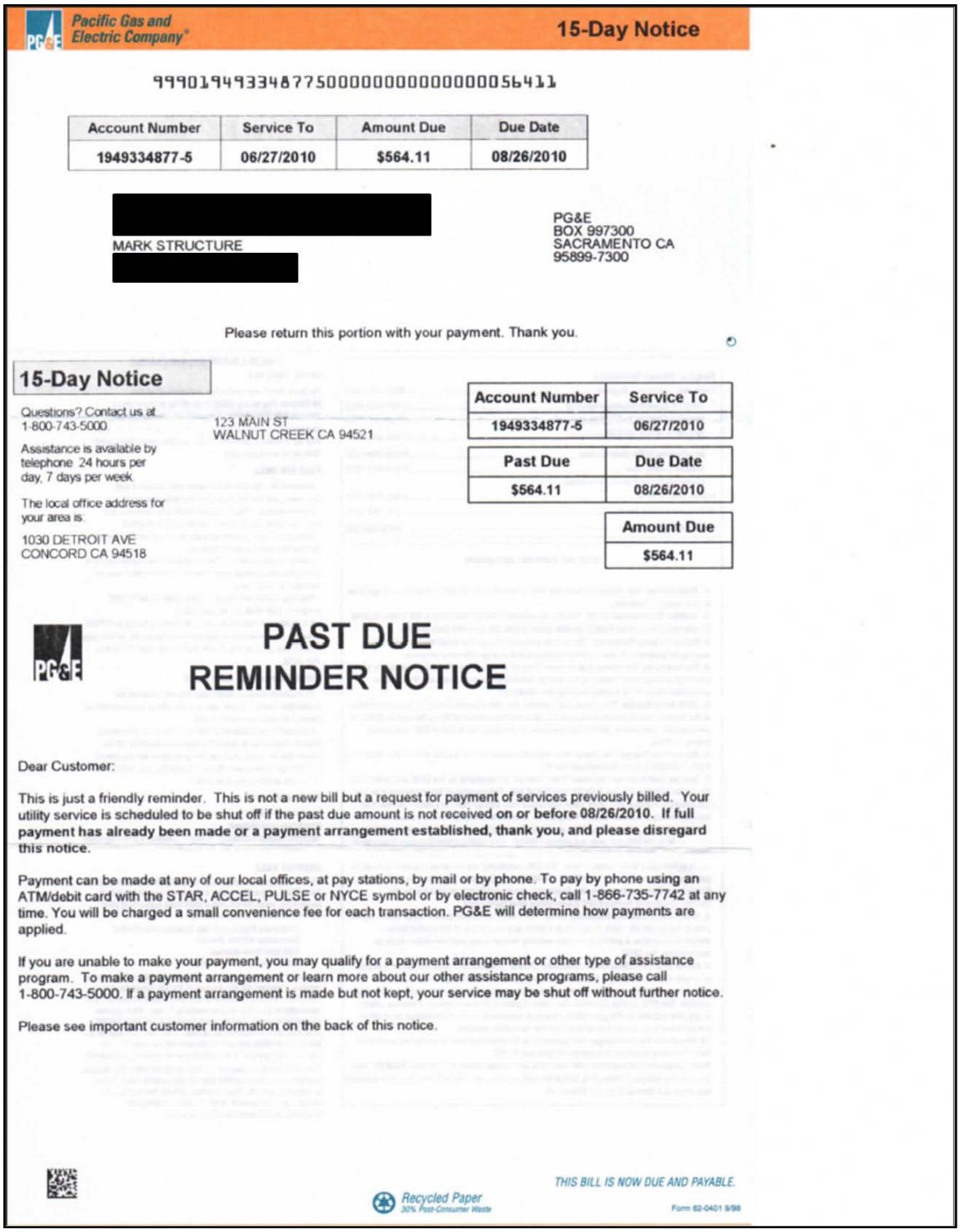
Generation includes charges for the portion of your energy usage provided by the Department of Water Resources (DWR) and is being collected by PG&E as an agent for DWR. DWR is collecting 23.139 cents per kWh from Bundled customers for each kWh it provides plus the Power Charge Indifference Adjustment component of the Cost Responsibility Surcharge from Direct Access and Transitional Bundled Service customers.

The rates shown above are applicable to bundled service customers. Direct Access and Community Choice Aggregation customers pay only a portion of these rates. Please see the appropriate rate schedule for the applicable charges.

1949534877-5
Page 4 of 4

Figure 12: End-to-End Test Case 1: Mark Structure Proxy Account Bill

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The Structure Group, LLC.



Pacific Gas and Electric Company®

15-Day Notice

99901949334877500000000000000056411

Account Number	Service To	Amount Due	Due Date
1949334877-5	06/27/2010	$564.11	08/26/2010

[redacted]
MARK STRUCTURE
[redacted]

PG&E
BOX 997300
SACRAMENTO CA
95899-7300

Please return this portion with your payment. Thank you.

15-Day Notice

Questions? Contact us at 1-800-743-5000.

Assistance is available by telephone 24 hours per day, 7 days per week.

The local office address for your area is:

1030 DETROIT AVE
CONCORD CA 94518

123 MAIN ST
WALNUT CREEK CA 94521

Account Number	Service To
1949334877-5	06/27/2010

Past Due	Due Date
$564.11	08/26/2010

Amount Due
$564.11

PAST DUE REMINDER NOTICE

Dear Customer:

This is just a friendly reminder. This is not a new bill but a request for payment of services previously billed. Your utility service is scheduled to be shut off if the past due amount is not received **on or before 08/26/2010. If full payment has already been made or a payment arrangement established, thank you, and please disregard this notice.**

Payment can be made at any of our local offices, at pay stations, by mail or by phone. To pay by phone using an ATM/debit card with the STAR, ACCEL, PULSE or NYCE symbol or by electronic check, call 1-866-735-7742 at any time. You will be charged a small convenience fee for each transaction. PG&E will determine how payments are applied.

If you are unable to make your payment, you may qualify for a payment arrangement or other type of assistance program. To make a payment arrangement or learn more about our other assistance programs, please call 1-800-743-5000. If a payment arrangement is made but not kept, your service may be shut off without further notice.

Please see important customer information on the back of this notice.

Recycled Paper 30% Post-Consumer Waste

THIS BILL IS NOW DUE AND PAYABLE.

Form 62-0401 9/98

Pacific Gas and Electric Company®

48-Hour Notice

99901949334877500000000000000056411

Account Number	Service To	Amount Due	Due Date
1949334877-5	06/27/2010	$564.11	08/26/2010

[redacted]

MARK STRUCTURE

[redacted]

Please return this portion with your payment. Thank you.

48-Hour Notice

Questions? Contact us at 1-800-743-5000.

Assistance is available by telephone 24 hours per day, 7 days per week.

The local office address for your area is:

1030 DETROIT AVE
CONCORD CA 94518

123 MAIN ST
WALNUT CREEK CA 94521

Account Number	Service To
1949334877-5	06/27/2010

Past Due	Due Date
$564.11	08/26/2010

Current Due	Total Due
$0.00	$564.11

Amount Due
$564.11

PAST DUE

Dear Customer:

This is just a friendly reminder. This is not a new bill but a request for payment of services previously billed. Your utility service is scheduled to be shut off if the past due amount is not received on or before **08/26/2010.** If full payment has already been made or a payment arrangement established, thank you, and please disregard this notice.

To avoid termination, payment can be made at any of our local offices (your local office location is shown above the PG&E logo), a Neighborhood Payment Center (NPC)* or by phone, but **not by mail**. To pay by phone using an ATM/debit card with the STAR, ACCEL, PULSE or NYCE symbol or by electronic check, call 1-866-735-7742 at any time. You will be charged a small convenience fee for each transaction. PG&E will determine how payments are applied.

If you are unable to make your payment, you may qualify for a payment arrangement or other type of assistance program. To make a payment arrangement or learn more about our other assistance programs, please call 1-800-743-5000. If a payment arrangement is made but not kept, your service may be shut off without further notice.

Please see important customer information on the back of this notice.

* You must bring a copy of your PG&E bill with you. After full payment is made, call us at 1-877-PGE-5050. Have your NPC receipt available.
**Reconnect fees for each gas and/or electric service (must be paid prior to reconnection) are:

$25.00 If bill is paid and PG&E is contacted $20.00 CARE Customer	**Monday-Friday** before 3pm for same-day restoration **Monday-Saturday** after 3pm for next business day (M-F) restoration **Sundays and Holidays** for next business day (M-F) restoration
$37.50 If bill is paid and PG&E is contacted $30.00 CARE Customer	**Monday-Friday** between 3pm and 5pm for same day or Saturday restoration **Saturday** before 3pm for same day restoration

In addition, PG&E may charge and collect any unusual costs associated with the termination or restoration of service (Electric and Gas Rule 11).

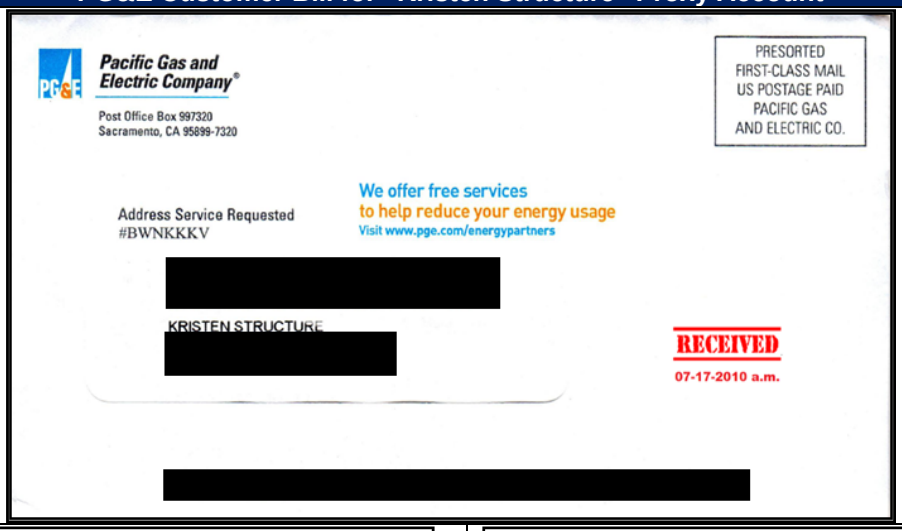
THIS BILL IS NOW DUE AND PAYABLE.

Recycled Paper 30% Post-Consumer Waste

Form 62-0401 9/98

13 End-to-End Test Case 3: "Kristen Structure" Proxy Account Bills

PG&E Customer Bill for "Kristen Structure" Proxy Account



Pacific Gas and Electric Company®
Post Office Box 997320
Sacramento, CA 95899-7320

PRESORTED
FIRST-CLASS MAIL
US POSTAGE PAID
PACIFIC GAS
AND ELECTRIC CO.

Address Service Requested
#BWNKKKV

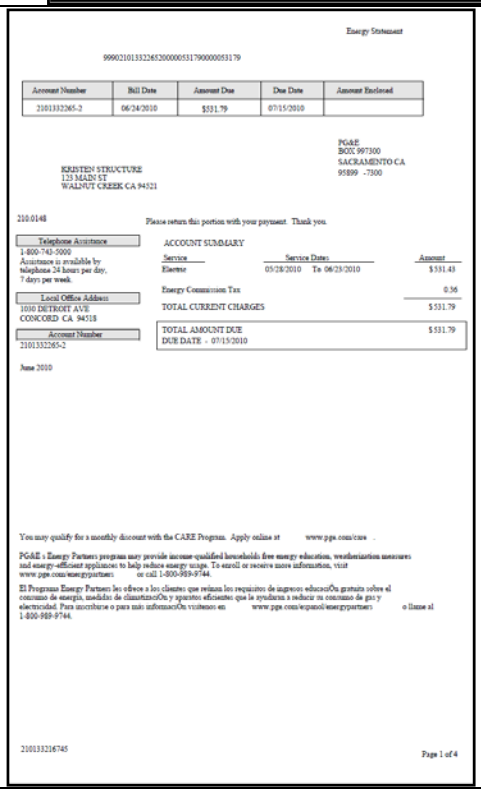
We offer free services
to help reduce your energy usage
Visit www.pge.com/energypartners

[redacted]

KRISTEN STRUCTURE
[redacted]

RECEIVED
07-17-2010 a.m.

[redacted]



Energy Statement

Account Number	Bill Date	Amount Due	Due Date	Amount Enclosed
2101332265-2	06/24/2010	$531.79	07/15/2010	

PG&E
BOX 997300
SACRAMENTO CA
95899 -7300

KRISTEN STRUCTURE
123 MAIN ST
WALNUT CREEK CA 94521

210.0148

Please return this portion with your payment. Thank you.

Telephone Assistance
1-800-743-5000
Assistance is available by telephone 24 hours per day, 7 days per week.

Local Office Address
1030 DETROIT AVE
CONCORD CA 94518

Account Number
2101332265-2

ACCOUNT SUMMARY

Service	Service Dates	Amount
Electric	05/28/2010 To 06/23/2010	$531.43
Energy Commission Tax		0.36
TOTAL CURRENT CHARGES		$531.79
TOTAL AMOUNT DUE DUE DATE - 07/15/2010		$531.79

June 2010

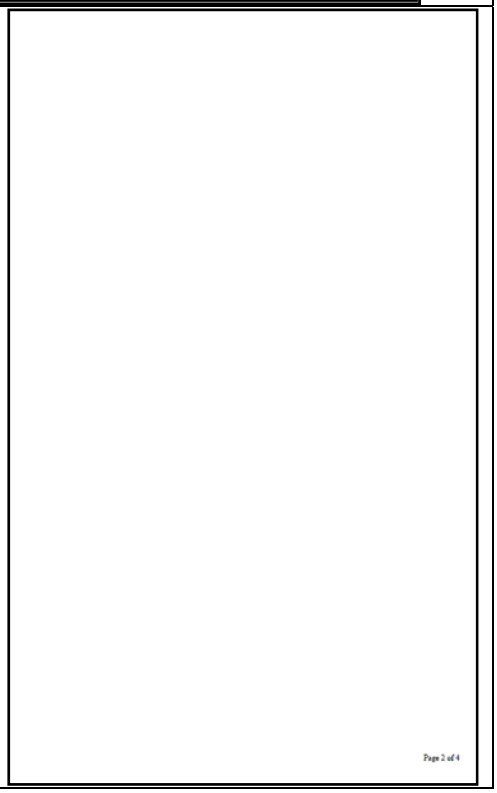
You may qualify for a monthly discount with the CARE Program. Apply online at www.pge.com/care .

PG&E's Energy Partners program may provide income-qualified households free energy education, weatherization measures and energy-efficient appliances to help reduce energy usage. To enroll or receive more information, visit www.pge.com/energypartners or call 1-800-989-9744.

El Programa Energy Partners les ofrece a los clientes que reúnan los requisitos de ingresos educación gratuita sobre el consumo de energía, medidas de climatización y aparatos eficientes que la ayudarán a reducir su consumo de gas y electricidad. Para inscribirse o para más información visítenos en www.pge.com/espanol/energypartners o llame al 1-800-989-9744.

210133216745

Page 1 of 4

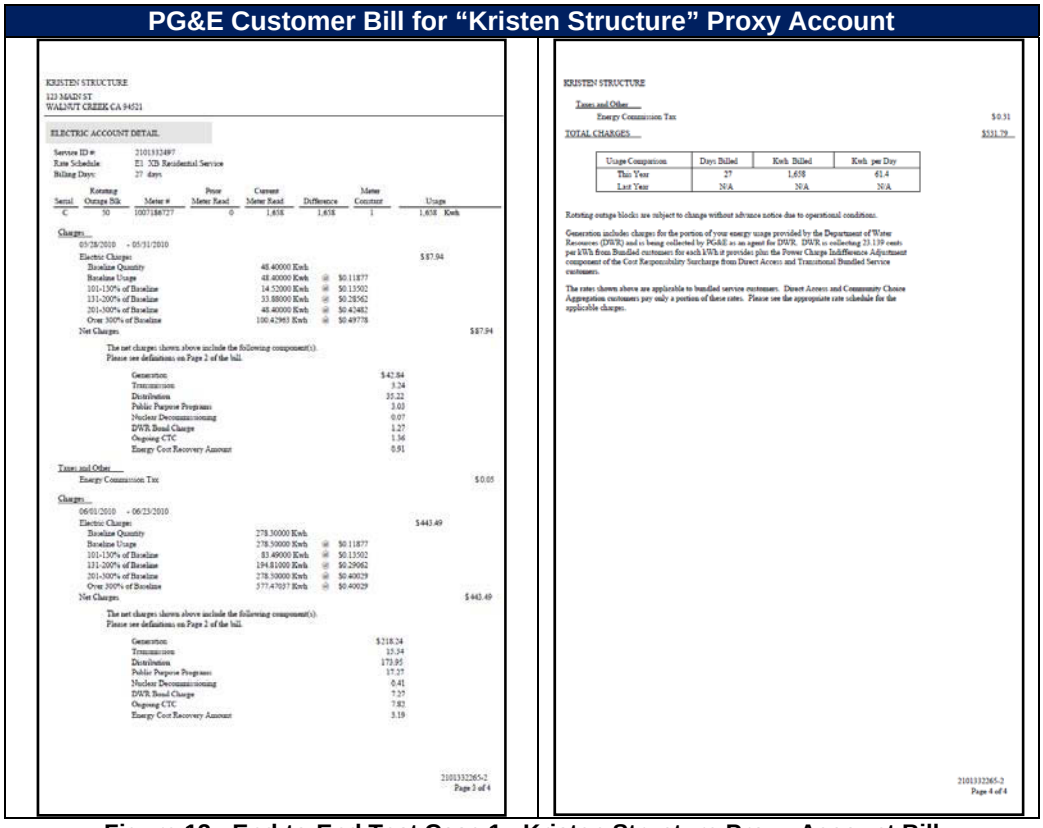


Page 2 of 4

Structure™

Appendix E
End-to-End Customer Bill Analysis

PG&E Customer Bill for "Kristen Structure" Proxy Account



KRISTEN STRUCTURE
123 MAIN ST
WALNUT CREEK CA 94521

ELECTRIC ACCOUNT DETAIL

Service ID #: 2101932497
Rate Schedule: E1 Xb Residential Service
Billing Days: 27 days

Serial	Rotating Outage Blk	Meter #	Prior Meter Read	Current Meter Read	Difference	Meter Constant	Usage
C	50	10071867277	0	1,658	1,658	1	1,658 Kwh

Charges
05/28/2010 - 05/31/2010
Electric Charges: $87.94

Baseline Quantity	48.40000 Kwh		
Baseline Usage	48.40000 Kwh	@	$0.11877
101-130% of Baseline	14.52000 Kwh	@	$0.13502
131-200% of Baseline	33.88000 Kwh	@	$0.28562
201-300% of Baseline	48.40000 Kwh	@	$0.40482
Over 300% of Baseline	100.42965 Kwh	@	$0.49778

Net Charges: $87.94

The net charges shown above include the following component(s). Please see definitions on Page 2 of the bill.

Generation:	$42.84
Transmission:	3.24
Distribution:	35.22
Public Purpose Programs:	3.03
Nuclear Decommissioning:	0.07
DWR Bond Charge:	1.27
Ongoing CTC:	1.36
Energy Cost Recovery Amount:	0.91

Taxes and Other
Energy Commission Tax: $0.05

Charges
06/01/2010 - 06/23/2010
Electric Charges: $443.49

Baseline Quantity	278.30000 Kwh		
Baseline Usage	278.30000 Kwh	@	$0.11877
101-130% of Baseline	83.49000 Kwh	@	$0.13502
131-200% of Baseline	194.81000 Kwh	@	$0.29062
201-300% of Baseline	278.30000 Kwh	@	$0.40029
Over 300% of Baseline	377.47937 Kwh	@	$0.49029

Net Charges: $443.49

The net charges shown above include the following component(s). Please see definitions on Page 2 of the bill.

Generation:	$218.24
Transmission:	15.34
Distribution:	170.95
Public Purpose Programs:	17.27
Nuclear Decommissioning:	0.41
DWR Bond Charge:	7.27
Ongoing CTC:	7.82
Energy Cost Recovery Amount:	5.19

2101332265-2
Page 3 of 4

KRISTEN STRUCTURE

Taxes and Other
Energy Commission Tax: $0.31

TOTAL CHARGES: $531.79

Usage Comparison	Days Billed	Kwh Billed	Kwh per Day
This Year	27	1,658	61.4
Last Year	N/A	N/A	N/A

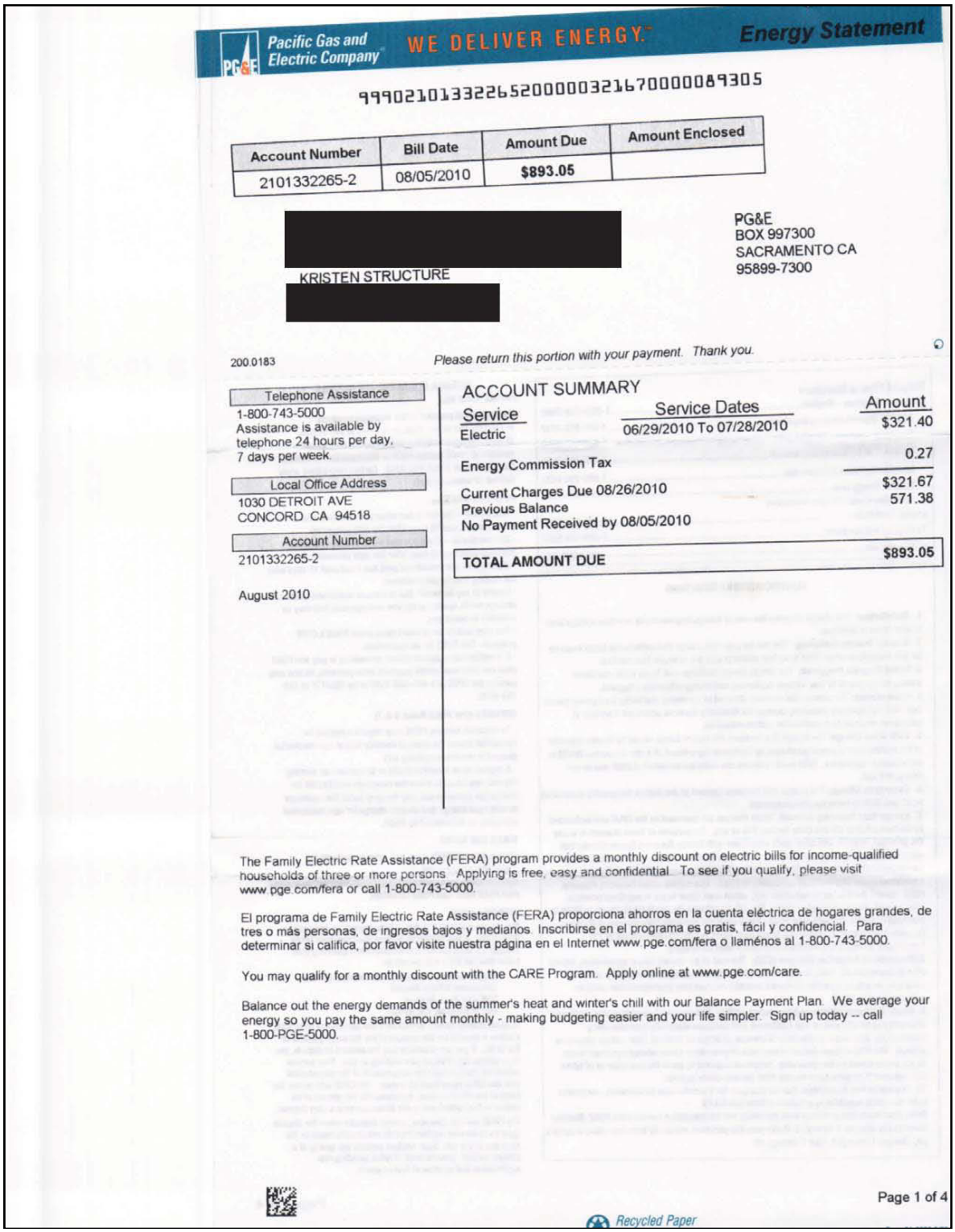
Rotating outage blocks are subject to change without advance notice due to operational conditions.

Generation includes charges for the portion of your energy usage provided by the Department of Water Resources (DWR) and is being collected by PG&E as an agent for DWR. DWR is collecting 23.139 cents per kWh from Bundled customers for each kWh it provides plus the Power Charge Indifference Adjustment component of the Cost Responsibility Surcharge from Direct Access and Transitional Bundled Service customers.

The rates shown above are applicable to bundled service customers. Direct Access and Community Choice Aggregation customers pay only a portion of these rates. Please see the appropriate rate schedule for the applicable charges.

2101332265-2
Page 4 of 4

Figure 13: End-to-End Test Case 1: Kristen Structure Proxy Account Bill



Pacific Gas and Electric Company WE DELIVER ENERGY.™ Energy Statement

99902101332265200000321670000089305

Account Number	Bill Date	Amount Due	Amount Enclosed
2101332265-2	08/05/2010	$893.05	

[redacted]

KRISTEN STRUCTURE

[redacted]

PG&E
BOX 997300
SACRAMENTO CA
95899-7300

200.0183

Please return this portion with your payment. Thank you.

Telephone Assistance
1-800-743-5000
Assistance is available by telephone 24 hours per day, 7 days per week.

Local Office Address
1030 DETROIT AVE
CONCORD CA 94518

Account Number
2101332265-2

August 2010

ACCOUNT SUMMARY

Service	Service Dates	Amount
Electric	06/29/2010 To 07/28/2010	$321.40
Energy Commission Tax		0.27
Current Charges Due 08/26/2010		$321.67
Previous Balance		571.38
No Payment Received by 08/05/2010		
TOTAL AMOUNT DUE		$893.05

The Family Electric Rate Assistance (FERA) program provides a monthly discount on electric bills for income-qualified households of three or more persons. Applying is free, easy and confidential. To see if you qualify, please visit www.pge.com/fera or call 1-800-743-5000.

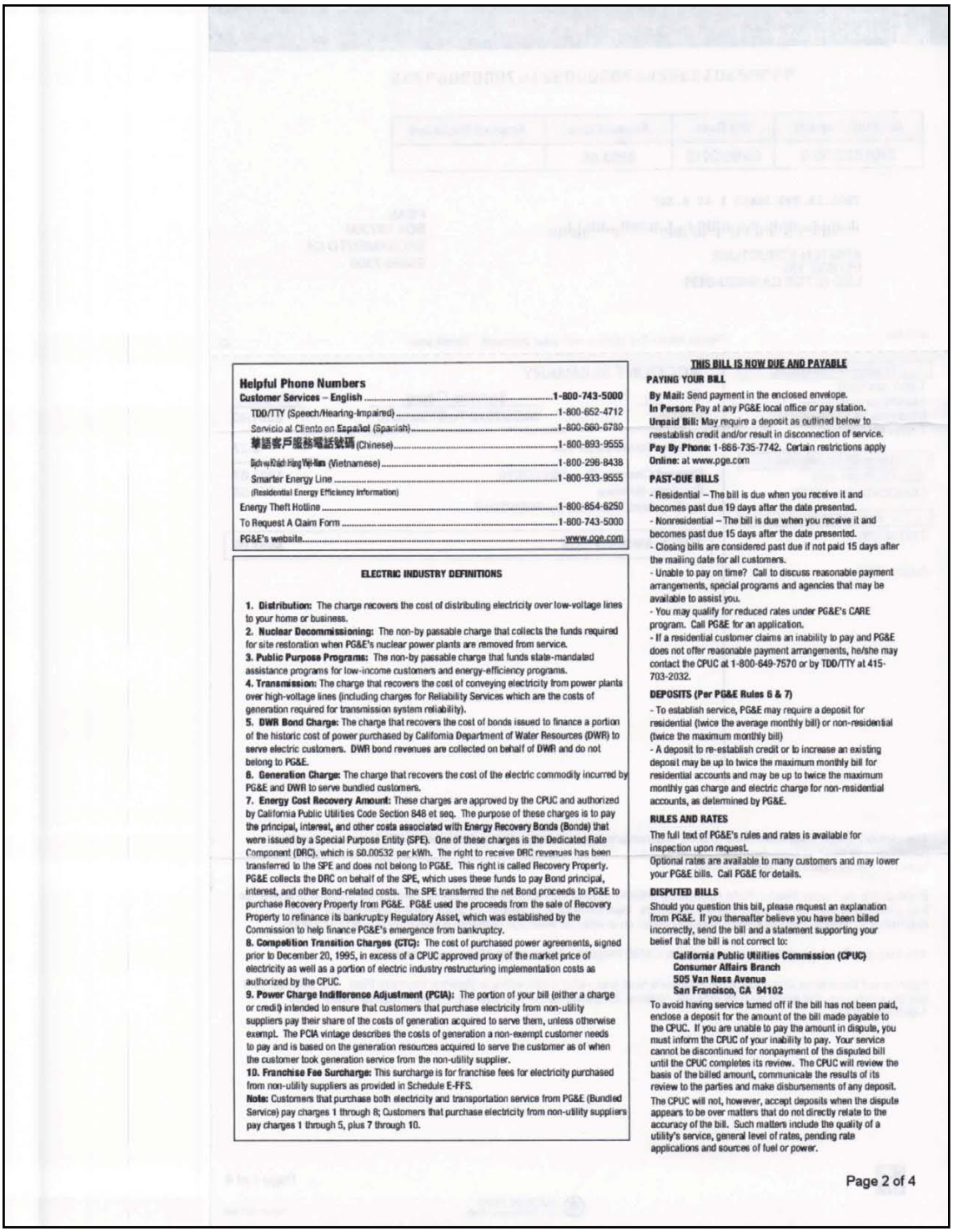
El programa de Family Electric Rate Assistance (FERA) proporciona ahorros en la cuenta eléctrica de hogares grandes, de tres o más personas, de ingresos bajos y medianos. Inscribirse en el programa es gratis, fácil y confidencial. Para determinar si califica, por favor visite nuestra página en el Internet www.pge.com/fera o llaménos al 1-800-743-5000.

You may qualify for a monthly discount with the CARE Program. Apply online at www.pge.com/care.

Balance out the energy demands of the summer's heat and winter's chill with our Balance Payment Plan. We average your energy so you pay the same amount monthly - making budgeting easier and your life simpler. Sign up today -- call 1-800-PGE-5000.

Page 1 of 4

Recycled Paper



Helpful Phone Numbers

Customer Services – English	**1-800-743-5000**
TDD/TTY (Speech/Hearing-Impaired)	1-800-652-4712
Servicio al Cliente en **Español** (Spanish)	1-800-660-6789
華語客戶服務電話號碼 (Chinese)	1-800-893-9555
Dịch vụ Khách Hàng Việt-Nam (Vietnamese)	1-800-298-8438
Smarter Energy Line (Residential Energy Efficiency Information)	1-800-933-9555
Energy Theft Hotline	1-800-854-6250
To Request A Claim Form	1-800-743-5000
PG&E's website	www.pge.com

ELECTRIC INDUSTRY DEFINITIONS

1. **Distribution:** The charge recovers the cost of distributing electricity over low-voltage lines to your home or business.
2. **Nuclear Decommissioning:** The non-by passable charge that collects the funds required for site restoration when PG&E's nuclear power plants are removed from service.
3. **Public Purpose Programs:** The non-by passable charge that funds state-mandated assistance programs for low-income customers and energy-efficiency programs.
4. **Transmission:** The charge that recovers the cost of conveying electricity from power plants over high-voltage lines (including charges for Reliability Services which are the costs of generation required for transmission system reliability).
5. **DWR Bond Charge:** The charge that recovers the cost of bonds issued to finance a portion of the historic cost of power purchased by California Department of Water Resources (DWR) to serve electric customers. DWR bond revenues are collected on behalf of DWR and do not belong to PG&E.
6. **Generation Charge:** The charge that recovers the cost of the electric commodity incurred by PG&E and DWR to serve bundled customers.
7. **Energy Cost Recovery Amount:** These charges are approved by the CPUC and authorized by California Public Utilities Code Section 848 et seq. The purpose of these charges is to pay the principal, interest, and other costs associated with Energy Recovery Bonds (Bonds) that were issued by a Special Purpose Entity (SPE). One of these charges is the Dedicated Rate Component (DRC), which is $0.00532 per kWh. The right to receive DRC revenues has been transferred to the SPE and does not belong to PG&E. This right is called Recovery Property. PG&E collects the DRC on behalf of the SPE, which uses these funds to pay Bond principal, interest, and other Bond-related costs. The SPE transferred the net Bond proceeds to PG&E to purchase Recovery Property from PG&E. PG&E used the proceeds from the sale of Recovery Property to refinance its bankruptcy Regulatory Asset, which was established by the Commission to help finance PG&E's emergence from bankruptcy.
8. **Competition Transition Charges (CTC):** The cost of purchased power agreements, signed prior to December 20, 1995, in excess of a CPUC approved proxy of the market price of electricity as well as a portion of electric industry restructuring implementation costs as authorized by the CPUC.
9. **Power Charge Indifference Adjustment (PCIA):** The portion of your bill (either a charge or credit) intended to ensure that customers that purchase electricity from non-utility suppliers pay their share of the costs of generation acquired to serve them, unless otherwise exempt. The PCIA vintage describes the costs of generation a non-exempt customer needs to pay and is based on the generation resources acquired to serve the customer as of when the customer took generation service from the non-utility supplier.
10. **Franchise Fee Surcharge:** This surcharge is for franchise fees for electricity purchased from non-utility suppliers as provided in Schedule E-FFS.

Note: Customers that purchase both electricity and transportation service from PG&E (Bundled Service) pay charges 1 through 8; Customers that purchase electricity from non-utility suppliers pay charges 1 through 5, plus 7 through 10.

THIS BILL IS NOW DUE AND PAYABLE

PAYING YOUR BILL

By Mail: Send payment in the enclosed envelope.
In Person: Pay at any PG&E local office or pay station.
Unpaid Bill: May require a deposit as outlined below to reestablish credit and/or result in disconnection of service.
Pay By Phone: 1-866-735-7742. Certain restrictions apply
Online: at www.pge.com

PAST-DUE BILLS

- Residential – The bill is due when you receive it and becomes past due 19 days after the date presented.
- Nonresidential – The bill is due when you receive it and becomes past due 15 days after the date presented.
- Closing bills are considered past due if not paid 15 days after the mailing date for all customers.
- Unable to pay on time? Call to discuss reasonable payment arrangements, special programs and agencies that may be available to assist you.
- You may qualify for reduced rates under PG&E's CARE program. Call PG&E for an application.
- If a residential customer claims an inability to pay and PG&E does not offer reasonable payment arrangements, he/she may contact the CPUC at 1-800-649-7570 or by TDD/TTY at 415-703-2032.

DEPOSITS (Per PG&E Rules 6 & 7)

- To establish service, PG&E may require a deposit for residential (twice the average monthly bill) or non-residential (twice the maximum monthly bill)
- A deposit to re-establish credit or to increase an existing deposit may be up to twice the maximum monthly bill for residential accounts and may be up to twice the maximum monthly gas charge and electric charge for non-residential accounts, as determined by PG&E.

RULES AND RATES

The full text of PG&E's rules and rates is available for inspection upon request.
Optional rates are available to many customers and may lower your PG&E bills. Call PG&E for details.

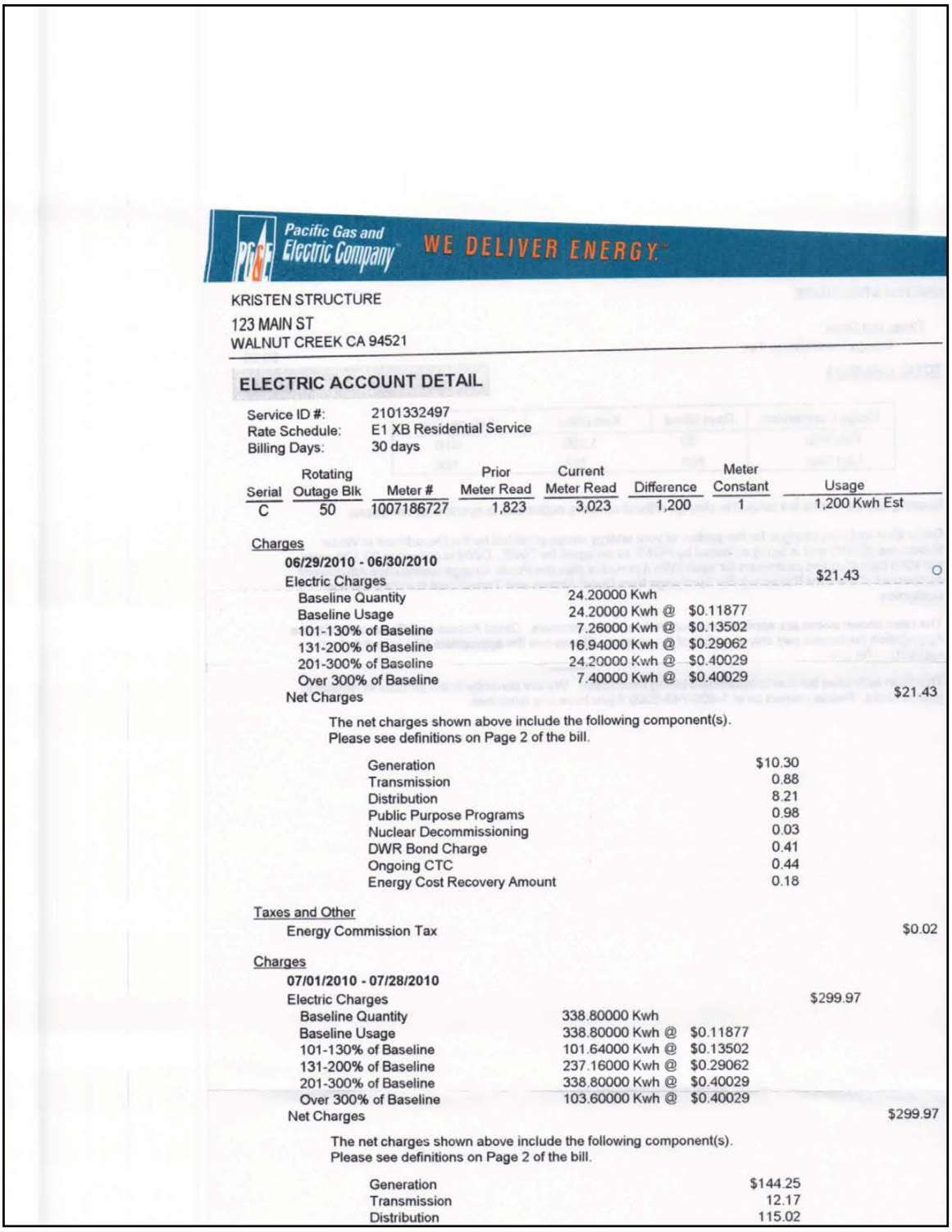
DISPUTED BILLS

Should you question this bill, please request an explanation from PG&E. If you thereafter believe you have been billed incorrectly, send the bill and a statement supporting your belief that the bill is not correct to:

California Public Utilities Commission (CPUC)
Consumer Affairs Branch
505 Van Ness Avenue
San Francisco, CA 94102

To avoid having service turned off if the bill has not been paid, enclose a deposit for the amount of the bill made payable to the CPUC. If you are unable to pay the amount in dispute, you must inform the CPUC of your inability to pay. Your service cannot be discontinued for nonpayment of the disputed bill until the CPUC completes its review. The CPUC will review the basis of the billed amount, communicate the results of its review to the parties and make disbursements of any deposit.
The CPUC will not, however, accept deposits when the dispute appears to be over matters that do not directly relate to the accuracy of the bill. Such matters include the quality of a utility's service, general level of rates, pending rate applications and sources of fuel or power.

Page 2 of 4



Pacific Gas and Electric Company WE DELIVER ENERGY.

KRISTEN STRUCTURE
123 MAIN ST
WALNUT CREEK CA 94521

ELECTRIC ACCOUNT DETAIL

Service ID #: 2101332497
Rate Schedule: E1 XB Residential Service
Billing Days: 30 days

Serial	Rotating Outage Blk	Meter #	Prior Meter Read	Current Meter Read	Difference	Meter Constant	Usage
C	50	1007186727	1,823	3,023	1,200	1	1,200 Kwh Est

Charges
06/29/2010 - 06/30/2010
Electric Charges $21.43

Baseline Quantity	24.20000 Kwh		
Baseline Usage	24.20000 Kwh @	$0.11877	
101-130% of Baseline	7.26000 Kwh @	$0.13502	
131-200% of Baseline	16.94000 Kwh @	$0.29062	
201-300% of Baseline	24.20000 Kwh @	$0.40029	
Over 300% of Baseline	7.40000 Kwh @	$0.40029	

Net Charges $21.43

The net charges shown above include the following component(s).
Please see definitions on Page 2 of the bill.

Generation	$10.30
Transmission	0.88
Distribution	8.21
Public Purpose Programs	0.98
Nuclear Decommissioning	0.03
DWR Bond Charge	0.41
Ongoing CTC	0.44
Energy Cost Recovery Amount	0.18

Taxes and Other
Energy Commission Tax $0.02

Charges
07/01/2010 - 07/28/2010
Electric Charges $299.97

Baseline Quantity	338.80000 Kwh		
Baseline Usage	338.80000 Kwh @	$0.11877	
101-130% of Baseline	101.64000 Kwh @	$0.13502	
131-200% of Baseline	237.16000 Kwh @	$0.29062	
201-300% of Baseline	338.80000 Kwh @	$0.40029	
Over 300% of Baseline	103.60000 Kwh @	$0.40029	

Net Charges $299.97

The net charges shown above include the following component(s).
Please see definitions on Page 2 of the bill.

Generation	$144.25
Transmission	12.17
Distribution	115.02

Copyright 2010. Confidential and Proprietary to
The Structure Group, LLC.

KRISTEN STRUCTURE

Taxes and Other

Energy Commission Tax $0.25

TOTAL CHARGES **$321.67**

Usage Comparison	Days Billed	Kwh Billed	Kwh per Day
This Year	30	1,200	40.0
Last Year	N/A	N/A	N/A

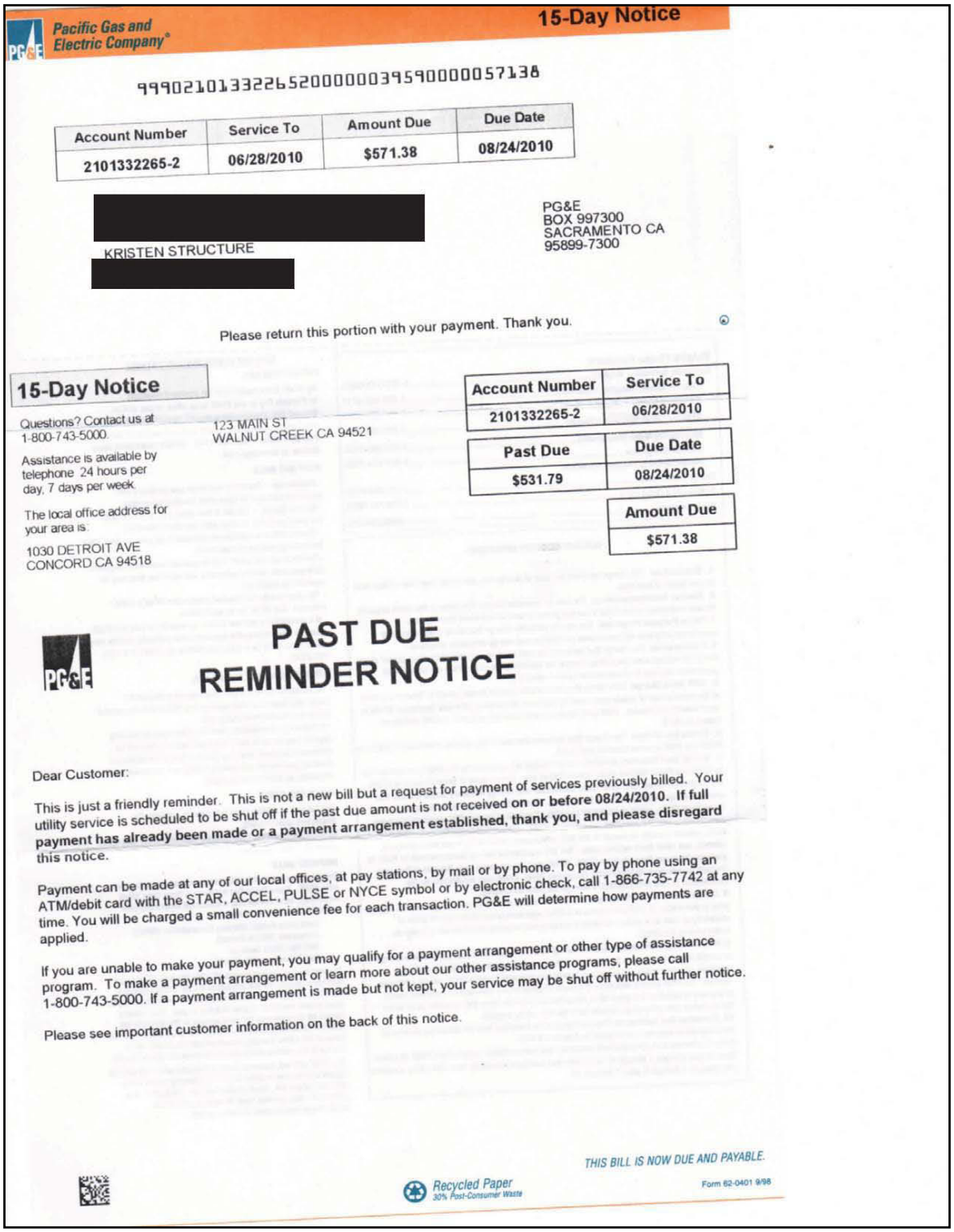
Rotating outage blocks are subject to change without advance notice due to operational conditions.

Generation includes charges for the portion of your energy usage provided by the Department of Water Resources (DWR) and is being collected by PG&E as an agent for DWR. DWR is collecting 23.139 cents per kWh from Bundled customers for each kWh it provides plus the Power Charge Indifference Adjustment component of the Cost Responsibility Surcharge from Direct Access and Transitional Bundled Service customers.

The rates shown above are applicable to bundled service customers. Direct Access and Community Choice Aggregation customers pay only a portion of these rates. Please see the appropriate rate schedule for the applicable charges.

This is an estimated bill due to insufficient billing information. We are currently in the process of reviewing your account. Please contact us at 1-800-743-5000 if you have any questions.

2101332265-2
Page 4 of 4



Pacific Gas and Electric Company

15-Day Notice

99902101332265200000039590000057138

Account Number	Service To	Amount Due	Due Date
2101332265-2	06/28/2010	$571.38	08/24/2010

[redacted]

KRISTEN STRUCTURE

[redacted]

PG&E
BOX 997300
SACRAMENTO CA
95899-7300

Please return this portion with your payment. Thank you.

15-Day Notice

Questions? Contact us at 1-800-743-5000.

Assistance is available by telephone 24 hours per day, 7 days per week.

The local office address for your area is:

1030 DETROIT AVE
CONCORD CA 94518

123 MAIN ST
WALNUT CREEK CA 94521

Account Number	Service To
2101332265-2	06/28/2010

Past Due	Due Date
$531.79	08/24/2010

Amount Due
$571.38

PG&E

PAST DUE
REMINDER NOTICE

Dear Customer:

This is just a friendly reminder. This is not a new bill but a request for payment of services previously billed. Your utility service is scheduled to be shut off if the past due amount is not received **on or before 08/24/2010. If full payment has already been made or a payment arrangement established, thank you, and please disregard** this notice.

Payment can be made at any of our local offices, at pay stations, by mail or by phone. To pay by phone using an ATM/debit card with the STAR, ACCEL, PULSE or NYCE symbol or by electronic check, call 1-866-735-7742 at any time. You will be charged a small convenience fee for each transaction. PG&E will determine how payments are applied.

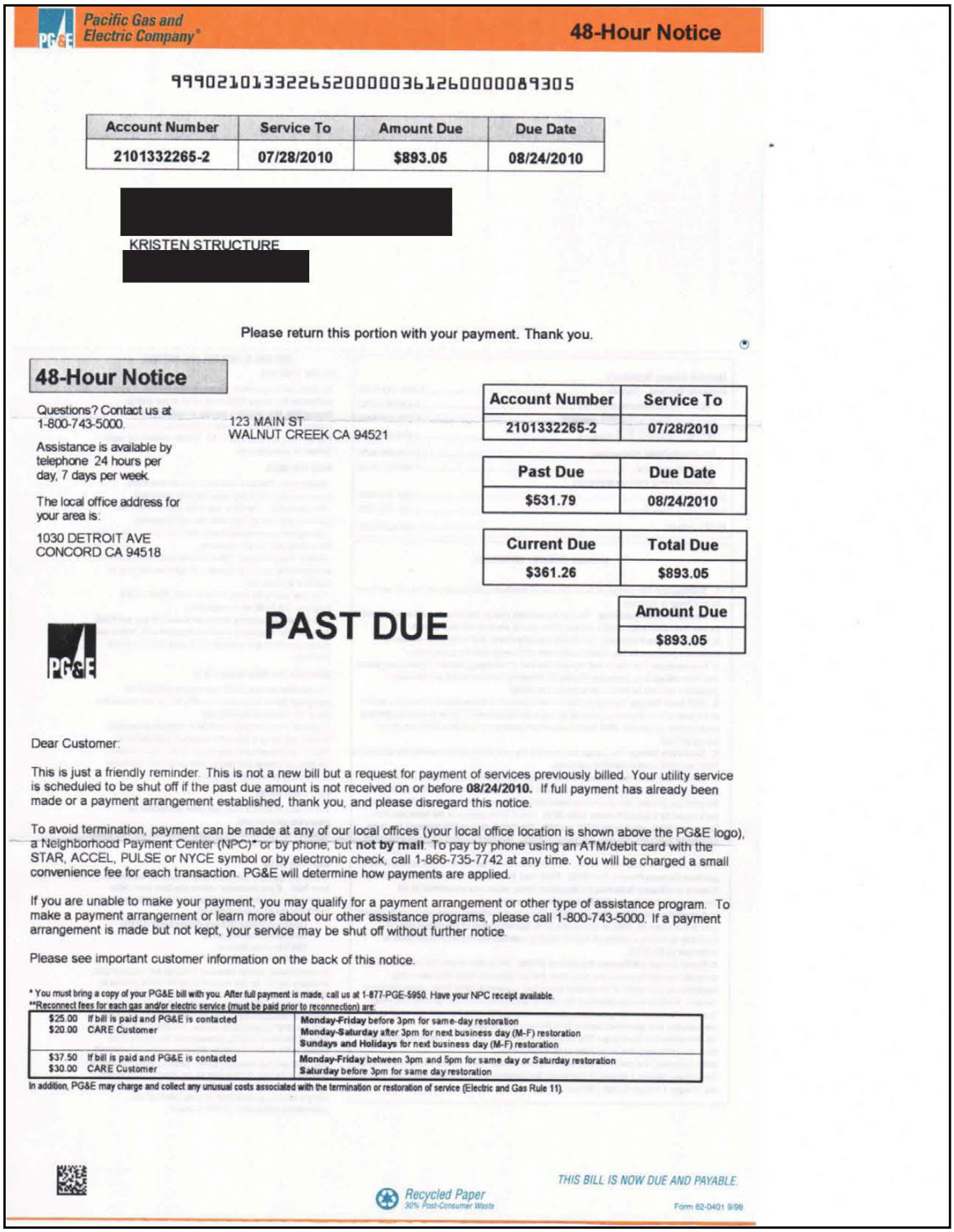
If you are unable to make your payment, you may qualify for a payment arrangement or other type of assistance program. To make a payment arrangement or learn more about our other assistance programs, please call 1-800-743-5000. If a payment arrangement is made but not kept, your service may be shut off without further notice.

Please see important customer information on the back of this notice.

THIS BILL IS NOW DUE AND PAYABLE.

Recycled Paper
30% Post-Consumer Waste

Form 62-0401 9/98



Pacific Gas and Electric Company®

48-Hour Notice

9990210133226520000036126000089305

Account Number	Service To	Amount Due	Due Date
2101332265-2	07/28/2010	$893.05	08/24/2010

[redacted]

KRISTEN STRUCTURE

[redacted]

Please return this portion with your payment. Thank you.

48-Hour Notice

Questions? Contact us at 1-800-743-5000.

Assistance is available by telephone 24 hours per day, 7 days per week.

The local office address for your area is:

1030 DETROIT AVE
CONCORD CA 94518

123 MAIN ST
WALNUT CREEK CA 94521

Account Number	Service To
2101332265-2	07/28/2010

Past Due	Due Date
$531.79	08/24/2010

Current Due	Total Due
$361.26	$893.05

PAST DUE

Amount Due
$893.05

Dear Customer:

This is just a friendly reminder. This is not a new bill but a request for payment of services previously billed. Your utility service is scheduled to be shut off if the past due amount is not received on or before **08/24/2010.** If full payment has already been made or a payment arrangement established, thank you, and please disregard this notice.

To avoid termination, payment can be made at any of our local offices (your local office location is shown above the PG&E logo), a Neighborhood Payment Center (NPC)* or by phone, but **not by mail**. To pay by phone using an ATM/debit card with the STAR, ACCEL, PULSE or NYCE symbol or by electronic check, call 1-866-735-7742 at any time. You will be charged a small convenience fee for each transaction. PG&E will determine how payments are applied.

If you are unable to make your payment, you may qualify for a payment arrangement or other type of assistance program. To make a payment arrangement or learn more about our other assistance programs, please call 1-800-743-5000. If a payment arrangement is made but not kept, your service may be shut off without further notice.

Please see important customer information on the back of this notice.

* You must bring a copy of your PG&E bill with you. After full payment is made, call us at 1-877-PGE-5950. Have your NPC receipt available.
**Reconnect fees for each gas and/or electric service (must be paid prior to reconnection) are:

$25.00 If bill is paid and PG&E is contacted $20.00 CARE Customer	**Monday-Friday** before 3pm for same-day restoration **Monday-Saturday** after 3pm for next business day (M-F) restoration **Sundays and Holidays** for next business day (M-F) restoration
$37.50 If bill is paid and PG&E is contacted $30.00 CARE Customer	**Monday-Friday** between 3pm and 5pm for same day or Saturday restoration **Saturday** before 3pm for same day restoration

In addition, PG&E may charge and collect any unusual costs associated with the termination or restoration of service (Electric and Gas Rule 11).

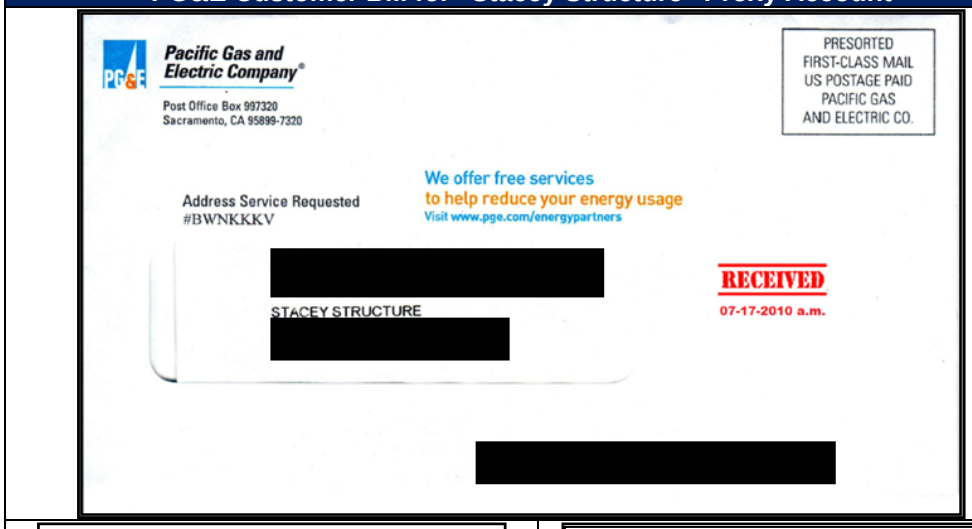
Recycled Paper
30% Post-Consumer Waste

THIS BILL IS NOW DUE AND PAYABLE.

Form 62-0401 9/98

14 End-to-End Test Case 4: "Stacey Structure" Proxy Account Bills

PG&E Customer Bill for "Stacey Structure" Proxy Account



Pacific Gas and Electric Company®
Post Office Box 997320
Sacramento, CA 95899-7320

PRESORTED
FIRST-CLASS MAIL
US POSTAGE PAID
PACIFIC GAS
AND ELECTRIC CO.

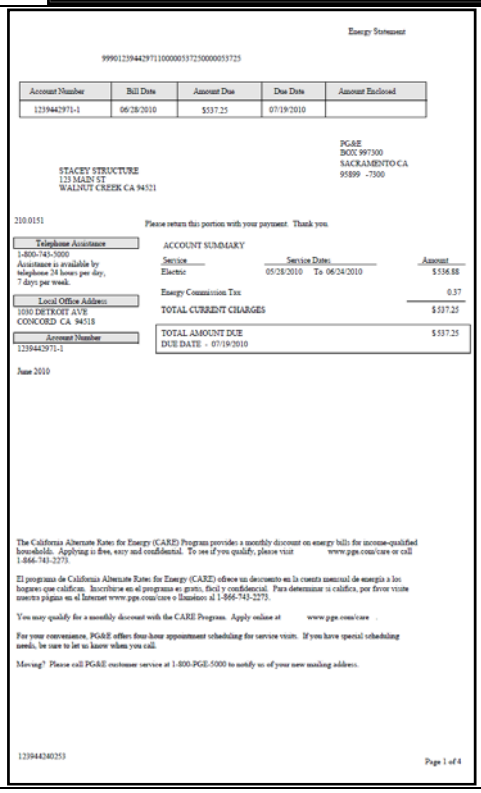
Address Service Requested
#BWNKKKV

We offer free services
to help reduce your energy usage
Visit www.pge.com/energypartners

[redacted]
STACEY STRUCTURE
[redacted]

RECEIVED
07-17-2010 a.m.

[redacted]



Energy Statement

Account Number	Bill Date	Amount Due	Due Date	Amount Enclosed
1239442971-1	06/28/2010	$537.25	07/19/2010	

PG&E
BOX 997300
SACRAMENTO CA
95899 -7300

STACEY STRUCTURE
123 MAIN ST
WALNUT CREEK CA 94521

Please return this portion with your payment. Thank you.

ACCOUNT SUMMARY

Service	Service Dates	Amount
Electric	05/28/2010 To 06/24/2010	$536.88
Energy Commission Tax		0.37
TOTAL CURRENT CHARGES		$537.25
TOTAL AMOUNT DUE DUE DATE - 07/19/2010		$537.25

Telephone Assistance
1-800-743-5000
Assistance is available by telephone 24 hours per day, 7 days per week.

Local Office Address
1030 DETROIT AVE
CONCORD CA 94518

Account Number
1239442971-1

June 2010

The California Alternate Rates for Energy (CARE) Program provides a monthly discount on energy bills for income-qualified households. Applying is free, easy and confidential. To see if you qualify, please visit www.pge.com/care or call 1-866-743-2273.

El programa de California Alternate Rates for Energy (CARE) ofrece un descuento en la cuenta mensual de energía a los hogares que califican. Inscribirse en el programa es gratis, fácil y confidencial. Para determinar si califica, por favor visite nuestra página en el Internet www.pge.com/care o llámenos al 1-866-743-2273.

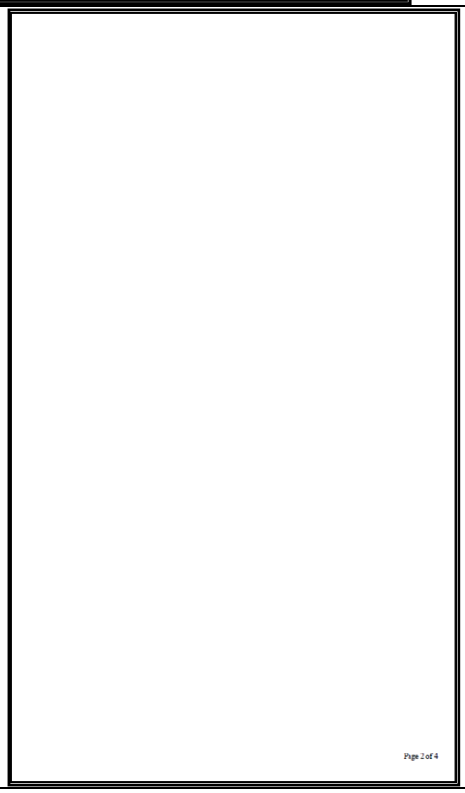
You may qualify for a monthly discount with the CARE Program. Apply online at www.pge.com/care .

For your convenience, PG&E offers four-hour appointment scheduling for service visits. If you have special scheduling needs, be sure to let us know when you call.

Moving? Please call PG&E customer service at 1-800-PGE-5000 to notify us of your new mailing address.

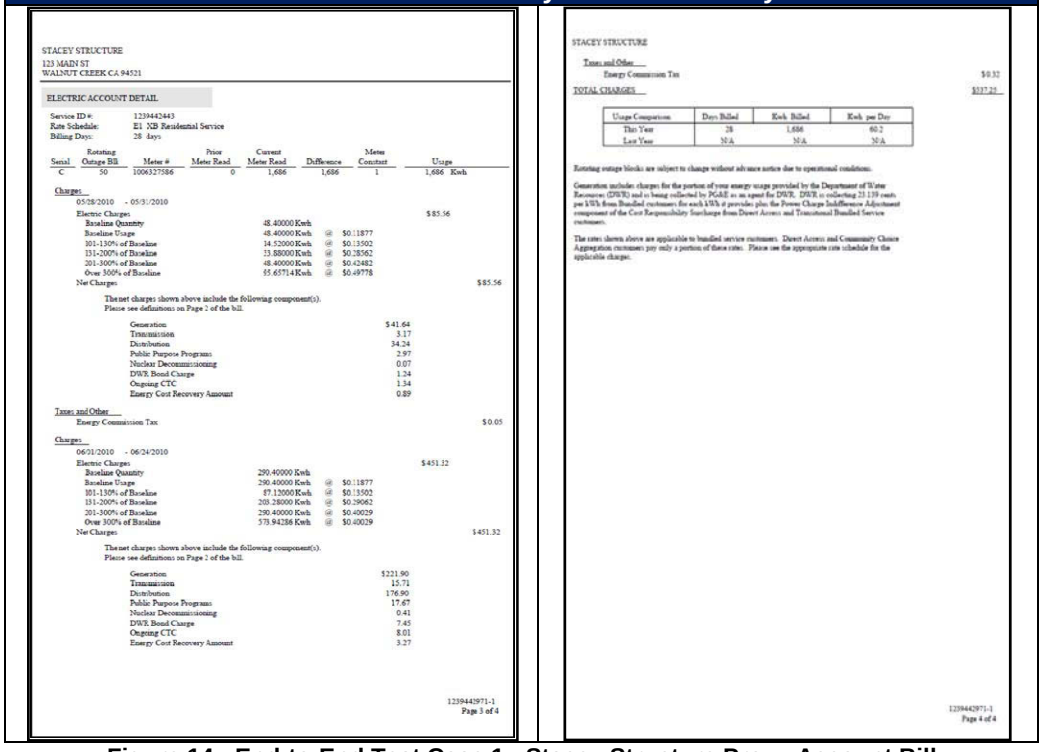
123944240253

Page 1 of 4



Page 2 of 4

PG&E Customer Bill for "Stacey Structure" Proxy Account



STACEY STRUCTURE
123 MAIN ST
WALNUT CREEK CA 94521

ELECTRIC ACCOUNT DETAIL

Service ID #: 1239442443
Rate Schedule: E1 XB Residential Service
Billing Days: 28 days

Serial	Rotating Outage Bill	Meter #	Prior Meter Read	Current Meter Read	Difference	Meter Constant	Usage
C	50	1006327586	0	1,686	1,686	1	1,686 Kwh

Charges
05/28/2010 - 05/31/2010
Electric Charges $85.56

Baseline Quantity	48.40000 Kwh		
Baseline Usage	48.40000 Kwh	@	$0.11877
101-130% of Baseline	14.52000 Kwh	@	$0.13502
131-200% of Baseline	13.88000 Kwh	@	$0.18562
201-300% of Baseline	48.40000 Kwh	@	$0.42482
Over 300% of Baseline	65.65714 Kwh	@	$0.49778

Net Charges $85.56

The net charges shown above include the following component(s).
Please see definitions on Page 2 of the bill.

Generation	$41.64
Transmission	3.17
Distribution	34.24
Public Purpose Programs	2.97
Nuclear Decommissioning	0.07
DWR Bond Charge	1.24
Ongoing CTC	1.34
Energy Cost Recovery Amount	0.89

Taxes and Other
Energy Commission Tax $0.05

Charges
06/01/2010 - 06/24/2010
Electric Charges $451.32

Baseline Quantity	290.40000 Kwh		
Baseline Usage	290.40000 Kwh	@	$0.11877
101-130% of Baseline	87.12000 Kwh	@	$0.13502
131-200% of Baseline	203.28000 Kwh	@	$0.29062
201-300% of Baseline	290.40000 Kwh	@	$0.40029
Over 300% of Baseline	573.94286 Kwh	@	$0.40029

Net Charges $451.32

The net charges shown above include the following component(s).
Please see definitions on Page 2 of the bill.

Generation	$221.90
Transmission	15.71
Distribution	176.90
Public Purpose Programs	17.67
Nuclear Decommissioning	0.41
DWR Bond Charge	7.45
Ongoing CTC	8.01
Energy Cost Recovery Amount	3.27

1239442971-1
Page 3 of 4

STACEY STRUCTURE

Taxes and Other
Energy Commission Tax $0.32

TOTAL CHARGES $327.25

Usage Comparison	Days Billed	Kwh Billed	Kwh per Day
This Year	28	1,686	60.2
Last Year	N/A	N/A	N/A

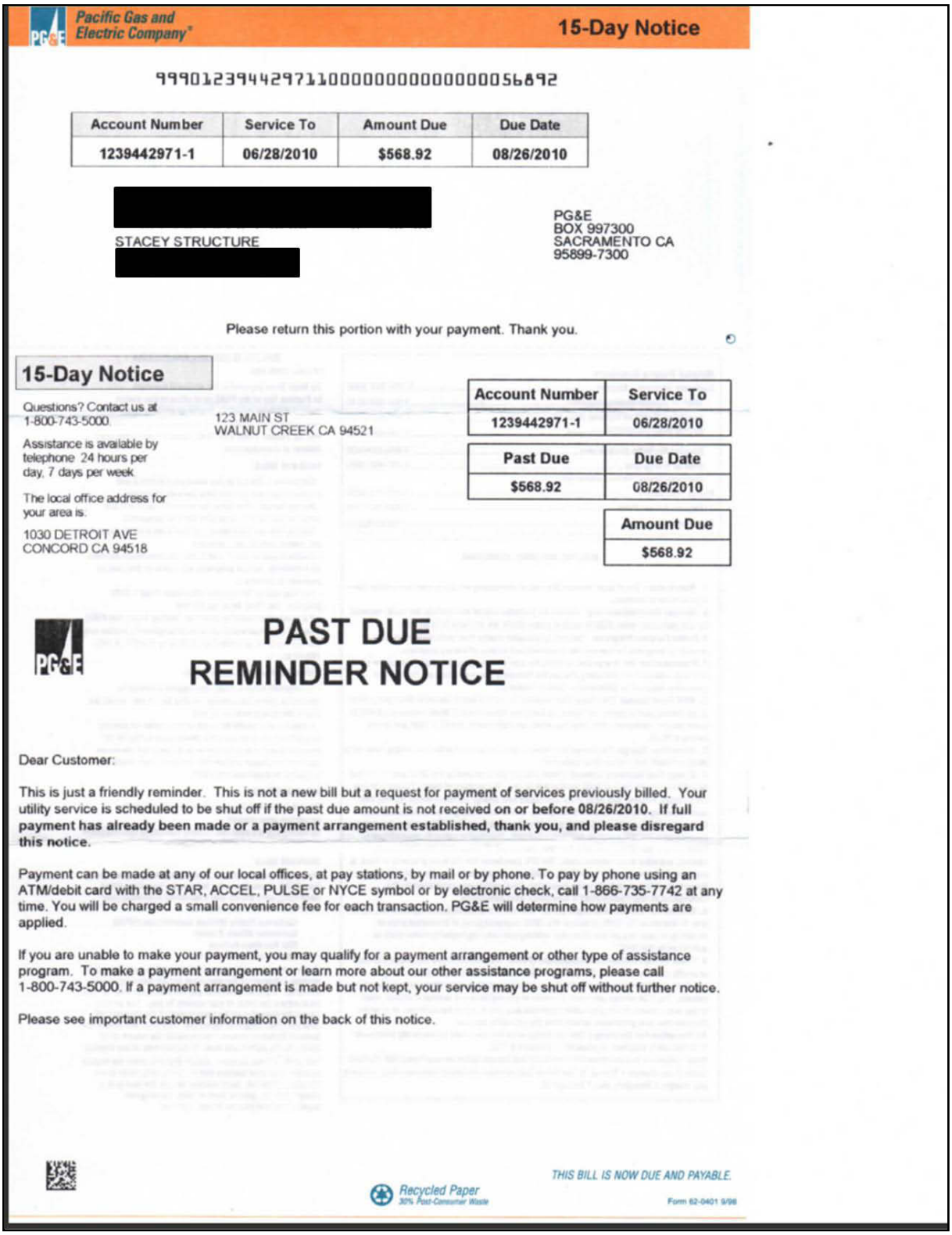
Rotating outage blocks are subject to change without advance notice due to operational conditions.

Generation includes charges for the portion of your energy usage provided by the Department of Water Resources (DWR) and is being collected by PG&E as an agent for DWR. DWR is collecting 21.139 cents per kWh from Bundled customers for each kWh it provides plus the Power Charge Indifference Adjustment component of the Cost Responsibility Surcharge from Direct Access and Transitional Bundled Service customers.

The rates shown above are applicable to bundled service customers. Direct Access and Community Choice Aggregation customers pay only a portion of these rates. Please see the appropriate rate schedule for the applicable charges.

1239442971-1
Page 4 of 4

Figure 14: End-to-End Test Case 1: Stacey Structure Proxy Account Bill



Pacific Gas and Electric Company®

15-Day Notice

99901239442971100000000000000056892

Account Number	Service To	Amount Due	Due Date
1239442971-1	06/28/2010	$568.92	08/26/2010

[redacted]

STACEY STRUCTURE
[redacted]

PG&E
BOX 997300
SACRAMENTO CA
95899-7300

Please return this portion with your payment. Thank you.

15-Day Notice

Questions? Contact us at 1-800-743-5000.

Assistance is available by telephone 24 hours per day, 7 days per week.

The local office address for your area is:

1030 DETROIT AVE
CONCORD CA 94518

123 MAIN ST
WALNUT CREEK CA 94521

Account Number	Service To
1239442971-1	06/28/2010

Past Due	Due Date
$568.92	08/26/2010

Amount Due
$568.92

PAST DUE REMINDER NOTICE

Dear Customer:

This is just a friendly reminder. This is not a new bill but a request for payment of services previously billed. Your utility service is scheduled to be shut off if the past due amount is not received **on or before 08/26/2010. If full payment has already been made or a payment arrangement established, thank you, and please disregard this notice.**

Payment can be made at any of our local offices, at pay stations, by mail or by phone. To pay by phone using an ATM/debit card with the STAR, ACCEL, PULSE or NYCE symbol or by electronic check, call 1-866-735-7742 at any time. You will be charged a small convenience fee for each transaction. PG&E will determine how payments are applied.

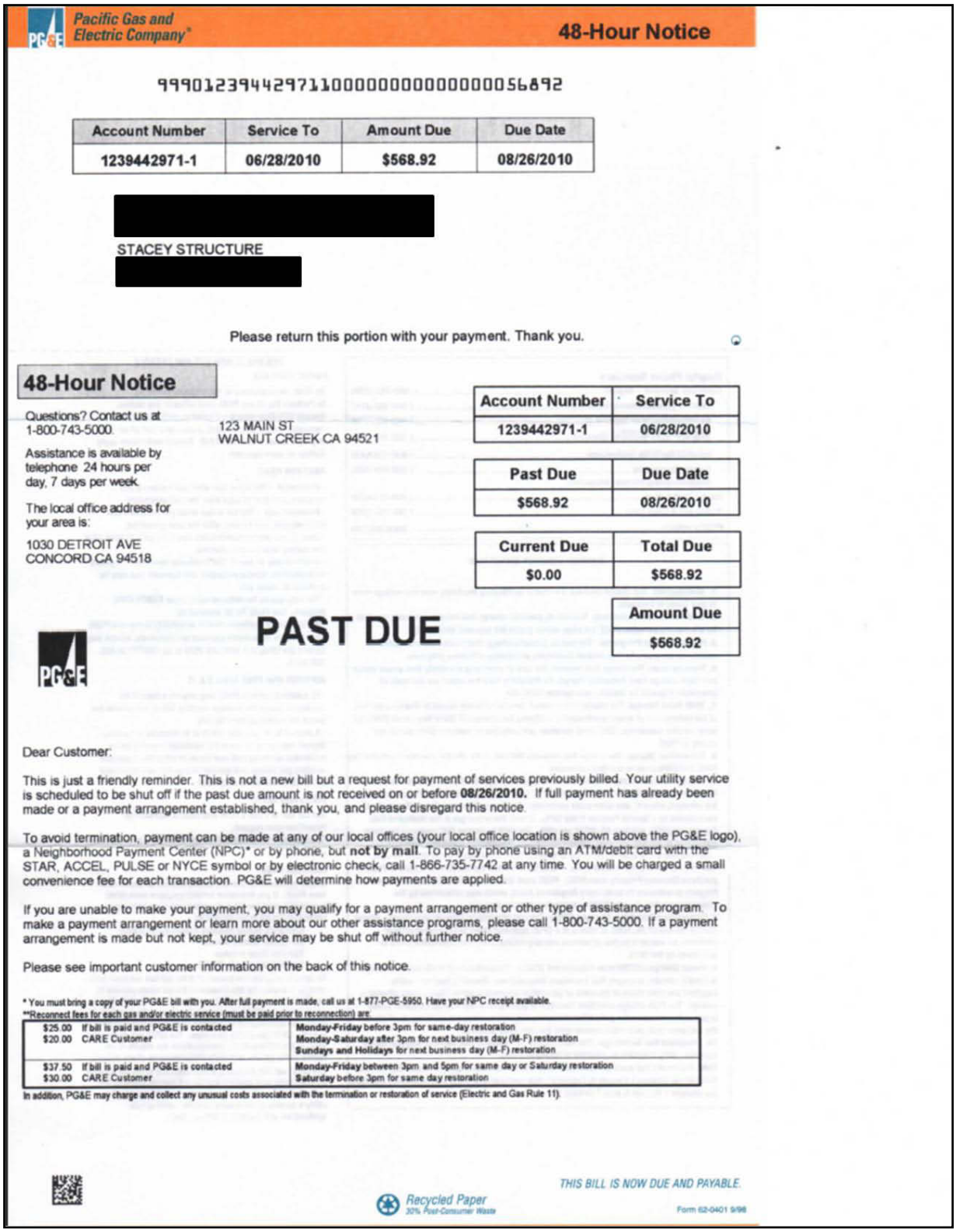
If you are unable to make your payment, you may qualify for a payment arrangement or other type of assistance program. To make a payment arrangement or learn more about our other assistance programs, please call 1-800-743-5000. If a payment arrangement is made but not kept, your service may be shut off without further notice.

Please see important customer information on the back of this notice.

Recycled Paper 30% Post-Consumer Waste

THIS BILL IS NOW DUE AND PAYABLE.

Form 62-0401 9/98



Pacific Gas and Electric Company®

48-Hour Notice

99901239442971100000000000000056892

Account Number	Service To	Amount Due	Due Date
1239442971-1	06/28/2010	$568.92	08/26/2010

[redacted]

STACEY STRUCTURE

[redacted]

Please return this portion with your payment. Thank you.

48-Hour Notice

Questions? Contact us at 1-800-743-5000.

Assistance is available by telephone 24 hours per day, 7 days per week.

The local office address for your area is:

1030 DETROIT AVE
CONCORD CA 94518

123 MAIN ST
WALNUT CREEK CA 94521

Account Number	Service To
1239442971-1	06/28/2010

Past Due	Due Date
$568.92	08/26/2010

Current Due	Total Due
$0.00	$568.92

PAST DUE

Amount Due
$568.92

Dear Customer:

This is just a friendly reminder. This is not a new bill but a request for payment of services previously billed. Your utility service is scheduled to be shut off if the past due amount is not received on or before **08/26/2010.** If full payment has already been made or a payment arrangement established, thank you, and please disregard this notice.

To avoid termination, payment can be made at any of our local offices (your local office location is shown above the PG&E logo), a Neighborhood Payment Center (NPC)* or by phone, but **not by mail**. To pay by phone using an ATM/debit card with the STAR, ACCEL, PULSE or NYCE symbol or by electronic check, call 1-866-735-7742 at any time. You will be charged a small convenience fee for each transaction. PG&E will determine how payments are applied.

If you are unable to make your payment, you may qualify for a payment arrangement or other type of assistance program. To make a payment arrangement or learn more about our other assistance programs, please call 1-800-743-5000. If a payment arrangement is made but not kept, your service may be shut off without further notice.

Please see important customer information on the back of this notice.

* You must bring a copy of your PG&E bill with you. After full payment is made, call us at 1-877-PGE-5950. Have your NPC receipt available.
**Reconnect fees for each gas and/or electric service (must be paid prior to reconnection) are:

$25.00 If bill is paid and PG&E is contacted $20.00 CARE Customer	**Monday-Friday** before 3pm for same-day restoration **Monday-Saturday** after 3pm for next business day (M-F) restoration **Sundays and Holidays** for next business day (M-F) restoration
$37.50 If bill is paid and PG&E is contacted $30.00 CARE Customer	**Monday-Friday** between 3pm and 5pm for same day or Saturday restoration **Saturday** before 3pm for same day restoration

In addition, PG&E may charge and collect any unusual costs associated with the termination or restoration of service (Electric and Gas Rule 11).

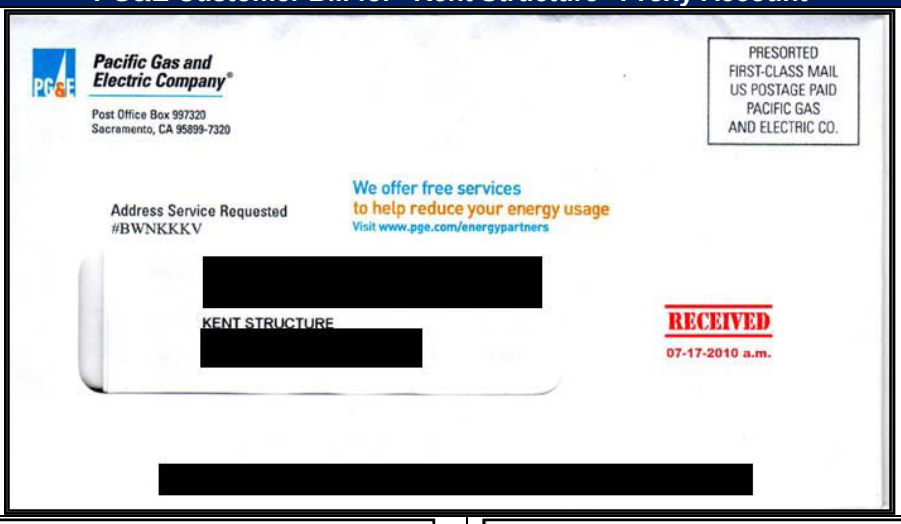
Recycled Paper 30% Post-Consumer Waste

THIS BILL IS NOW DUE AND PAYABLE.

Form 62-0401 9/98

15 End-to-End Test Case 5: "Kent Structure" Proxy Account BillS

PG&E Customer Bill for "Kent Structure" Proxy Account



Pacific Gas and Electric Company®
Post Office Box 997320
Sacramento, CA 95899-7320

PRESORTED
FIRST-CLASS MAIL
US POSTAGE PAID
PACIFIC GAS
AND ELECTRIC CO.

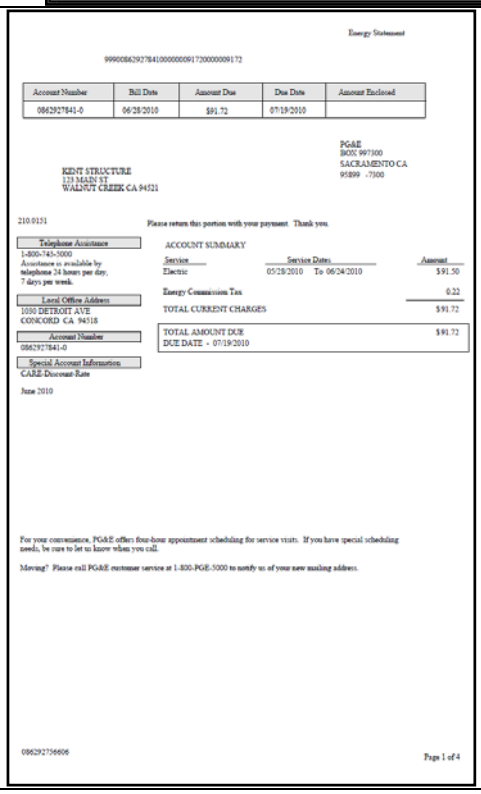
Address Service Requested
#BWNKKKV

We offer free services
to help reduce your energy usage
Visit www.pge.com/energypartners

[redacted]
KENT STRUCTURE
[redacted]

RECEIVED
07-17-2010 a.m.

[redacted]



Energy Statement

Account Number	Bill Date	Amount Due	Due Date	Amount Enclosed
0862927841-0	06/28/2010	$91.72	07/19/2010	

PG&E
BOX 997300
SACRAMENTO CA
95899 -7300

KENT STRUCTURE
123 MAIN ST
WALNUT CREEK CA 94521

210:0151

Please return this portion with your payment. Thank you.

Telephone Assistance
1-800-743-5000
Assistance is available by telephone 24 hours per day, 7 days per week.

Local Office Address
1030 DETROIT AVE
CONCORD CA 94518

Account Number
0862927841-0

Special Account Information
CARE-Discount-Rate

ACCOUNT SUMMARY

Service	Service Dates	Amount
Electric	05/28/2010 To 06/24/2010	$91.50
Energy Commission Tax		0.22
TOTAL CURRENT CHARGES		$91.72
TOTAL AMOUNT DUE DUE DATE - 07/19/2010		$91.72

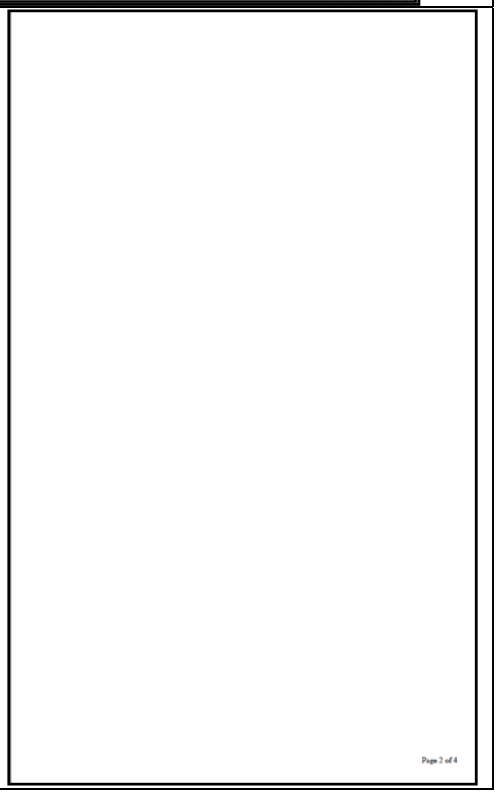
June 2010

For your convenience, PG&E offers four-hour appointment scheduling for service visits. If you have special scheduling needs, be sure to let us know when you call.

Moving? Please call PG&E customer service at 1-800-PGE-5000 to notify us of your new mailing address.

0862927566606

Page 1 of 4

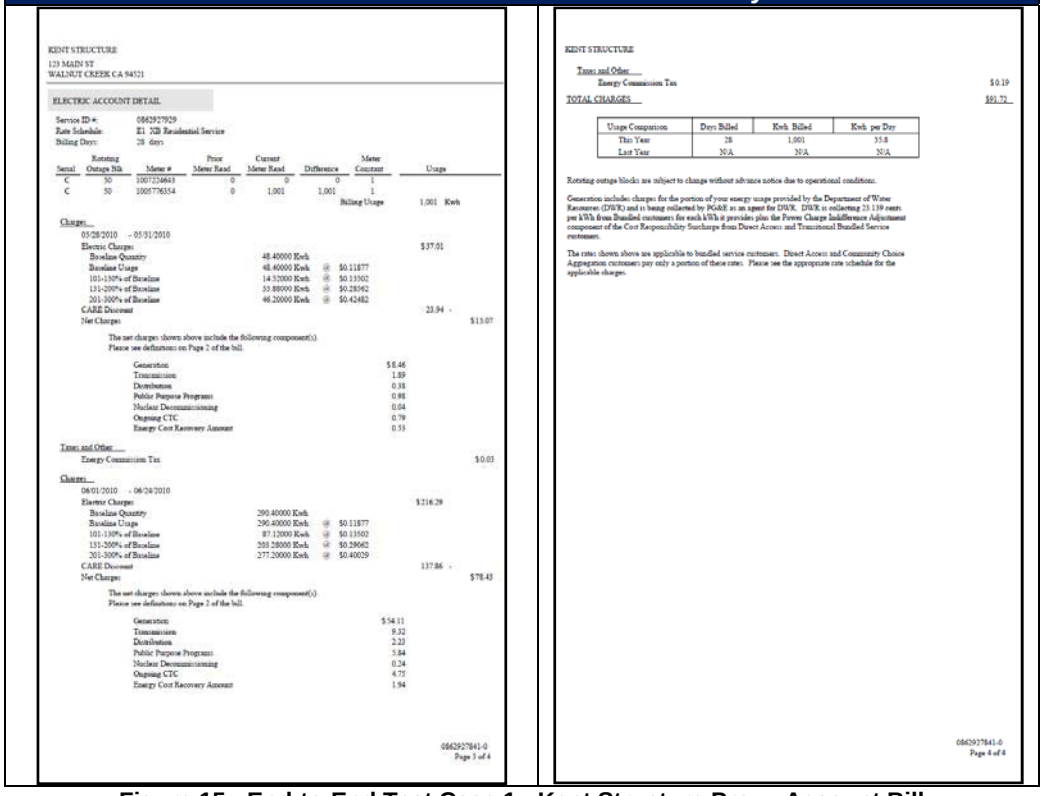


Page 2 of 4

Structure™

Appendix E
End-to-End Customer Bill Analysis

PG&E Customer Bill for "Kent Structure" Proxy Account



KENT STRUCTURE
123 MAIN ST
WALNUT CREEK CA 94521

ELECTRIC ACCOUNT DETAIL

Service ID #: 0862927929
Rate Schedule: E1 XB Residential Service
Billing Days: 28 days

Serial	Rotating Outage Blk	Meter #	Prior Meter Read	Current Meter Read	Difference	Meter Constant	Usage
C	50	1007226843	0	0	0	1	
C	50	1005778354	0	1,001	1,001	1	
						Billing Usage	1,001 Kwh

Charges
05/28/2010 - 05/31/2010
Electric Charges: $37.01

Baseline Quantity	48.40000 Kwh		
Baseline Usage	48.40000 Kwh	@	$0.11877
101-130% of Baseline	14.52000 Kwh	@	$0.13502
131-200% of Baseline	33.88000 Kwh	@	$0.28562
201-300% of Baseline	46.20000 Kwh	@	$0.42482
CARE Discount			23.94 -
Net Charges			$13.07

The net charges shown above include the following component(s).
Please see definitions on Page 2 of the bill.

Generation	$8.46
Transmission	1.89
Distribution	0.38
Public Purpose Programs	0.98
Nuclear Decommissioning	0.04
Ongoing CTC	0.79
Energy Cost Recovery Amount	0.53

Taxes and Other
Energy Commission Tax $0.03

Charges
06/01/2010 - 06/24/2010
Electric Charges: $216.29

Baseline Quantity	290.40000 Kwh		
Baseline Usage	290.40000 Kwh	@	$0.11877
101-130% of Baseline	87.12000 Kwh	@	$0.13502
131-200% of Baseline	203.28000 Kwh	@	$0.28062
201-300% of Baseline	277.20000 Kwh	@	$0.40029
CARE Discount			137.86 -
Net Charges			$78.43

The net charges shown above include the following component(s).
Please see definitions on Page 2 of the bill.

Generation	$54.11
Transmission	9.32
Distribution	2.23
Public Purpose Programs	5.84
Nuclear Decommissioning	0.24
Ongoing CTC	4.75
Energy Cost Recovery Amount	1.94

0862927841-0
Page 3 of 4

KENT STRUCTURE

Taxes and Other
Energy Commission Tax $0.19
TOTAL CHARGES $91.72

Usage Comparison	Days Billed	Kwh Billed	Kwh per Day
This Year	28	1,001	35.8
Last Year	N/A	N/A	N/A

Rotating outage blocks are subject to change without advance notice due to operational conditions.

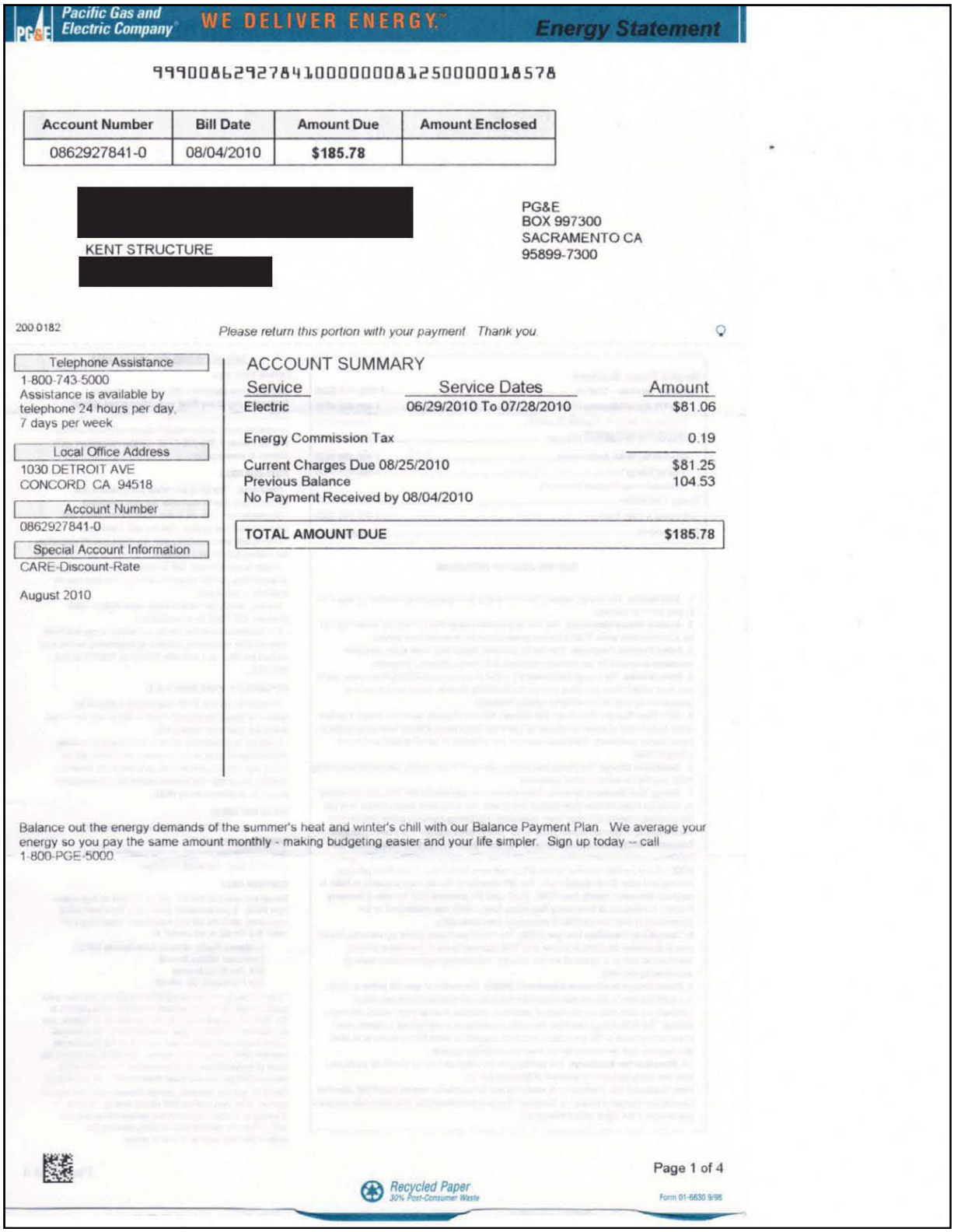
Generation includes charges for the portion of your energy usage provided by the Department of Water Resources (DWR) and is being collected by PG&E as an agent for DWR. DWR is collecting 23.139 cents per kWh from Bundled customers for each kWh it provides plus the Power Charge Indifference Adjustment component of the Cost Responsibility Surcharge from Direct Access and Transitional Bundled Service customers.

The rates shown above are applicable to bundled service customers. Direct Access and Community Choice Aggregation customers pay only a portion of these rates. Please see the appropriate rate schedule for the applicable charges.

0862927841-0
Page 4 of 4

Figure 15: End-to-End Test Case 1: Kent Structure Proxy Account Bill

Copyright 2010. Confidential and Proprietary to
The Structure Group, LLC.



Pacific Gas and Electric Company WE DELIVER ENERGY.™ Energy Statement

99900862927841000000008125000001857 8

Account Number	Bill Date	Amount Due	Amount Enclosed
0862927841-0	08/04/2010	$185.78	

[redacted]
KENT STRUCTURE
[redacted]

PG&E
BOX 997300
SACRAMENTO CA
95899-7300

200.0182

Please return this portion with your payment. Thank you.

Telephone Assistance
1-800-743-5000
Assistance is available by telephone 24 hours per day, 7 days per week

Local Office Address
1030 DETROIT AVE
CONCORD CA 94518

Account Number
0862927841-0

Special Account Information
CARE-Discount-Rate

August 2010

ACCOUNT SUMMARY

Service	Service Dates	Amount
Electric	06/29/2010 To 07/28/2010	$81.06
Energy Commission Tax		0.19
Current Charges Due 08/25/2010		$81.25
Previous Balance		104.53
No Payment Received by 08/04/2010		
TOTAL AMOUNT DUE		**$185.78**

Balance out the energy demands of the summer's heat and winter's chill with our Balance Payment Plan. We average your energy so you pay the same amount monthly - making budgeting easier and your life simpler. Sign up today -- call 1-800-PGE-5000.

Page 1 of 4

Recycled Paper 30% Post-Consumer Waste

Form 01-6630 9/98



Helpful Phone Numbers

Customer Services – English	**1-800-743-5000**
TDD/TTY (Speech/Hearing-Impaired)	1-800-652-4712
Servicio al Cliente en **Español** (Spanish)	1-800-660-6789
華語客戶服務電話號碼 (Chinese)	1-800-893-9555
Dịch Vụ Khách Hàng Tiếng Việt (Vietnamese)	1-800-298-8438
Smarter Energy Line (Residential Energy Efficiency Information)	1-800-933-9555
Energy Theft Hotline	1-800-854-6250
To Request A Claim Form	1-800-743-5000
PG&E's website	www.pge.com

ELECTRIC INDUSTRY DEFINITIONS

1. **Distribution:** The charge recovers the cost of distributing electricity over low-voltage lines to your home or business.
2. **Nuclear Decommissioning:** The non-by passable charge that collects the funds required for site restoration when PG&E's nuclear power plants are removed from service.
3. **Public Purpose Programs:** The non-by passable charge that funds state-mandated assistance programs for low-income customers and energy-efficiency programs.
4. **Transmission:** The charge that recovers the cost of conveying electricity from power plants over high-voltage lines (including charges for Reliability Services which are the costs of generation required for transmission system reliability).
5. **DWR Bond Charge:** The charge that recovers the cost of bonds issued to finance a portion of the historic cost of power purchased by California Department of Water Resources (DWR) to serve electric customers. DWR bond revenues are collected on behalf of DWR and do not belong to PG&E.
6. **Generation Charge:** The charge that recovers the cost of the electric commodity incurred by PG&E and DWR to serve bundled customers.
7. **Energy Cost Recovery Amount:** These charges are approved by the CPUC and authorized by California Public Utilities Code Section 848 et seq. The purpose of these charges is to pay the principal, interest, and other costs associated with Energy Recovery Bonds (Bonds) that were issued by a Special Purpose Entity (SPE). One of these charges is the Dedicated Rate Component (DRC), which is $0.00532 per kWh. The right to receive DRC revenues has been transferred to the SPE and does not belong to PG&E. This right is called Recovery Property. PG&E collects the DRC on behalf of the SPE, which uses these funds to pay Bond principal, interest, and other Bond-related costs. The SPE transferred the net Bond proceeds to PG&E to purchase Recovery Property from PG&E. PG&E used the proceeds from the sale of Recovery Property to refinance its bankruptcy Regulatory Asset, which was established by the Commission to help finance PG&E's emergence from bankruptcy.
8. **Competition Transition Charges (CTC):** The cost of purchased power agreements, signed prior to December 20, 1995, in excess of a CPUC approved proxy of the market price of electricity as well as a portion of electric industry restructuring implementation costs as authorized by the CPUC.
9. **Power Charge Indifference Adjustment (PCIA):** The portion of your bill (either a charge or credit) intended to ensure that customers that purchase electricity from non-utility suppliers pay their share of the costs of generation acquired to serve them, unless otherwise exempt. The PCIA vintage describes the costs of generation a non-exempt customer needs to pay and is based on the generation resources acquired to serve the customer as of when the customer took generation service from the non-utility supplier.
10. **Franchise Fee Surcharge:** This surcharge is for franchise fees for electricity purchased from non-utility suppliers as provided in Schedule E-FFS.

Note: Customers that purchase both electricity and transportation service from PG&E (Bundled Service) pay charges 1 through 6; Customers that purchase electricity from non-utility suppliers pay charges 1 through 5, plus 7 through 10.

THIS BILL IS NOW DUE AND PAYABLE

PAYING YOUR BILL

By Mail: Send payment in the enclosed envelope.
In Person: Pay at any PG&E local office or pay station.
Unpaid Bill: May require a deposit as outlined below to reestablish credit and/or result in disconnection of service.
Pay By Phone: 1-866-735-7742. Certain restrictions apply
Online: at www.pge.com

PAST-DUE BILLS

- Residential – The bill is due when you receive it and becomes past due 19 days after the date presented.
- Nonresidential – The bill is due when you receive it and becomes past due 15 days after the date presented.
- Closing bills are considered past due if not paid 15 days after the mailing date for all customers.
- Unable to pay on time? Call to discuss reasonable payment arrangements, special programs and agencies that may be available to assist you.
- You may qualify for reduced rates under PG&E's CARE program. Call PG&E for an application.
- If a residential customer claims an inability to pay and PG&E does not offer reasonable payment arrangements, he/she may contact the CPUC at 1-800-649-7570 or by TDD/TTY at 415-703-2032.

DEPOSITS (Per PG&E Rules 5 & 7)

- To establish service, PG&E may require a deposit for residential (twice the average monthly bill) or non-residential (twice the maximum monthly bill)
- A deposit to re-establish credit or to increase an existing deposit may be up to twice the maximum monthly bill for residential accounts and may be up to twice the maximum monthly gas charge and electric charge for non-residential accounts, as determined by PG&E.

RULES AND RATES

The full text of PG&E's rules and rates is available for inspection upon request.
Optional rates are available to many customers and may lower your PG&E bills. Call PG&E for details.

DISPUTED BILLS

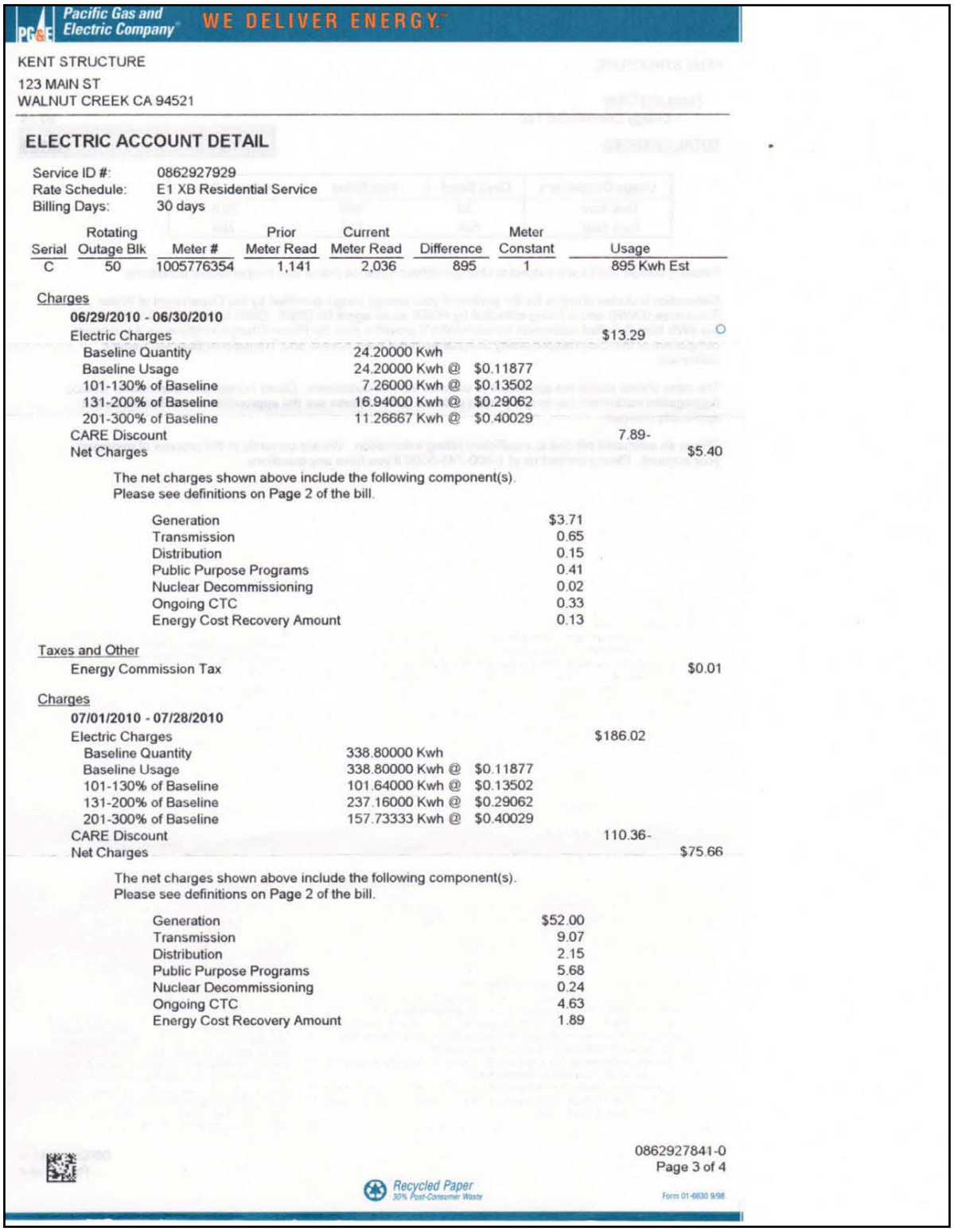
Should you question this bill, please request an explanation from PG&E. If you thereafter believe you have been billed incorrectly, send the bill and a statement supporting your belief that the bill is not correct to:

California Public Utilities Commission (CPUC)
Consumer Affairs Branch
505 Van Ness Avenue
San Francisco, CA 94102

To avoid having service turned off if the bill has not been paid, enclose a deposit for the amount of the bill made payable to the CPUC. If you are unable to pay the amount in dispute, you must inform the CPUC of your inability to pay. Your service cannot be discontinued for nonpayment of the disputed bill until the CPUC completes its review. The CPUC will review the basis of the billed amount, communicate the results of its review to the parties and make disbursements of any deposit.

The CPUC will not, however, accept deposits when the dispute appears to be over matters that do not directly relate to the accuracy of the bill. Such matters include the quality of a utility's service, general level of rates, pending rate applications and sources of fuel or power.

Page 2 of 4



Pacific Gas and Electric Company® WE DELIVER ENERGY.™

KENT STRUCTURE
123 MAIN ST
WALNUT CREEK CA 94521

ELECTRIC ACCOUNT DETAIL

Service ID #: 0862927929
Rate Schedule: E1 XB Residential Service
Billing Days: 30 days

Serial	Rotating Outage Blk	Meter #	Prior Meter Read	Current Meter Read	Difference	Meter Constant	Usage
C	50	1005776354	1,141	2,036	895	1	895 Kwh Est

Charges
06/29/2010 - 06/30/2010

Electric Charges				$13.29
Baseline Quantity	24.20000 Kwh			
Baseline Usage	24.20000 Kwh	@	$0.11877	
101-130% of Baseline	7.26000 Kwh	@	$0.13502	
131-200% of Baseline	16.94000 Kwh	@	$0.29062	
201-300% of Baseline	11.26667 Kwh	@	$0.40029	
CARE Discount				7.89-
Net Charges				$5.40

The net charges shown above include the following component(s).
Please see definitions on Page 2 of the bill.

Generation	$3.71
Transmission	0.65
Distribution	0.15
Public Purpose Programs	0.41
Nuclear Decommissioning	0.02
Ongoing CTC	0.33
Energy Cost Recovery Amount	0.13

Taxes and Other

Energy Commission Tax	$0.01

Charges
07/01/2010 - 07/28/2010

Electric Charges				$186.02
Baseline Quantity	338.80000 Kwh			
Baseline Usage	338.80000 Kwh	@	$0.11877	
101-130% of Baseline	101.64000 Kwh	@	$0.13502	
131-200% of Baseline	237.16000 Kwh	@	$0.29062	
201-300% of Baseline	157.73333 Kwh	@	$0.40029	
CARE Discount				110.36-
Net Charges				$75.66

The net charges shown above include the following component(s).
Please see definitions on Page 2 of the bill.

Generation	$52.00
Transmission	9.07
Distribution	2.15
Public Purpose Programs	5.68
Nuclear Decommissioning	0.24
Ongoing CTC	4.63
Energy Cost Recovery Amount	1.89

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Page 3 of 4

Recycled Paper 30% Post-Consumer Waste

Form 01-6630 9/98

KENT STRUCTURE

Taxes and Other

Energy Commission Tax $0.18

TOTAL CHARGES **$81.25**

Usage Comparison	Days Billed	Kwh Billed	Kwh per Day
This Year	30	895	29.8
Last Year	N/A	N/A	N/A

Rotating outage blocks are subject to change without advance notice due to operational conditions.

Generation includes charges for the portion of your energy usage provided by the Department of Water Resources (DWR) and is being collected by PG&E as an agent for DWR. DWR is collecting 23.139 cents per kWh from Bundled customers for each kWh it provides plus the Power Charge Indifference Adjustment component of the Cost Responsibility Surcharge from Direct Access and Transitional Bundled Service customers.

The rates shown above are applicable to bundled service customers. Direct Access and Community Choice Aggregation customers pay only a portion of these rates. Please see the appropriate rate schedule for the applicable charges.

This is an estimated bill due to insufficient billing information. We are currently in the process of reviewing your account. Please contact us at 1-800-743-5000 if you have any questions.

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16 End-to-End Field Shadow Test #1 (Shadow Meter #6) Comparison of Shadow and Smart Meter Reads

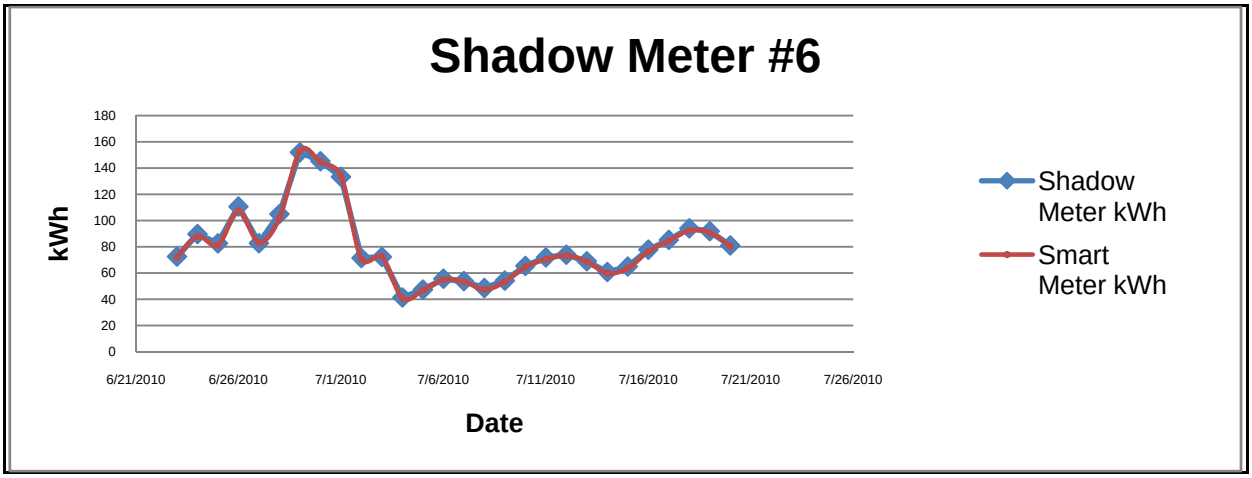


Figure 16: Comparison of Shadow Meter #6 Usage to Corresponding Customer's Smart Meter Usage

17 End-to-End Field Shadow Test #2 (Shadow Meter #7) Comparison of Shadow and Smart Meter Reads

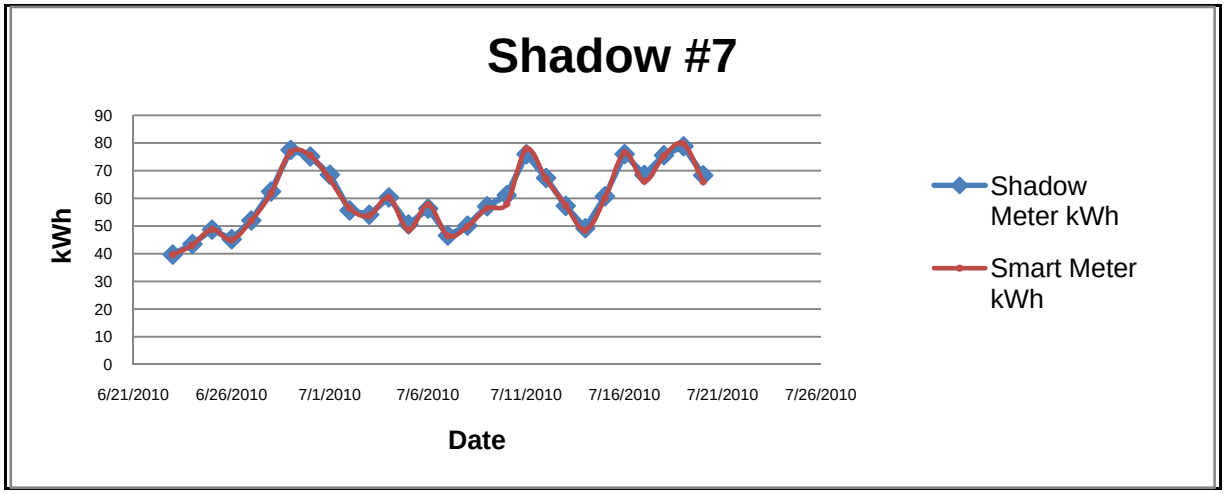


Figure 17: Comparison of Shadow Meter #7 Usage to Corresponding Customer's Smart Meter Usage

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18 End-to-End Field Shadow Test #3 (Shadow Meter #8) Comparison of Shadow and Smart Meter Reads

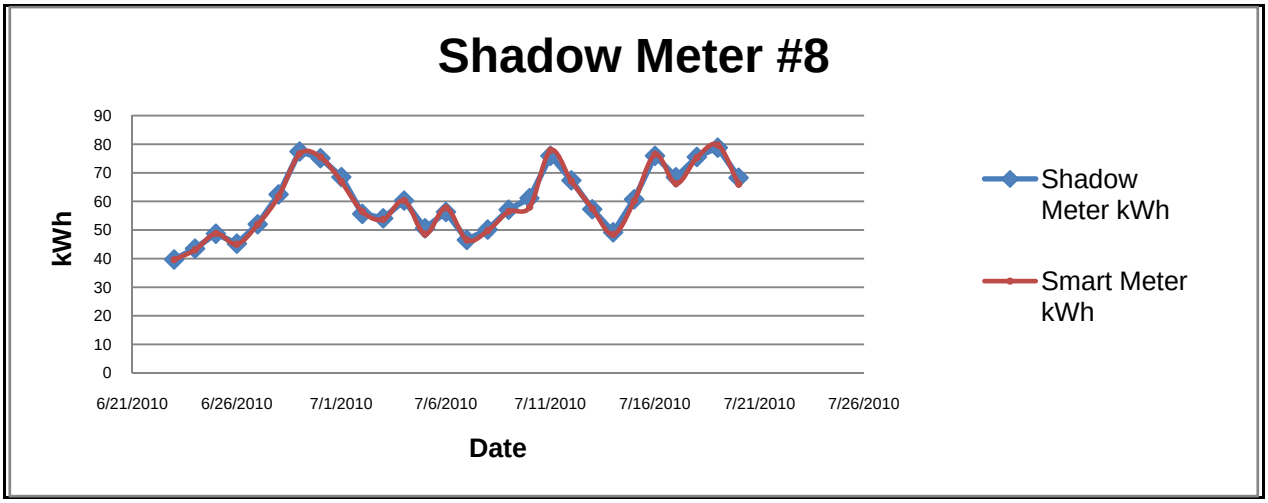


Figure 18: Comparison of Shadow Meter #8 Usage to Corresponding Customer's Smart Meter Usage

19 End-to-End Field Shadow Test #4 (Shadow Meter #9) Comparison of Shadow and Smart Meter Reads

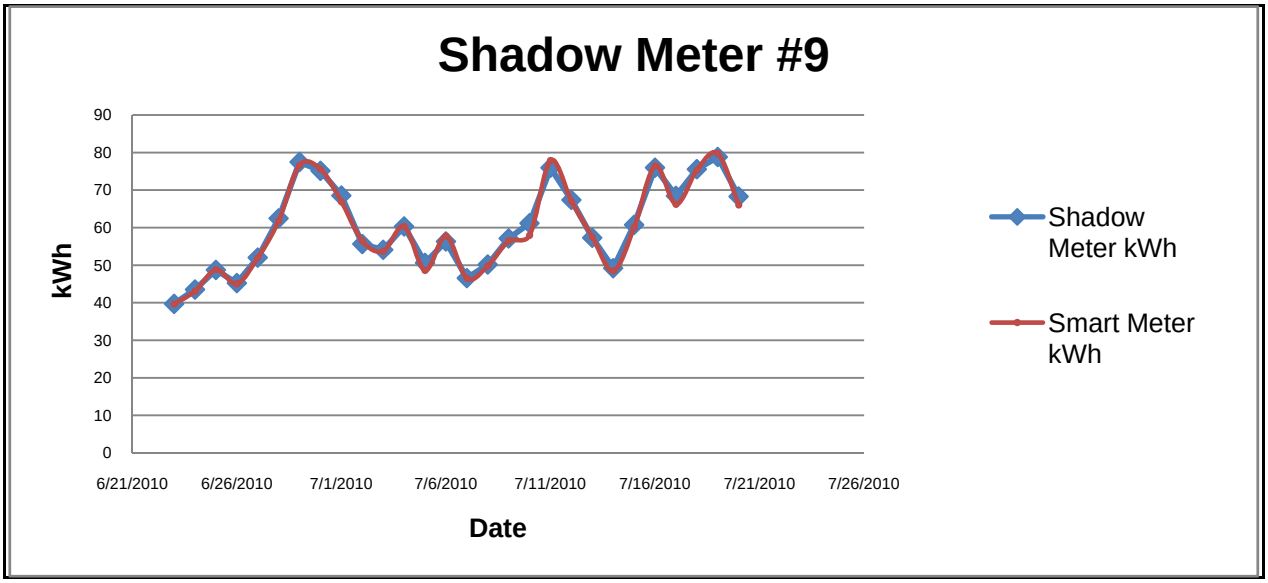


Figure 19: Comparison of Shadow Meter #9 Usage to Corresponding Customer's Smart Meter Usage

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APPENDIX F

CPUC.500

Appendix F – Unauthorized Scenario 6 Meter Swaps Exhibitions

Prepared by: The Structure Group

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Appendix F
Unauthorized Scenario 6 Meter Swaps Exhibitions

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1 Overview

Structure selected 20 PG&E high-bill complaint Customers for field meter testing Scenario 6, High Bill Complaint Shadow Meter Field Test. These Customers were selected as the highest priority premises for complaint-meter testing based on the application of specific high-bill complaint analysis criteria.

CPUC protocol mandated that Structure personnel performing field meter tests be accompanied by a PG&E meter technician. To facilitate coordination of the premise and technician schedules, Structure created the Field Meter Test Schedule Summary, which served as the primary mechanism for coordinating PG&E and Structure field personnel. On June 17, 2010, Structure issued the Field Meter Test Schedule Summary to PG&E. The June 17 version of the Field Meter Test Schedule Summary included Structure-selected PG&E premises scheduled for testing through June 25, 2010. PG&E issued corresponding field work-orders for these premises on June 17.

Of the 20 Customer premises to be tested for the shadow meter scenario, Structure encountered 4 instances where PG&E protocol pertaining to work-order management and coordination with Structure field personnel ultimately precluded Structure from performing the shadow meter test. This breach of protocol was encountered over a month into the testing process, with the initiation of the high-bill complaint shadow meter field test scenario that Structure had identified as the most critical high bill complaint Customers in the PG&E territory.

On June 21, 2010, Structure personnel executed shadow-meter tests in Bakersfield, Stockton, Antioch, and Walnut Creek. Upon arrival at two Walnut Creek premises scheduled for shadow-meter testing, Structure personnel discovered newly installed PG&E Smart Meters. Structure therefore terminated the shadow meter test. During the subsequent inquiry outlined below, Structure discovered that PG&E performed a smart meter swap the same day (June 21), prior to Structure's arrival at the Walnut Creek premises.

Also on June 21, 2010, Structure personnel arrived on-site at a Customer premise in Antioch at 1PM. The Structure tester contacted the designated PG&E field manager to inquire as to the estimated arrival time of the PG&E resource assigned to the Antioch premise. The PG&E field manager informed Structure that there was no work-order for the Antioch premise and that PG&E could not support the meter test. Structure therefore terminated the shadow meter test. During the subsequent inquiry outlined below, Structure identified that at 5:37PM that evening (June 21), PG&E performed a meter swap at the Antioch location, independently and without coordination or notification to Structure.

The evening of June 21, 2010 a conversation took place with the Field Metering supervisor and it was agreed that PG&E needed to make sure that this would not happen again.

The final instance involved a PG&E Smart Meter swap in Bakersfield that was completed several weeks in advance of Structure's issue of the Field Meter Test Schedule Summary to PG&E on June 17, 2010. Given PG&E's completed test two weeks in advance of Structure's testing, the premise should have been removed from Structure's testing schedule. However, this incident is noted in this report since the Customer was initially available for testing, and Structure had repeatedly discussed with PG&E the Customer's inclusion at the center of Structure's advanced high-bill complaint analysis.

Upon recognition of the above circumstances, Structure initiated a series of inquiries to determine root-cause for PG&E's failure to follow the agreed-to protocol for conducting Structure meter tests. The inquiry studied:

- Timelines of PG&E on-site field personnel
- Hard-copy review of work-orders initiated through the PG&E field work management system
- Acquisition, by Structure, of the removed high-bill complaint Smart Meters (identified via meter badge ID)

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- Independent test at the Structure laboratory test facility of each of the original meters involved in the unauthorized meter swaps.

Appendix F - Unauthorized Scenario 6 Meter Swaps Exhibitions for a complete repository of correspondence between Structure and PG&E, documentation provided by PG&E (work-orders, timelines, etc.), and PG&E's formal response to the inquiry.

Structure reviewed the provided PG&E documentation and conducted a series of investigative interviews related to these unauthorized meter swaps. Structure concluded that the unauthorized meter swap conditions appeared to be a result of PG&E's failure to coordinate with field managers and PG&E's failure to properly code work-orders. Structure did not identify malicious intent on the part of PG&E to swap meters prior to Structure performing the meter tests.

Following Structure's inquiry into the unauthorized meter swaps, PG&E initiated a more explicit indication of Structure protocol to PG&E field personnel. Structure cannot vouch as to the implementation of this additional protocol; however, in Structure's experience this protocol was subsequently not followed on at least one other occasion, where Structure testers were scheduled to conduct a test, only to find that PG&E had just conducted a meter test without Structure. One Scenario 4 Customer reported that PG&E was at their residence for about an hour prior to Structure's arrival. Structure researched the PG&E work order management system and verified that no unauthorized work orders had been issued for the residence.

Structure's testing procedures included verification of meter badge identification and firmware version, which allowed Structure to conclude that the meter had not been compromised.

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Structure™ [redacted]

2 PG&E's Explanation of Unauthorized Scenario 6 Meter Swaps

The following note provides PG&E's "formalized" response to the unauthorized meter swaps issue. The note is rendered verbatim, as received by Structure from PG&E.

2.1 PG&E's Explanatory Note to Structure

"John:

Please accept our apology for PG&E's inadvertent replacement of four SmartMeters that Structure identified as meters to be included as part of its dual-socket meter testing to be installed on June 21st/22nd. Immediately upon being notified of this problem, PG&E began an internal investigation to understand why the meters were replaced and to identify additional controls necessary to avoid this problem in the future.

Summary of Issue:

On June 21st & 22nd, 2010 Structure planned to install dual-socket meter tests on certain installed PG&E SmartMeters including the following four customers as identified by Field Test Scenario "6" in the scheduling worksheet provided on June 17th:
1) [redacted]
2) [redacted]
3) [redacted]
4) [redacted]

At some time, in advance of Structure's arrival at the above-identified premises, PG&E personnel replaced the existing SmartMeter at each of the four premises. Upon arrival to install the dual socket tests, Structure discovered that the SmartMeters that were intended to be part of the dual socket testing had been removed by PG&E earlier in the day.

PG&E's Preliminary Findings:

PG&E has determined that the four meter replacements by PG&E personnel occurred as the result of an e-mail and subsequent field order request that inadvertently contained the wrong test order code. Structure uses a number coding system which associates numbers with test types. Field Test Scenario "6" equates to a dual-socket test, and Field Test Scenario "7" equates to a legacy meter test for Structure and a subsequent SmartMeter meter replacement. Consistent with PG&E's process for scheduling meter tests/ installations for Structure, on June 17th, PG&E personnel sent an internal e-mail requesting that field tag orders be issued for the meters that Structure planned to install on June 21st and 22nd as identified on Structure's scheduling worksheet. For all of the planned meter tests coded "6" on Structure's list, the e-mail mistakenly requested that an order go out to the field requesting a meter replacement, which is consistent with Scenario 7. For all of the planned meter tests coded "7" on Structure's list, PG&E's e-mail mistakenly requested that an order go out to the field requesting a dual-socket meter, which is consistent with Scenario 6. The person sending the e-mail request mistakenly switched the associated meter tests for codes "6" and "7" for all of the Structure planned meter tests for June 21st, 22nd, and 23rd. As a result of the reversing the stated Scenario codes in the e-mail request, the field tag orders issued for all of the Scenario 6 meters contained the same mistake, i.e., the field tag orders requested a "meter replacement" and not a "dual-socket meter", however only four of those field orders were inappropriately worked as a meter exchange without Structure present.

According to agreed internal procedures, all SmartMeter work on meters to be tested by Structure are to be sent to certain Title 300 field crews or Meter Tech field crews, whose supervisors have been alerted to these

scheduled tests. Four of the incorrectly coded (6 versus 7) field tag orders for the June 21st and 22nd were dispatched incorrectly to the wrong field crews to be completed. Although all four of the field tag orders properly referenced "Structure" in the "remarks" section, dispatch incorrectly sent them to Gas Service Reps and unauthorized T300 personnel. These personnel are generally not involved in any Structure work and, as a result, a cryptic "Structure" notation in the remarks section would not signify to them any specific course of action. Accordingly, upon receipt of the field tag orders requesting meter replacements, they proceeded to the four premises and replaced the SmartMeters without any knowledge that the meters were actually supposed to remain in place and be included as part of a Structure dual-socket test.

Immediate Process Improvements:

PG&E will develop and distribute to Personnel issuing field tag orders, Dispatchers, Meter Techs and T300s a "legend" of the number codes used by Structure (e.g.6=dual socket tests)
Dispatch supervisors and all 87 dispatch employees will receive a written reminder that a) they must open and review the "remarks" section for each field tag order received ; and b) all field tag orders that reference "Structure" must only go to either a T300 or Meter Tech.
The Personnel issuing field tag orders now has revised language that will appear in the "remarks" to provide additional clarity that the request is Structure related.
T300 Management and Meter Techs Management will each independently send a written reminder to those processing tags that no tag referencing "Structure" can be processed without a Structure person on site.

Based on our investigation, we are confident that the four meter replacements occurred as the result of inadvertent errors and confusion by some PG&E personnel. We apologize for the inconvenience to Structure. We are taking immediate steps to add controls to avoid this type of problem in the future.

In addition to the process improvements, PG&E is committed to providing as much evidence as possible for Structure to decide next steps. PG&E will immediately provide:

- The four meters removed inadvertently. Structure will be able to lab test these meters for any inaccuracies or if helpful, PG&E could reinstall these meters at the removed premise.
- All collected data available on these four accounts will be provided. UIQ read information, meter alarm and status flag information, or any other available report data can be provided to produce documentation as to the status of the account.

We are happy to provide you with the internal documentation to support the findings stated herein and to answer any additional questions that you have.

Jim Meadows”

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3 PG&E's Event Log of the Unauthorized Meter Swaps

The following section was provided by PG&E per Structure's request for information regarding the unauthorized Scenario 6 meter swaps as a complete paper-trail (event timeline, copies of work orders, etc.) of their findings. The data provided includes:

- Event logs
- Field schedules
- Field orders generated by a CC&B Online Query
- Field order activity reports
- Daily work reports
- Expo-facto e-mail correspondence between Structure and PG&E regarding the unauthorized meter swaps

The supplemental data in this section contains Customer information, and is confidential to the CPUC pursuant to P.U. Code Section 583.

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APPENDIX G

CPUC.500

Appendix G -

Shadow Meter Analysis

Prepared by: The Structure Group

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Shadow Meter Analysis

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1 Overview

The figures presented in this document display register read comparisons for usage data collected by the PG&E Meter Data Management System (MDMS) vs. midnight register reads collected manually from Structure shadow meters. Both Field and Laboratory shadow meter tests are presented.

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2 Lab Shadow Meter Register Usage Comparisons

2.1 End-to-End Test Case 1: "John Structure" Midnight Register Read Report

END-TO-END TEST: MIDNIGHT REGISTER READ REPORT					
Customer Name	John Structure				
Premise ID					
SP ID	2312175400				
Account ID	5235000629				
SA (Rate) ID	5235000525				
Historical ADU					
	Shadow Meter #1		PG&E Meter		
Meter Badge ID	TSG-001		1007216524		
Meter Manufacturer	Elster		GE I-210+		
Meter Mfg Serial ID	11876358		42912285		
Meter Form	2S		2S		
Network ID	N/A		0013500100C53910		
DATE	Register	Usage Calc	Register	Usage Calc	DELTA
5/27/2010					
5/28/2010	9.4	9.4			
5/29/2010	17.3973	7.9973			
5/30/2010		0			
5/31/2010		0			
6/1/2010		0			
6/2/2010	54.0582	0	0	0	
6/3/2010	129.4338	75.3756	0	0	
6/4/2010	203.6571	74.2233	0	0	
6/5/2010	273.2256	69.5685	0	0	
6/6/2010	341.8203	68.5947	425.58	68.584	-0.011
6/7/2010	409.8009	67.9806	493.67	68.09	0.1094
6/8/2010	477.4023	67.6014	561.219	67.549	-0.052
6/9/2010	544.9593	67.557	628.794	67.575	0.018
6/10/2010	612.3231	67.3638	696.079	67.285	-0.079
6/11/2010	680.8518	68.5287	764.627	68.548	0.0193
6/12/2010	749.2092	68.3574	833.017	68.39	0.0326
6/13/2010	817.2702	68.061	901.105	68.088	0.027
6/14/2010	884.9577	67.6875	968.834	67.729	0.0415
6/15/2010	951.7677	66.81	1035.677	66.843	0.033
6/16/2010	1019.6802	67.9125	1103.615	67.938	0.0255
6/17/2010	1088.2845	68.6043	1172.292	68.677	0.0727
6/18/2010	1156.3122	68.0277	1240.384	68.092	0.0643
6/19/2010	1224.1197	67.8075	1308.241	67.857	0.0495
6/20/2010	1292.6349	68.5152	1376.815	68.574	0.0588
6/21/2010	1361.0607	68.4258	1445.26	68.445	0.0192
6/22/2010	1429.2924	68.2317	1513.45	68.19	-0.042
6/23/2010	1497.6975	68.4051	1581.865	68.415	0.0099
6/24/2010	1566.1929	68.4954	1650.409	68.544	0.0486
6/25/2010	1633.986	67.7931	1718.24	67.831	0.0379
6/26/2010	1702.4901	68.5041	1786.723	68.483	-0.021
6/27/2010	1771.6071	69.117	1855.843	69.12	0.003
6/28/2010	1840.3521	68.745	1924.596	68.753	0.008

Figure 1: End-to-End Laboratory Test Case #1 – Midnight Register Read Report

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2.2 End-to-End Test Case 2: "Mark Structure" Midnight Register Read Report

END-TO-END TEST: MIDNIGHT REGISTER READ REPORT					
Customer Name	Mark Structure				
Premise ID					
SP ID	2312175412				
Account ID	1949334877				
SA (Rate) ID	1949334558				
Historical ADU					
	Shadow Meter #2		PG&E Meter		
Meter Badge ID	TSG-002		1006334261		
Meter Manufacturer	Elster		L+G		
Meter Mfg Serial ID	11939883		105811649		
Meter Form	2S		2S		
Network ID	N/A		0013500100C330CF		
DATE	Register	Usage Calc	Register	Usage Calc	DELTA
5/27/2010					
5/28/2010		0	0	0	
5/29/2010		0	0	0	
5/30/2010		0	0	0	
5/31/2010	317.1267	317.1267	0	0	
6/1/2010	435.2739	118.1472			
6/2/2010	503.3703	68.0964	605.675	70.887	2.7906
6/3/2010	565.8945	62.5242	668.21	62.535	0.0108
6/4/2010	620.5428	54.6483	722.868	54.658	0.0097
6/5/2010	708.8895	88.3467	807.871	85.003	-3.344
6/6/2010	839.7813	130.8918	938.927	131.056	0.1642
6/7/2010	967.1025	127.3212	1066.304	127.377	0.0558
6/8/2010	1046.8785	79.776	1151.231	84.927	5.151
6/9/2010	1061.88	15.0015	1166.213	14.982	-0.02
6/10/2010	1085.7606	23.8806	1189.301	23.088	-0.793
6/11/2010	1119.6966	33.936	1223.231	33.93	-0.006
6/12/2010	1153.6707	33.9741	1257.173	33.942	-0.032
6/13/2010	1187.7363	34.0656	1291.268	34.095	0.0294
6/14/2010	1221.8178	34.0815	1325.371	34.103	0.0215
6/15/2010	1255.3767	33.5589	1358.956	33.585	0.0261
6/16/2010	1289.0619	33.6852	1392.616	33.66	-0.025
6/17/2010	1322.8209	33.759	1426.414	33.798	0.039
6/18/2010	1356.4797	33.6588	1460.044	33.63	-0.029
6/19/2010	1390.176	33.6963	1493.716	33.672	-0.024
6/20/2010	1424.2158	34.0398	1527.778	34.062	0.0222
6/21/2010	1458.2304	34.0146	1561.778	34	-0.015
6/22/2010	1491.8592	33.6288	1595.41	33.632	0.0032
6/23/2010	1525.1724	33.3132	1628.68	33.27	-0.043
6/24/2010	1558.5216	33.3492	1662.055	33.375	0.0258
6/25/2010	1591.7172	33.1956	1695.257	33.202	0.0064
6/26/2010	1624.9566	33.2394	1728.549	33.292	0.0526
6/27/2010	1658.4435	33.4869	1762.033	33.484	-0.003
6/28/2010	1691.9523	33.5088	1795.546	33.513	0.0042

Figure 2: End-to-End Laboratory Test Case #2 – Midnight Register Read Report

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2.3 End-to-End Test Case 3: "Kristen Structure" Midnight Register Read Report

END-TO-END TEST: MIDNIGHT REGISTER READ REPORT					
Customer Name	Kristen Structure				
Premise ID					
SP ID	2312175433				
Account ID	2101332265				
SA (Rate) ID	2101332497				
Historical ADU					
	Shadow Meter #3		PG&E Meter		
Meter Badge ID	TSG-003		1007186727		
Meter Manufacturer	Elster		GE I-210+		
Meter Mfg Serial ID	11939880		42690619		
Meter Form	2S		2S		
Network ID	N/A		0013500100C2F531		
DATE	Register	Usage Calc	Register	Usage Calc	DELTA
5/27/2010					
5/28/2010		0	0	0	
5/29/2010		0	0	0	
5/30/2010		0	0	0	
5/31/2010	316.5042	316.5042	0	0	
6/1/2010	434.4216	117.9174			
6/2/2010	502.3683	67.9467	604.371	70.713	2.7663
6/3/2010	564.7539	62.3856	666.752	62.381	-0.0046
6/4/2010	619.2762	54.5223	721.349	54.597	0.0747
6/5/2010	707.4351	88.1589	806.182	84.833	-3.3259
6/6/2010	838.0557	130.6206	936.967	130.785	0.1644
6/7/2010	965.1087	127.053	1064.224	127.257	0.204
6/8/2010	1044.6876	79.5789	1148.94	84.716	5.1371
6/9/2010	1059.5943	14.9067	1163.829	14.889	-0.0177
6/10/2010	1083.3741	23.7798	1186.802	22.973	-0.8068
6/11/2010	1117.2033	33.8292	1220.633	33.831	0.0018
6/12/2010	1151.0703	33.867	1254.52	33.887	0.02
6/13/2010	1185.0288	33.9585	1288.488	33.968	0.0095
6/14/2010	1219.0023	33.9735	1322.5	34.012	0.0385
6/15/2010	1252.4541	33.4518	1355.986	33.486	0.0342
6/16/2010	1286.0316	33.5775	1389.596	33.61	0.0325
6/17/2010	1319.6829	33.6513	1423.286	33.69	0.0387
6/18/2010	1353.2337	33.5508	1456.854	33.568	0.0172
6/19/2010	1386.8217	33.588	1490.469	33.615	0.027
6/20/2010	1420.7532	33.9315	1524.42	33.951	0.0195
6/21/2010	1454.6592	33.906	1558.346	33.926	0.02
6/22/2010	1488.1797	33.5205	1591.901	33.555	0.0345
6/23/2010	1521.3849	33.2052	1625.122	33.221	0.0158
6/24/2010	1554.6264	33.2415	1658.378	33.256	0.0145
6/25/2010	1587.7143	33.0879	1691.501	33.123	0.0351
6/26/2010	1620.8457	33.1314	1724.639	33.138	0.0066
6/27/2010	1654.2246	33.3789	1758.017	33.378	-0.0009
6/28/2010	1687.6254	33.4008	1791.423	33.406	0.0052

Figure 3: End-to-End Laboratory Test Case #3 – Midnight Register Read Report

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2.4 End-to-End Test Case 4: "Stacey Structure" Midnight Register Read Report

END-TO-END TEST: MIDNIGHT REGISTER READ REPORT					
Customer Name	Stacey Structure				
Premise ID					
SP ID	2312175466				
Account ID	1239442971				
SA (Rate) ID	1239442443				
Historical ADU					
	Shadow Meter #4		**PG&E Meter**		
Meter Badge ID	TSG-004		1006327586		
Meter Manufacturer	Elster		L+G FOCUS		
Meter Mfg Serial ID	11939882		105804974		
Meter Form	2S		2S		
Network ID	N/A		0013500100C359DC		
DATE	**Register**	**Usage Calc**	**Register**	**Usage Calc**	**DELTA**
5/27/2010			113.182		
5/28/2010		0	178.891	65.709	
5/29/2010		0	296.695	117.804	
5/30/2010		0	414.789	118.094	
5/31/2010	316	316	532.501	117.712	
6/1/2010	433.7241	117.7241			
6/2/2010	501.5454	67.8213	603.091	70.59	2.7687
6/3/2010	563.814	62.2686	665.311	62.22	-0.049
6/4/2010	618.2289	54.4149	719.747	54.436	0.0211
6/5/2010	706.2306	88.0017	804.191	84.444	-3.558
6/6/2010	836.622	130.3914	934.794	130.603	0.2116
6/7/2010	963.4512	126.8292	1061.669	126.875	0.0458
6/8/2010	1042.8678	79.4166	1146.185	84.516	5.0994
6/9/2010	1057.6854	14.8176	1160.959	14.774	-0.044
6/10/2010	1081.3725	23.6871	1183.812	22.853	-0.834
6/11/2010	1115.1069	33.7344	1217.539	33.727	-0.007
6/12/2010	1148.8791	33.7722	1251.32	33.781	0.0088
6/13/2010	1182.7419	33.8628	1285.195	33.875	0.0122
6/14/2010	1216.6197	33.8778	1319.127	33.932	0.0542
6/15/2010	1249.9767	33.357	1352.492	33.365	0.008
6/16/2010	1283.46	33.4833	1385.968	33.476	-0.007
6/17/2010	1317.0168	33.5568	1419.549	33.581	0.0242
6/18/2010	1350.4737	33.4569	1453.009	33.46	0.0031
6/19/2010	1383.9675	33.4938	1486.473	33.464	-0.03
6/20/2010	1417.8045	33.837	1520.294	33.821	-0.016
6/21/2010	1451.6163	33.8118	1554.098	33.804	-0.008
6/22/2010	1485.0435	33.4272	1587.539	33.441	0.0138
6/23/2010	1518.1551	33.1116	1620.622	33.083	-0.029
6/24/2010	1551.3027	33.1476	1653.811	33.189	0.0414
6/25/2010	1584.2961	32.9934	1686.783	32.972	-0.021
6/26/2010	1617.3339	33.0378	1719.81	33.027	-0.011
6/27/2010	1650.6186	33.2847	1753.08	33.27	-0.015
6/28/2010	1683.9246	33.306	1786.338	33.258	-0.048

Figure 4: End-to-End Laboratory Test Case #4 – Midnight Register Read Report

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2.5 End-to-End Test Case 5: "Kent Structure" Midnight Register Read Report

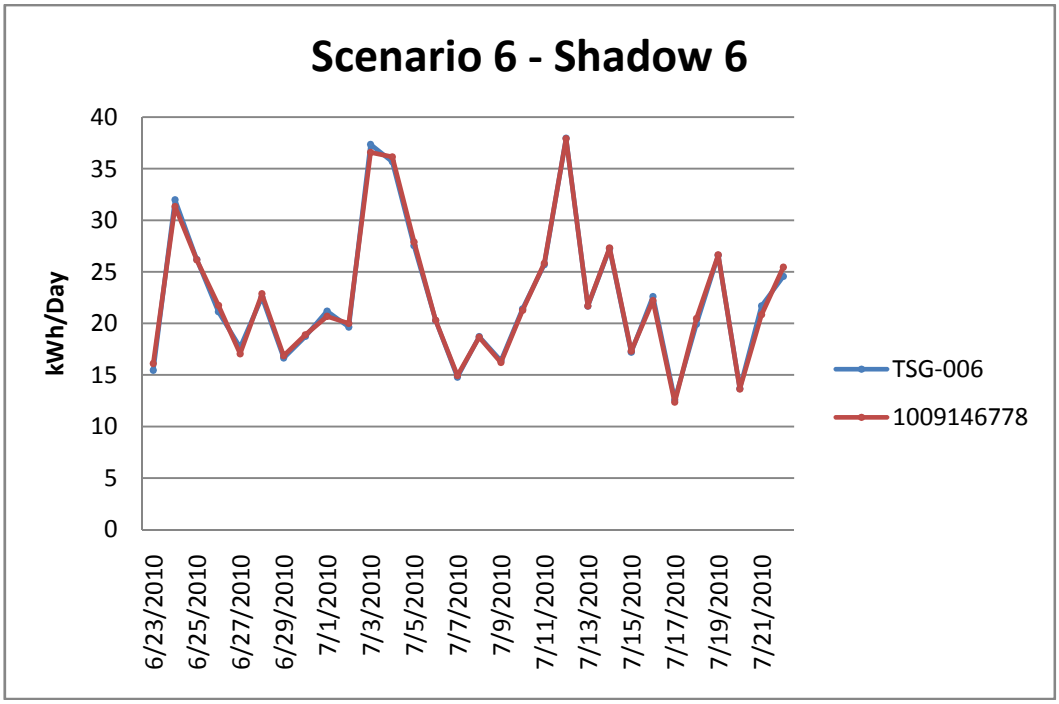
END-TO-END TEST: MIDNIGHT REGISTER READ REPORT					
Customer Name	Kent Structure				
Premise ID					
SP ID	2312175472				
Account ID	862927841				
SA (Rate) ID	862927929				
Historical ADU					
	Shadow Meter #5		PG&E Meter		
Meter Badge ID	TSG-005		1005776354		
Meter Manufacturer	Elster		GE I-210+		
Meter Mfg Serial ID	12074014		39346916		
Meter Form	1S		1S		
Network ID	N/A		00135001001462B7		
DATE	Register	Usage Calc	Register	Usage Calc	DELTA
5/27/2010			0		
5/28/2010		0	13.345	13.345	
5/29/2010		0	46.621	33.276	
5/30/2010		0	82.525	35.904	
5/31/2010		0	118.49	35.965	
6/1/2010		0			
6/2/2010		0	187.593	33.39	
6/3/2010		0	222.977	35.384	
6/4/2010	0	0	258.407	35.43	
6/5/2010	15.3465	15.3465	293.16	34.753	
6/6/2010	51.0831	35.7366	321.567	40.849	5.1124
6/7/2010	86.7318	35.6487	363.425	41.858	6.2093
6/8/2010	122.0676	35.3358	401.303	37.878	2.5422
6/9/2010	157.4997	35.4321	437.439	36.136	0.7039
6/10/2010	192.8979	35.3982	470.473	33.034	-2.364
6/11/2010	228.4614	35.5635	505.995	35.522	-0.042
6/12/2010	264.0615	35.6001	541.566	35.571	-0.029
6/13/2010	299.7156	35.6541	577.176	35.61	-0.044
6/14/2010	335.3646	35.649	612.801	35.625	-0.024
6/15/2010	370.503	35.1384	647.915	35.114	-0.024
6/16/2010	405.8502	35.3472	683.225	35.31	-0.037
6/17/2010	441.3588	35.5086	718.71	35.485	-0.024
6/18/2010	476.7789	35.4201	754.084	35.374	-0.046
6/19/2010	512.1891	35.4102	789.457	35.373	-0.037
6/20/2010	547.9524	35.7633	825.176	35.719	-0.044
6/21/2010	583.7379	35.7855	860.922	35.746	-0.039
6/22/2010	619.1265	35.3886	896.28	35.358	-0.031
6/23/2010	654.2736	35.1471	931.393	35.113	-0.034
6/24/2010	689.4036	35.13	966.49	35.097	-0.033
6/25/2010	724.5276	35.124	1001.587	35.097	-0.027
6/26/2010	759.8049	35.2773	1036.832	35.245	-0.032
6/27/2010	795.2679	35.463	1072.255	35.423	-0.04
6/28/2010	830.6148	35.3469	1107.568	35.313	-0.034

Figure 5: End-to-End Laboratory Test Case #5 – Midnight Register Read Report

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3 Field Shadow Meter Usage Comparisons

3.1 Field Shadow Meter Test Case #6



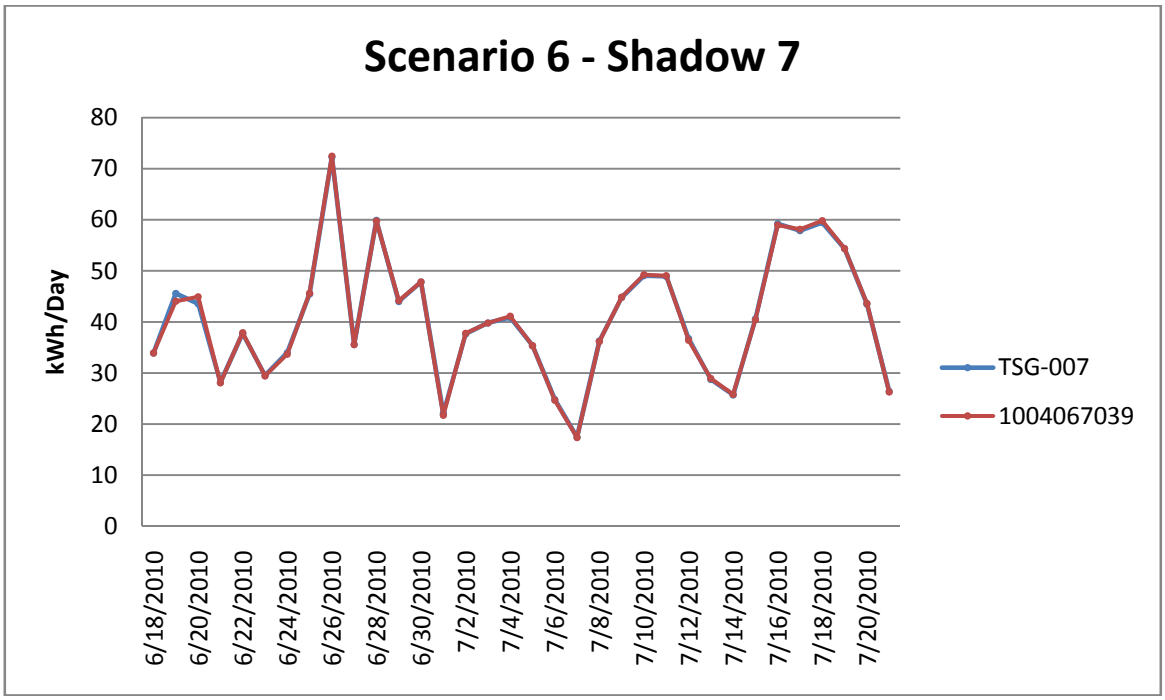
Date	TSG-006	1009146778	Delta
6/18/2010			
6/19/2010			
6/20/2010			
6/21/2010			
6/22/2010			
6/23/2010	15.4602	16.109	0.6488
6/24/2010	31.9935	31.3426	0.6488
6/25/2010	26.2035	26.1521	-0.6509
6/26/2010	21.1359	21.753	-0.0514
6/27/2010	17.6712	17.0446	0.6171
6/28/2010	22.5369	22.8713	-0.6266
6/29/2010	16.6539	16.8585	0.3344
6/30/2010	18.7413	18.8967	0.2046
7/1/2010	21.1935	20.6854	0.1554
7/2/2010	19.6521	19.9976	-0.5081
7/3/2010	37.3509	36.5849	0.3455

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Date	TSG-006	1009146778	Delta
7/4/2010	35.6814	36.1443	-0.766
7/5/2010	27.5433	27.886	0.4629
7/6/2010	20.2797	20.303	0.3427
7/7/2010	14.7921	14.9346	0.0233
7/8/2010	18.7314	18.6581	0.1425
7/9/2010	16.389	16.2061	-0.0733
7/10/2010	21.4059	21.2712	-0.1829
7/11/2010	25.7022	25.8278	-0.1347
7/12/2010	37.9614	37.9146	0.1256
7/13/2010	21.6723	21.6962	-0.0468
7/14/2010	27.258	27.322	0.0239
7/15/2010	17.2026	17.3096	0.064
7/16/2010	22.6044	22.2159	0.107
7/17/2010	12.6012	12.3636	-0.3885
7/18/2010	19.9233	20.4704	-0.2376
7/19/2010	26.6013	26.6552	0.5471
7/20/2010	13.6824	13.6335	0.0539
7/21/2010	21.7095	20.8498	-0.0489
7/22/2010	24.5643	25.4515	-0.8597
7/23/2010			
7/24/2010			
7/25/2010			
7/26/2010			
		675.4091	**0.2721**
		Deviation	**0.04%**

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3.2 Field Shadow Meter Test Case #7



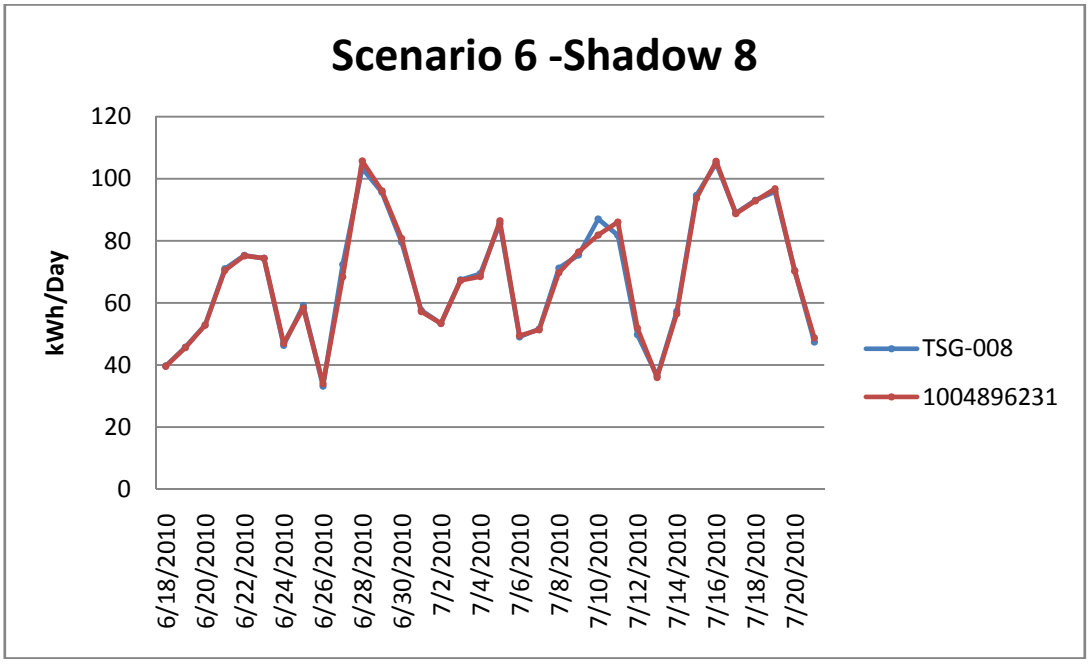
Date	TSG-007	1004067039	Delta
6/18/2010	33.9192	33.92	0.0008
6/19/2010	45.5955	44.064	-1.5315
6/20/2010	43.575	44.923	1.348
6/21/2010	28.1571	28.088	-0.0691
6/22/2010	37.7343	37.898	0.1637
6/23/2010	29.496	29.44	-0.056
6/24/2010	33.9774	33.685	-0.2924
6/25/2010	45.4833	45.625	0.1417
6/26/2010	72.3237	72.469	0.1453
6/27/2010	35.5737	35.579	0.0053
6/28/2010	59.9031	59.791	-0.1121
6/29/2010	44.0238	44.179	0.1552
6/30/2010	47.8356	47.844	0.0084
7/1/2010	22.0863	21.727	-

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Date	TSG-007	1004067039	Delta
			0.3593
7/2/2010	37.6443	37.795	0.1507
7/3/2010	39.8052	39.787	-0.0182
7/4/2010	40.8888	41.126	0.2372
7/5/2010	35.3535	35.361	0.0075
7/6/2010	24.8241	24.676	-0.1481
7/7/2010	17.4369	17.363	-0.0739
7/8/2010	36.2784	36.179	-0.0994
7/9/2010	44.817	44.856	0.039
7/10/2010	49.0803	49.256	0.1757
7/11/2010	48.9267	49.051	0.1243
7/12/2010	36.7653	36.428	-0.3373
7/13/2010	28.7379	28.938	0.2001
7/14/2010	25.7061	25.811	0.1049
7/15/2010	40.6101	40.429	-0.1811
7/16/2010	59.259	58.958	-0.301
7/17/2010	57.8859	58.163	0.2771
7/18/2010	59.4729	59.834	0.3611
7/19/2010	54.3762	54.38	0.0038
7/20/2010	43.5165	43.632	0.1155
7/21/2010	26.4138	26.298	-0.1158
7/22/2010			
7/23/2010			
7/24/2010			
7/25/2010			
7/26/2010			
		1387.553	**0.0701**
		Deviation	**0.01%**

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3.3 Field Shadow Meter Test Case #8



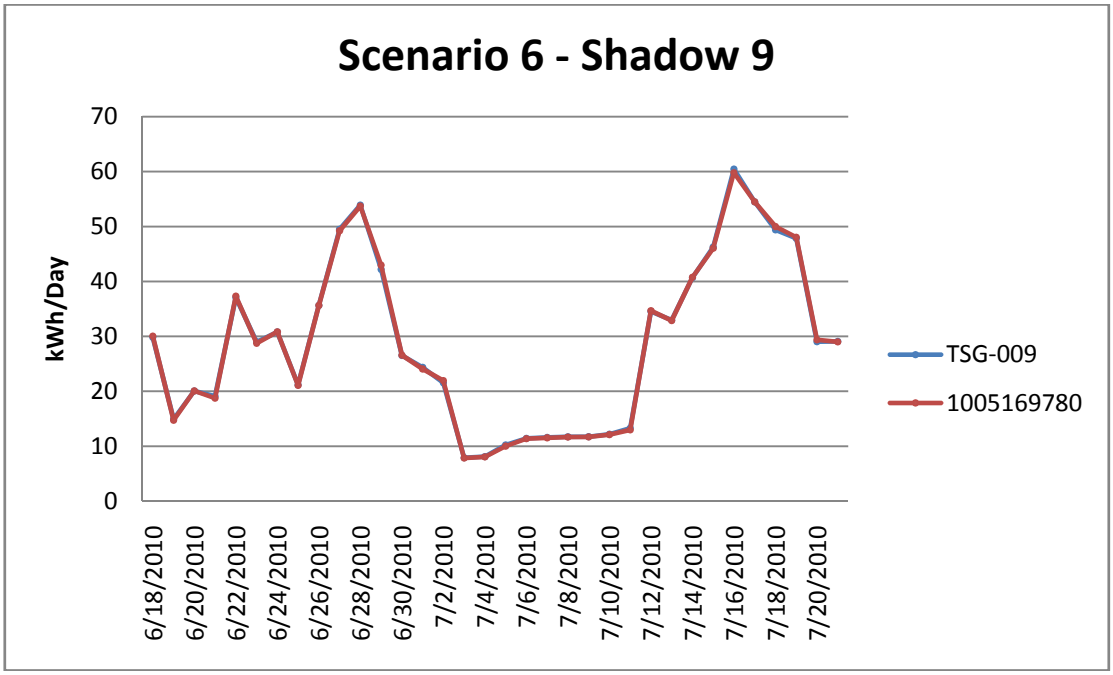
Date	TSG-008	1004896231	Delta
6/18/2010	39.699	39.617	-0.082
6/19/2010	45.7386	45.641	-0.0976
6/20/2010	52.9257	52.814	-0.1117
6/21/2010	70.9998	70.479	-0.5208
6/22/2010	75.3339	75.175	-0.1589
6/23/2010	74.3655	74.395	0.0295
6/24/2010	46.3503	46.992	0.6417
6/25/2010	59.1396	58.371	-0.7686
6/26/2010	33.1803	33.978	0.7977
6/27/2010	72.366	68.396	-3.97
6/28/2010	103.3686	105.744	2.3754
6/29/2010	95.6607	96.112	0.4513
6/30/2010	79.5867	80.809	1.2223
7/1/2010	57.6228	57.235	-0.3878
7/2/2010	53.4093	53.404	-0.0053
7/3/2010	67.4403	67.24	-0.2003
7/4/2010	69.4326	68.488	-0.9446
7/5/2010	85.5408	86.488	0.9472
7/6/2010	49.0341	49.514	0.4799

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Date	TSG-008	1004896231	Delta
7/7/2010	51.6195	51.365	-0.2545
7/8/2010	71.2263	69.716	-1.5103
7/9/2010	75.453	76.411	0.958
7/10/2010	87.0363	81.868	-5.1683
7/11/2010	81.7803	86.08	4.2997
7/12/2010	49.7553	51.909	2.1537
7/13/2010	36.4851	35.964	-0.5211
7/14/2010	57.351	56.488	-0.863
7/15/2010	94.6623	93.689	-0.9733
7/16/2010	104.979	105.649	0.67
7/17/2010	88.9074	88.732	-0.1754
7/18/2010	93.0486	92.874	-0.1746
7/19/2010	95.8767	96.756	0.8793
7/20/2010	70.4592	70.262	-0.1972
7/21/2010	47.397	48.74	1.343
7/22/2010			
7/23/2010			
7/24/2010			
7/25/2010			
7/26/2010			
		2337.395	**0.1634**
		Deviation	**0.01%**

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3.4 Field Shadow Meter Test Case #9



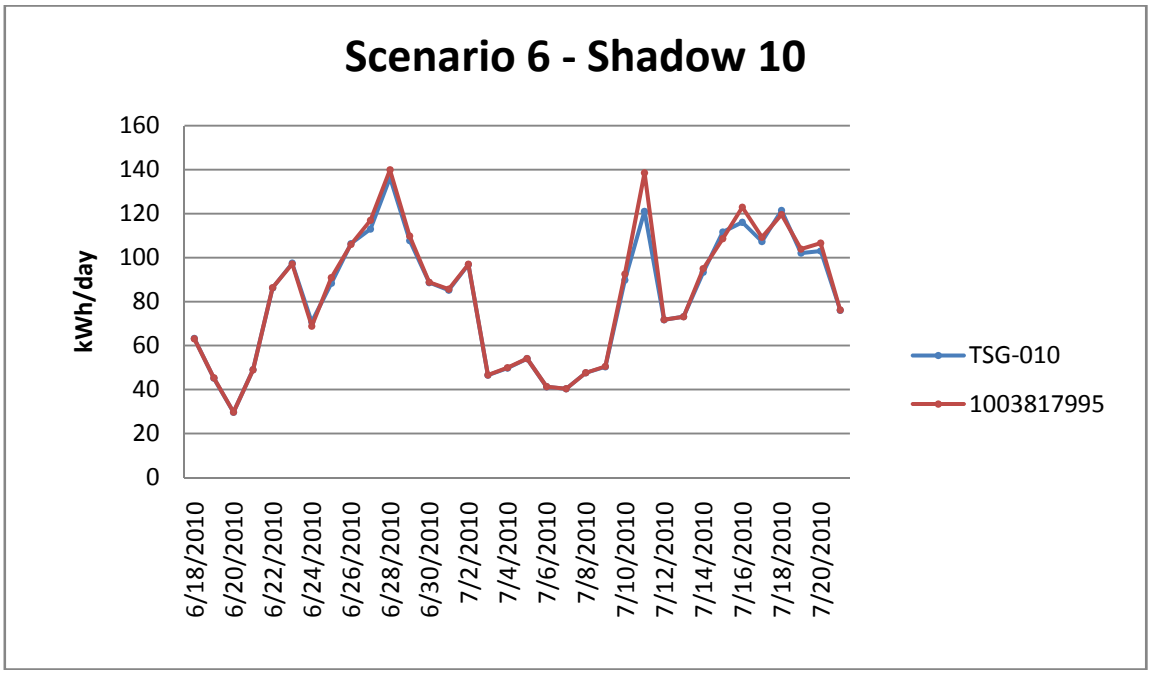
Date	TSG-009	1005169780	Delta
6/18/2010	29.829	30.054	0.225
6/19/2010	14.9292	14.735	-0.194
6/20/2010	20.0514	20.091	0.0396
6/21/2010	19.1016	18.763	-0.339
6/22/2010	37.0983	37.35	0.2517
6/23/2010	28.983	28.766	-0.217
6/24/2010	30.7911	30.846	0.0549
6/25/2010	21.1659	21.101	-0.065
6/26/2010	35.6355	35.652	0.0165
6/27/2010	49.5195	49.249	-0.27
6/28/2010	53.9148	53.74	-0.175
6/29/2010	42.1965	42.987	0.7905
6/30/2010	26.5323	26.606	0.0737
7/1/2010	24.375	24.082	-0.293
7/2/2010	21.5598	21.975	0.4152
7/3/2010	7.9158	7.871	-0.045
7/4/2010	8.1204	8.067	-0.053
7/5/2010	10.2369	10.033	-0.204

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Date	TSG-009	1005169780	Delta
7/6/2010	11.43	11.399	-0.031
7/7/2010	11.6019	11.55	-0.052
7/8/2010	11.7237	11.686	-0.038
7/9/2010	11.7438	11.714	-0.03
7/10/2010	12.1953	12.136	-0.059
7/11/2010	13.2951	12.998	-0.297
7/12/2010	34.5504	34.687	0.1366
7/13/2010	32.9598	32.883	-0.077
7/14/2010	40.6776	40.777	0.0994
7/15/2010	46.2582	46.058	-0.2
7/16/2010	60.4584	59.801	-0.657
7/17/2010	54.4935	54.498	0.0045
7/18/2010	49.3905	50.002	0.6115
7/19/2010	47.8569	48.056	0.1991
7/20/2010	29.0292	29.385	0.3558
7/21/2010	29.0829	29.014	-0.069
7/22/2010			
7/23/2010			
7/24/2010			
7/25/2010			
7/26/2010			
		978.612	**-0.091**
		Deviation	**-0.01%**

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3.5 Field Shadow Meter Test Case #10



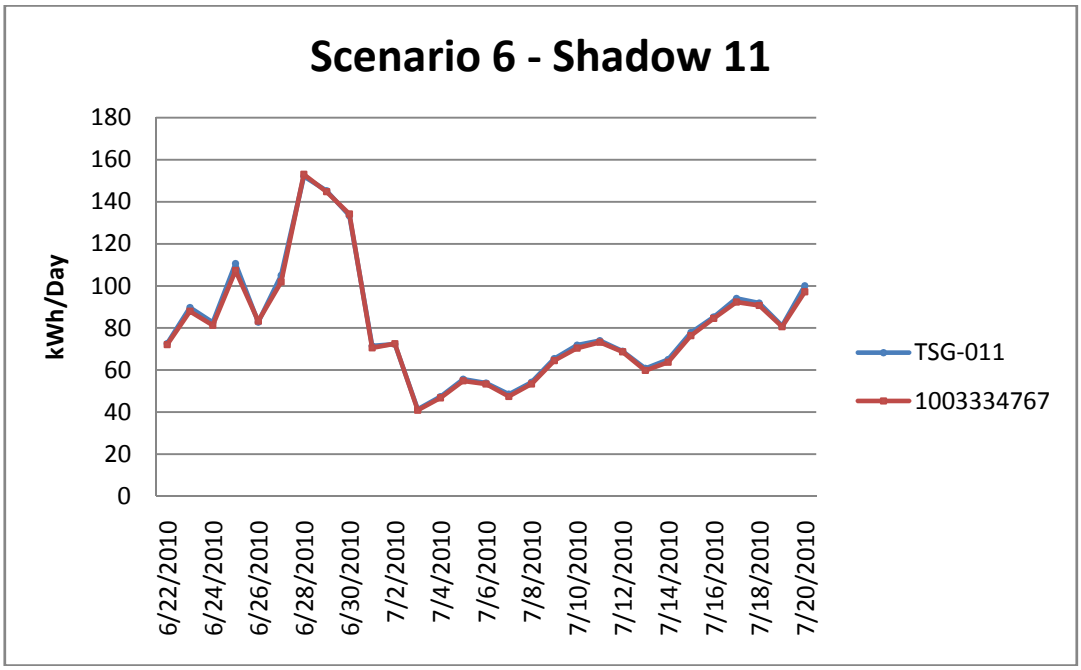
Date	TSG-010	1003817995	Delta
6/18/2010	63.2748	63.064	-0.2108
6/19/2010	45.1608	45.294	0.1332
6/20/2010	29.6511	29.705	0.0539
6/21/2010	49.0341	48.882	-0.1521
6/22/2010	86.1951	86.303	0.1079
6/23/2010	97.4988	97.056	-0.4428
6/24/2010	70.7427	68.789	-1.9537
6/25/2010	88.3038	90.847	2.5432
6/26/2010	106.371	105.959	-0.412
6/27/2010	112.992	116.947	3.955
6/28/2010	136.3269	139.921	3.5941
6/29/2010	107.7333	109.768	2.0347
6/30/2010	88.6392	88.79	0.1508
7/1/2010	85.1727	85.622	0.4493
7/2/2010	96.8202	96.954	0.1338
7/3/2010	46.5093	46.604	0.0947
7/4/2010	49.7133	49.903	0.1897
7/5/2010	54.0642	54.059	-0.0052

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Date	TSG-010	1003817995	Delta
7/6/2010	41.2449	41.291	0.0461
7/7/2010	40.3458	40.352	0.0062
7/8/2010	47.616	47.618	0.002
7/9/2010	50.3229	50.481	0.1581
7/10/2010	89.8053	92.496	2.6907
7/11/2010	121.0641	138.516	17.4519
7/12/2010	71.715	71.745	0.03
7/13/2010	73.1835	73.072	-0.1115
7/14/2010	93.3654	94.976	1.6106
7/15/2010	111.6885	108.596	-3.0925
7/16/2010	116.0679	122.901	6.8331
7/17/2010	107.3163	109.204	1.8877
7/18/2010	121.47	119.554	-1.916
7/19/2010	102.0777	103.83	1.7523
7/20/2010	102.9933	106.562	3.5687
7/21/2010	76.0467	76.164	0.1173
7/22/2010			
7/23/2010			
7/24/2010			
7/25/2010			
7/26/2010			
		2821.825	**41.2984**
		Deviation	**1.46%**

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3.6 Field Shadow Meter Test Case #11



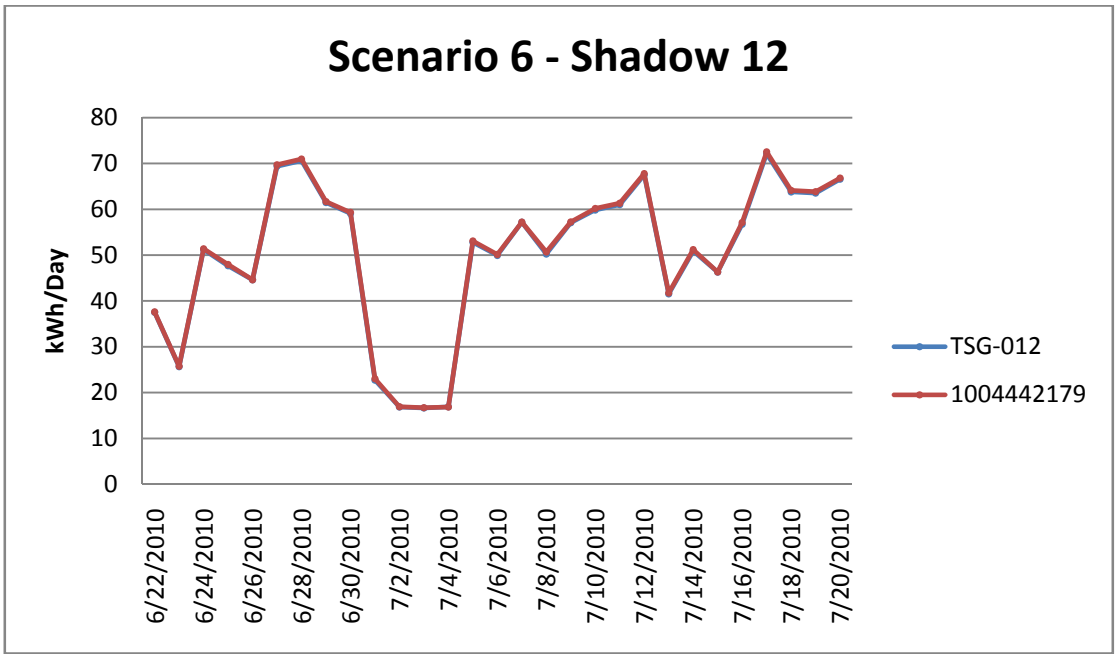
Date	TSG-011	1003334767	Delta
6/18/2010			
6/19/2010			
6/20/2010			
6/21/2010			
6/22/2010	72.5883	72.108	-0.48
6/23/2010	89.742	87.976	-1.766
6/24/2010	82.6302	81.303	-1.327
6/25/2010	110.664	107.337	-3.327
6/26/2010	82.7535	83.297	0.5435
6/27/2010	104.9946	101.895	-3.1
6/28/2010	152.1273	153.086	0.9587
6/29/2010	145.3092	144.785	-0.524
6/30/2010	133.3785	134.244	0.8655
7/1/2010	71.4567	70.574	-0.883
7/2/2010	72.3147	72.569	0.2543
7/3/2010	41.3529	40.918	-0.435
7/4/2010	47.3487	46.8	-0.549
7/5/2010	55.6368	54.878	-0.759

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Date	TSG-011	1003334767	Delta
7/6/2010	53.8203	53.366	-0.454
7/7/2010	48.5331	47.448	-1.085
7/8/2010	54.1971	53.403	-0.794
7/9/2010	65.4174	64.533	-0.884
7/10/2010	71.8434	70.445	-1.398
7/11/2010	73.9608	73.224	-0.737
7/12/2010	68.9685	68.717	-0.252
7/13/2010	60.7767	59.825	-0.952
7/14/2010	64.995	63.72	-1.275
7/15/2010	77.8203	76.392	-1.428
7/16/2010	85.272	84.585	-0.687
7/17/2010	94.0716	92.355	-1.717
7/18/2010	91.8627	90.741	-1.122
7/19/2010	81.009	80.619	-0.39
7/20/2010	100.1109	97.229	-2.882
7/21/2010			
7/22/2010			
7/23/2010			
7/24/2010			
7/25/2010			
7/26/2010			
		2328.372	**-26.58**
		Deviation	**-1.14%**

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3.7 Field Shadow Meter Test Case #12



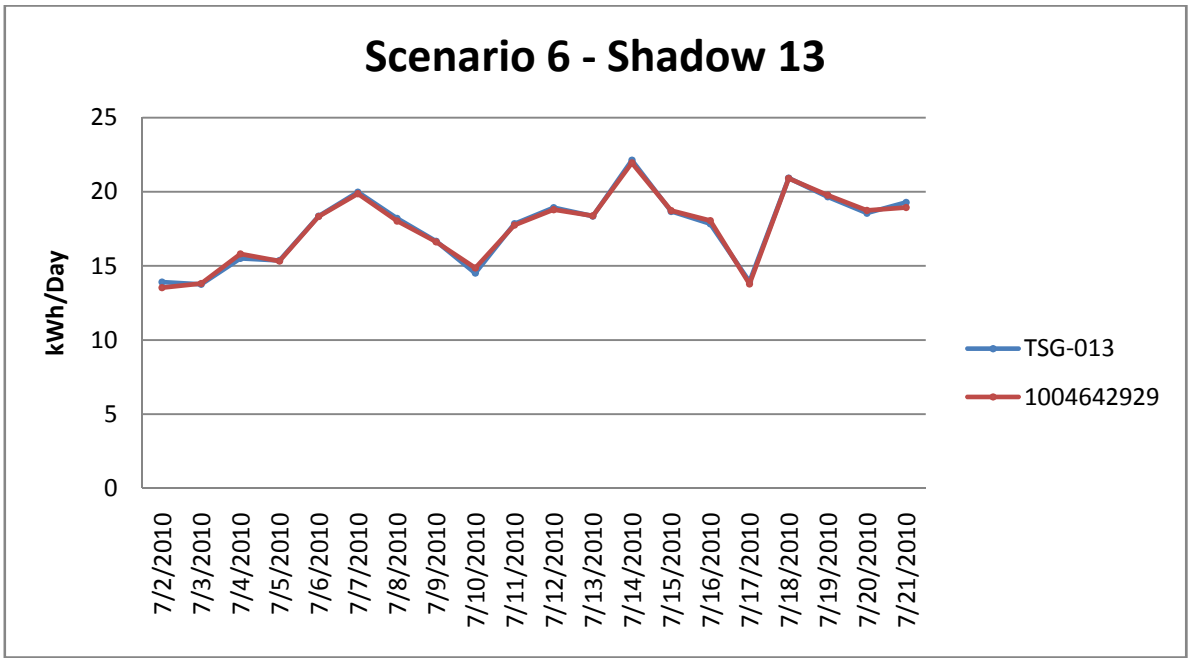
Date	TSG-012	1004442179	Delta
6/18/2010			
6/19/2010			
6/20/2010			
6/21/2010			
6/22/2010	37.5213	37.62	0.099
6/23/2010	25.6614	25.754	0.093
6/24/2010	51.2601	51.385	0.125
6/25/2010	47.694	47.968	0.274
6/26/2010	44.6289	44.646	0.017
6/27/2010	69.4374	69.732	0.295
6/28/2010	70.6353	70.979	0.344
6/29/2010	61.4967	61.696	0.199
6/30/2010	59.1009	59.341	0.24
7/1/2010	22.7043	23.046	0.342
7/2/2010	16.8414	16.929	0.088
7/3/2010	16.635	16.723	0.088
7/4/2010	16.8642	16.876	0.012
7/5/2010	52.8063	53.109	0.303
7/6/2010	49.9464	50.158	0.212

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Date	TSG-012	1004442179	Delta
7/7/2010	57.1782	57.239	0.061
7/8/2010	50.2428	50.693	0.45
7/9/2010	57.0927	57.264	0.171
7/10/2010	59.8671	60.208	0.341
7/11/2010	61.0371	61.336	0.299
7/12/2010	67.5618	67.794	0.232
7/13/2010	41.5341	41.765	0.231
7/14/2010	50.898	51.208	0.31
7/15/2010	46.3092	46.326	0.017
7/16/2010	56.7531	57.122	0.369
7/17/2010	72.1455	72.558	0.413
7/18/2010	63.8148	64.142	0.327
7/19/2010	63.5646	63.857	0.292
7/20/2010	66.603	66.843	0.24
7/21/2010	48.3711	48.727	0.356
7/22/2010			
7/23/2010			
7/24/2010			
7/25/2010			
7/26/2010			
		1513.044	**6.837**
		Deviation	**0.45%**

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3.8 Field Shadow Meter Test Case #13



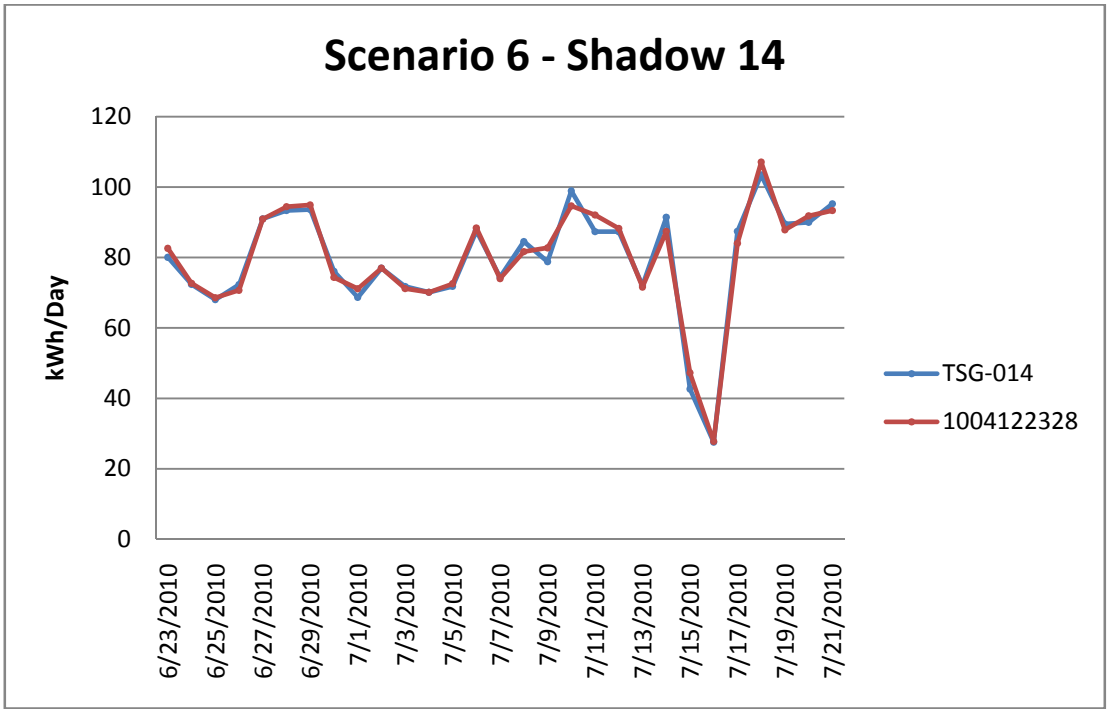
Date	TSG-013	1004642929	Delta
6/18/2010			
6/19/2010			
6/20/2010			
6/21/2010			
6/22/2010			
6/23/2010			
6/24/2010			
6/25/2010			
6/26/2010			
6/27/2010			
6/28/2010			
6/29/2010			
6/30/2010			
7/1/2010			
7/2/2010	13.9134	13.536	-0.377
7/3/2010	13.7622	13.812	0.0498
7/4/2010	15.5112	15.815	0.3038
7/5/2010	15.3714	15.327	-0.044
7/6/2010	18.3567	18.341	-0.016

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Date	TSG-013	1004642929	Delta
7/7/2010	19.9782	19.876	-0.102
7/8/2010	18.2049	18.031	-0.174
7/9/2010	16.6593	16.625	-0.034
7/10/2010	14.52	14.864	0.344
7/11/2010	17.8452	17.755	-0.09
7/12/2010	18.933	18.799	-0.134
7/13/2010	18.3627	18.382	0.0193
7/14/2010	22.1334	21.954	-0.179
7/15/2010	18.6768	18.733	0.0562
7/16/2010	17.8374	18.055	0.2176
7/17/2010	13.9428	13.781	-0.162
7/18/2010	20.9298	20.911	-0.019
7/19/2010	19.6632	19.779	0.1158
7/20/2010	18.5592	18.744	0.1848
7/21/2010	19.2885	18.946	-0.342
7/22/2010			
7/23/2010			
7/24/2010			
7/25/2010			
7/26/2010			
		352.066	**-0.383**
		Deviation	**-0.11%**

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3.9 Field Shadow Meter Test Case #14



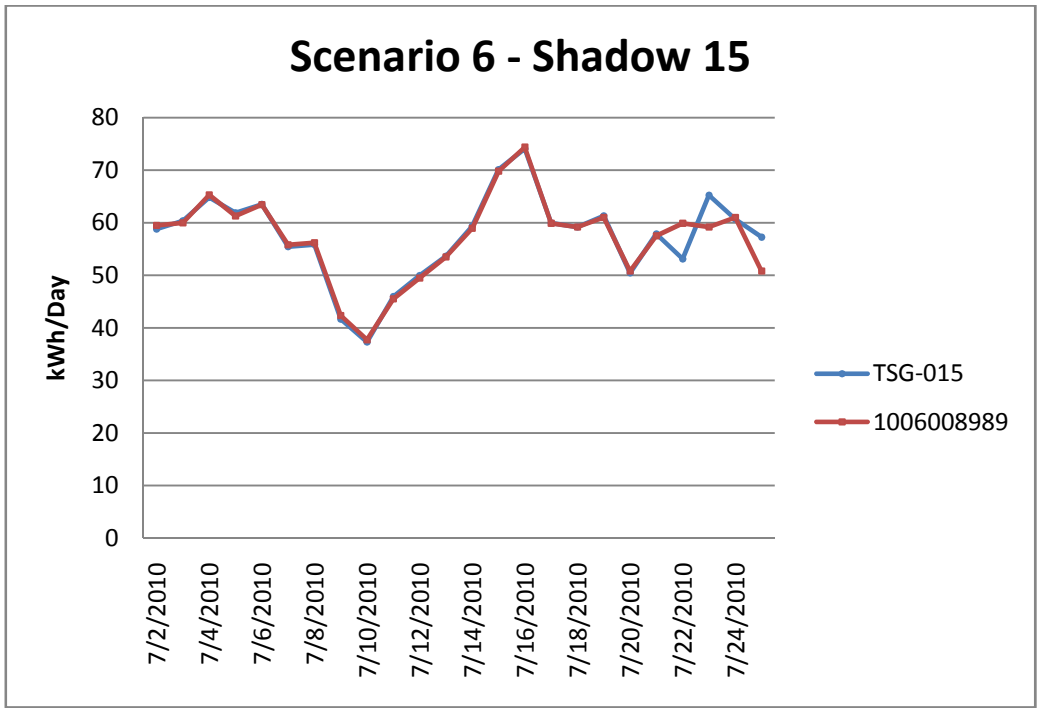
Date	TSG-014	1004122328	Delta
6/18/2010			
6/19/2010			
6/20/2010			
6/21/2010			
6/22/2010			
6/23/2010	80.0709	82.627	2.5561
6/24/2010	72.3789	72.699	0.3201
6/25/2010	68.0724	68.606	0.5336
6/26/2010	72.3219	70.714	-1.6079
6/27/2010	90.9867	90.937	-0.0497
6/28/2010	93.3675	94.47	1.1025
6/29/2010	93.639	94.937	1.298
6/30/2010	76.1013	74.357	-1.7443
7/1/2010	68.6955	71.131	2.4355
7/2/2010	77.0103	77.012	0.0017
7/3/2010	71.7879	71.195	-0.5929
7/4/2010	70.1388	70.132	-0.0068

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Date	TSG-014	1004122328	Delta
7/5/2010	71.8164	72.569	0.7526
7/6/2010	87.5499	88.41	0.8601
7/7/2010	74.3973	73.995	-0.4023
7/8/2010	84.5349	81.694	-2.8409
7/9/2010	78.8256	82.765	3.9394
7/10/2010	98.9427	94.669	-4.2737
7/11/2010	87.3627	92.096	4.7333
7/12/2010	87.348	88.291	0.943
7/13/2010	72.0993	71.624	-0.4753
7/14/2010	91.4532	87.445	-4.0082
7/15/2010	42.6705	47.253	4.5825
7/16/2010	27.564	27.783	0.219
7/17/2010	87.4557	84.064	-3.3917
7/18/2010	103.5003	107.139	3.6387
7/19/2010	89.5629	87.88	-1.6829
7/20/2010	90.0039	91.845	1.8411
7/21/2010	95.2911	93.371	-1.9201
7/22/2010			
7/23/2010			
7/24/2010			
7/25/2010			
7/26/2010			
		2311.71	**6.7605**
		Deviation	**0.29%**

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3.10 Field Shadow Meter Test Case #15



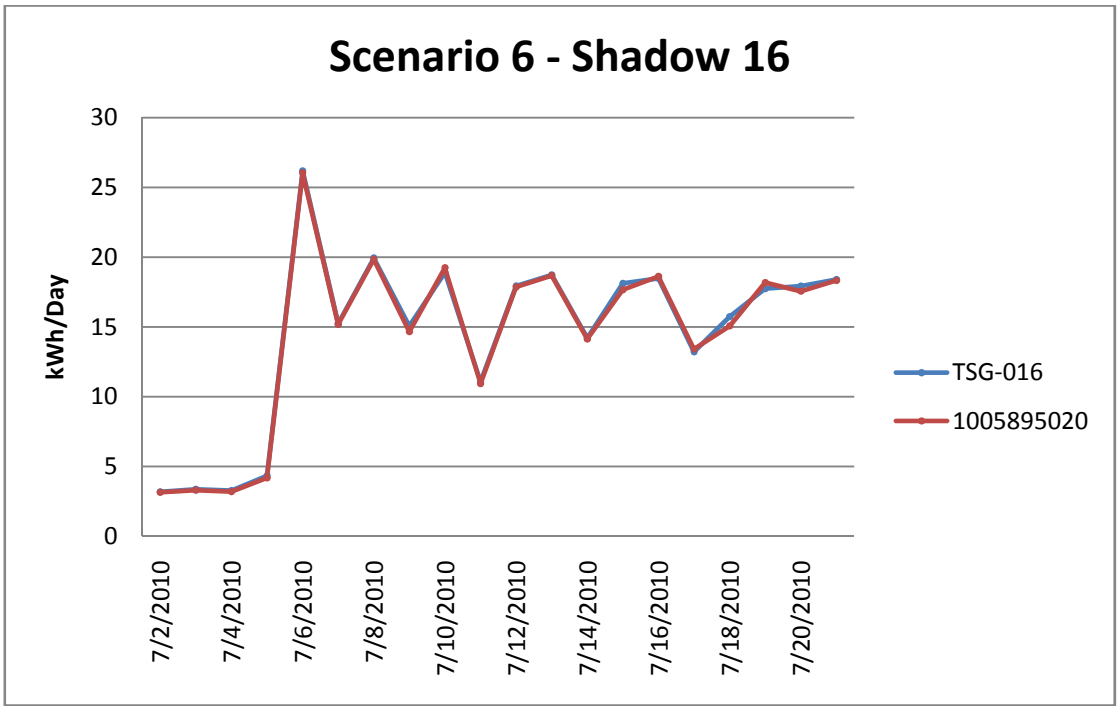
Date	TSG-015	1006008989	Delta
6/18/2010			
6/19/2010			
6/20/2010			
6/21/2010			
6/22/2010			
6/23/2010			
6/24/2010			
6/25/2010			
6/26/2010			
6/27/2010			
6/28/2010			
6/29/2010			
6/30/2010			
7/1/2010			
7/2/2010	58.8075	59.509	0.7015
7/3/2010	60.3867	59.994	-0.393
7/4/2010	64.8327	65.318	0.4853

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Date	TSG-015	1006008989	Delta
7/5/2010	61.9077	61.298	-0.61
7/6/2010	63.5076	63.459	-0.049
7/7/2010	55.4604	55.815	0.3546
7/8/2010	55.8387	56.214	0.3753
7/9/2010	41.6727	42.37	0.6973
7/10/2010	37.308	37.761	0.453
7/11/2010	45.9624	45.535	-0.427
7/12/2010	49.9782	49.507	-0.471
7/13/2010	53.6559	53.509	-0.147
7/14/2010	59.3841	58.96	-0.424
7/15/2010	70.1349	69.809	-0.326
7/16/2010	74.0817	74.405	0.3233
7/17/2010	59.9664	59.917	-0.049
7/18/2010	59.2026	59.201	-0.002
7/19/2010	61.3332	61.02	-0.313
7/20/2010	50.4609	50.835	0.3741
7/21/2010	57.8835	57.522	-0.361
7/22/2010	53.1249	59.917	6.7921
7/23/2010	65.2536	59.201	-6.053
7/24/2010	60.6879	61.02	0.3321
7/25/2010	57.2661	50.835	-6.431
7/26/2010			
		1372.931	**-5.167**
		Deviation	**-0.38%**

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3.11 Field Shadow Meter Test Case #16



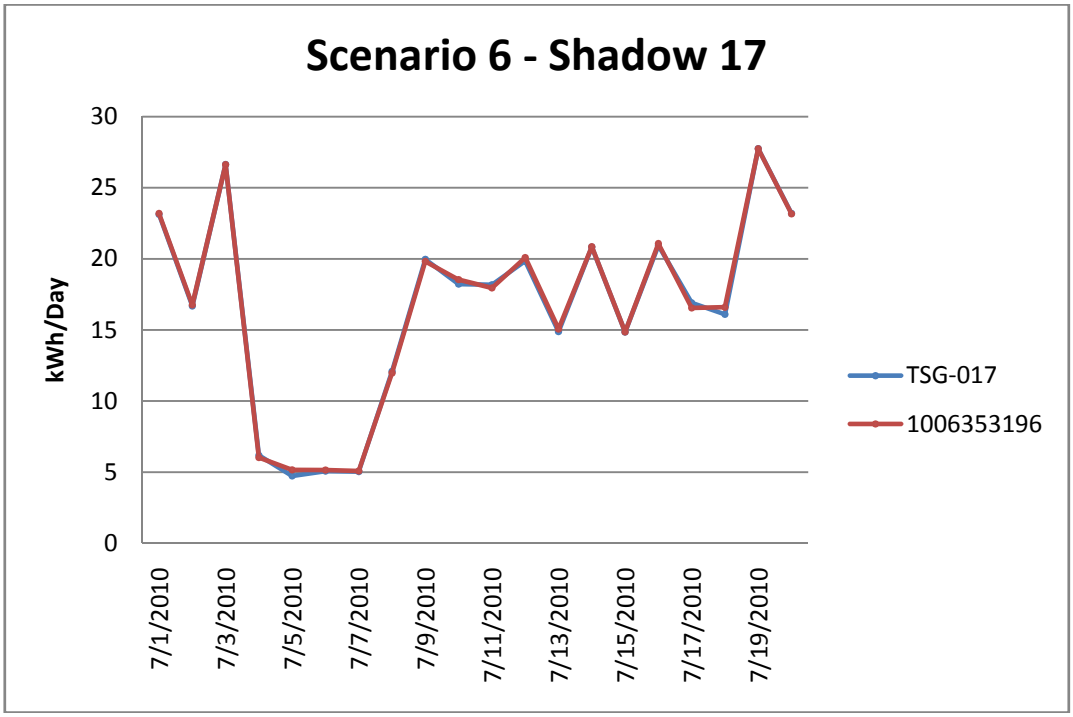
Date	TSG-016	1005895020	Delta
6/18/2010			
6/19/2010			
6/20/2010			
6/21/2010			
6/22/2010			
6/23/2010			
6/24/2010			
6/25/2010			
6/26/2010			
6/27/2010			
6/28/2010			
6/29/2010			
6/30/2010			
7/1/2010			
7/2/2010	3.1809	3.152	-0.029
7/3/2010	3.3621	3.303	-0.059
7/4/2010	3.2721	3.198	-0.074

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Date	TSG-016	1005895020	Delta
7/5/2010	4.3263	4.181	-0.145
7/6/2010	26.1846	26.045	-0.14
7/7/2010	15.2412	15.181	-0.06
7/8/2010	19.9455	19.851	-0.094
7/9/2010	15.0612	14.665	-0.396
7/10/2010	18.8904	19.246	0.3556
7/11/2010	11.0679	10.941	-0.127
7/12/2010	17.9349	17.867	-0.068
7/13/2010	18.7329	18.686	-0.047
7/14/2010	14.2113	14.134	-0.077
7/15/2010	18.1254	17.668	-0.457
7/16/2010	18.4785	18.626	0.1475
7/17/2010	13.2201	13.417	0.1969
7/18/2010	15.7365	15.073	-0.663
7/19/2010	17.7462	18.183	0.4368
7/20/2010	17.931	17.562	-0.369
7/21/2010	18.4017	18.334	-0.068
7/22/2010			
7/23/2010			
7/24/2010			
7/25/2010			
7/26/2010			
		289.313	**-1.738**
		Deviation	**-0.60%**

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3.12 Field Shadow Meter Test Case #17



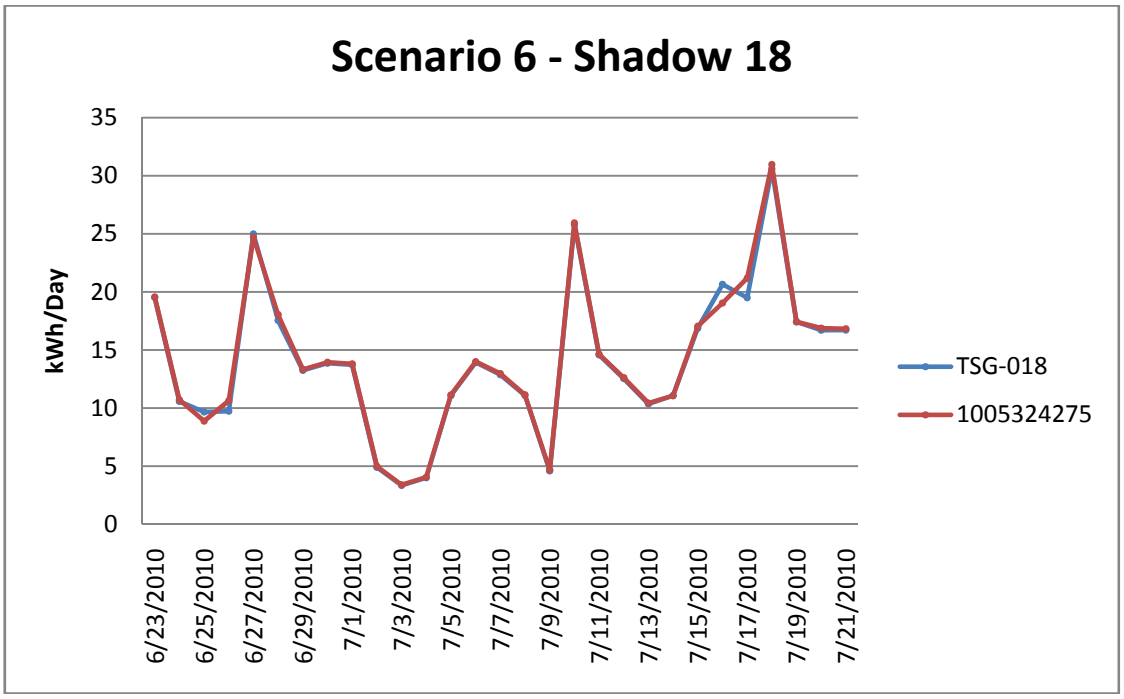
Date	TSG-017	1006353196	Delta
6/18/2010			
6/19/2010			
6/20/2010			
6/21/2010			
6/22/2010			
6/23/2010			
6/24/2010			
6/25/2010			
6/26/2010			
6/27/2010			
6/28/2010			
6/29/2010			
6/30/2010			
7/1/2010	23.1336	23.194	0.06
7/2/2010	16.6806	16.762	0.081
7/3/2010	26.6436	26.636	-0.01
7/4/2010	6.1788	6.029	-0.15

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Date	TSG-017	1006353196	Delta
7/5/2010	4.731	5.158	0.427
7/6/2010	5.0739	5.149	0.075
7/7/2010	5.0313	5.083	0.052
7/8/2010	12.0843	11.975	-0.11
7/9/2010	19.9647	19.826	-0.14
7/10/2010	18.2208	18.538	0.317
7/11/2010	18.1737	17.955	-0.22
7/12/2010	19.8603	20.092	0.232
7/13/2010	14.8788	15.065	0.186
7/14/2010	20.832	20.856	0.024
7/15/2010	14.8515	14.86	0.008
7/16/2010	20.9418	21.078	0.136
7/17/2010	16.9092	16.55	-0.36
7/18/2010	16.0989	16.602	0.503
7/19/2010	27.7548	27.746	-0.01
7/20/2010	23.1951	23.166	-0.03
7/21/2010			
7/22/2010			
7/23/2010			
7/24/2010			
7/25/2010			
7/26/2010			
		332.32	**1.081**
		Deviation	**0.33%**

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3.13 Field Shadow Meter Test Case #18



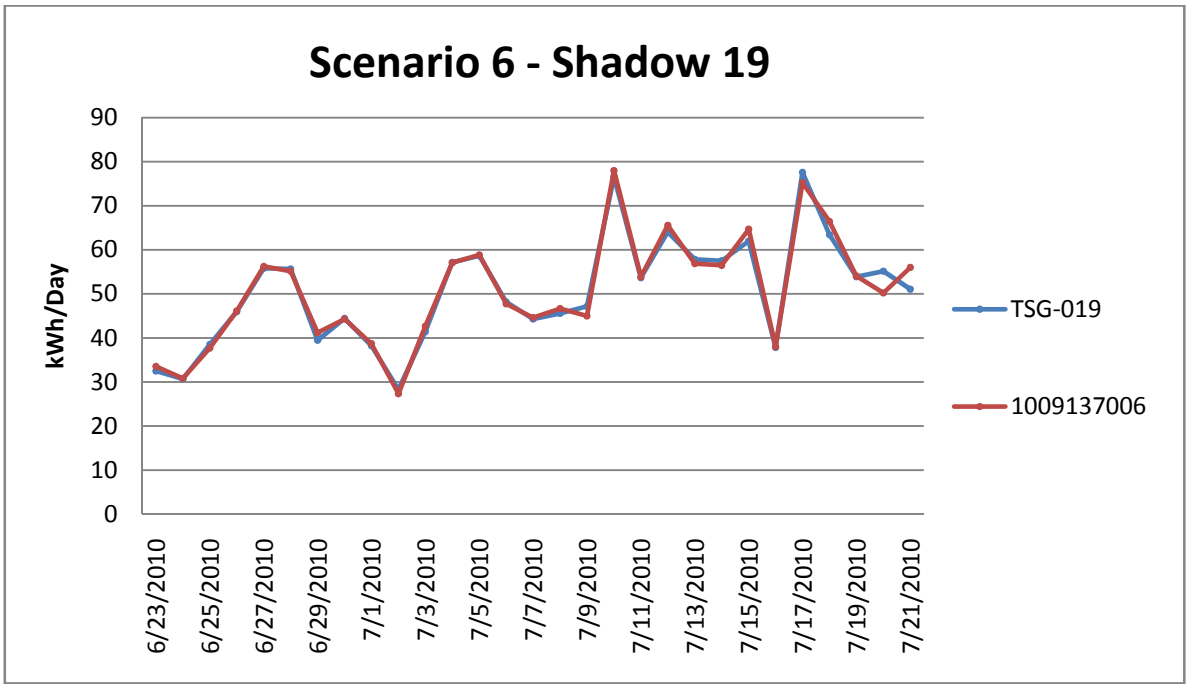
Date	TSG-018	1005324275	Delta
6/18/2010			
6/19/2010			
6/20/2010			
6/21/2010			
6/22/2010			
6/23/2010	19.5279	19.571	0.0431
6/24/2010	10.5765	10.714	0.1375
6/25/2010	9.6645	8.882	-0.782
6/26/2010	9.7299	10.641	0.9111
6/27/2010	24.9897	24.72	-0.27
6/28/2010	17.5458	18.049	0.5032
6/29/2010	13.242	13.333	0.091
6/30/2010	13.8678	13.951	0.0832
7/1/2010	13.728	13.814	0.086
7/2/2010	4.9029	4.984	0.0811
7/3/2010	3.3438	3.396	0.0522
7/4/2010	4.0041	4.055	0.0509
7/5/2010	11.0811	11.132	0.0509

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Date	TSG-018	1005324275	Delta
7/6/2010	13.9284	14.003	0.0746
7/7/2010	12.8751	12.972	0.0969
7/8/2010	11.1006	11.145	0.0444
7/9/2010	4.5951	4.667	0.0719
7/10/2010	25.7922	25.944	0.1518
7/11/2010	14.5788	14.647	0.0682
7/12/2010	12.5421	12.629	0.0869
7/13/2010	10.3578	10.438	0.0802
7/14/2010	11.0775	11.072	-0.006
7/15/2010	16.8732	17.051	0.1778
7/16/2010	20.6598	19.044	-1.616
7/17/2010	19.5054	21.19	1.6846
7/18/2010	30.6135	30.976	0.3625
7/19/2010	17.418	17.439	0.021
7/20/2010	16.7022	16.881	0.1788
7/21/2010	16.7238	16.832	0.1082
7/22/2010			
7/23/2010			
7/24/2010			
7/25/2010			
7/26/2010			
		414.172	**2.6245**
		Deviation	**0.63%**

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3.14 Field Shadow Meter Test Case #19



Date	TSG-019	1009137006	Delta
6/18/2010			
6/19/2010			
6/20/2010			
6/21/2010			
6/22/2010			
6/23/2010	32.5053	33.564	1.0587
6/24/2010	30.7101	30.824	0.1139
6/25/2010	38.5812	37.705	-0.876
6/26/2010	45.9765	46.134	0.1575
6/27/2010	55.8177	56.239	0.4213
6/28/2010	55.6671	55.159	-0.508
6/29/2010	39.486	41.226	1.74
6/30/2010	44.451	44.301	-0.15
7/1/2010	38.2617	38.728	0.4663
7/2/2010	28.3005	27.352	-0.948
7/3/2010	41.4627	42.694	1.2313
7/4/2010	57.1737	57.105	-0.069
7/5/2010	58.6713	58.864	0.1927

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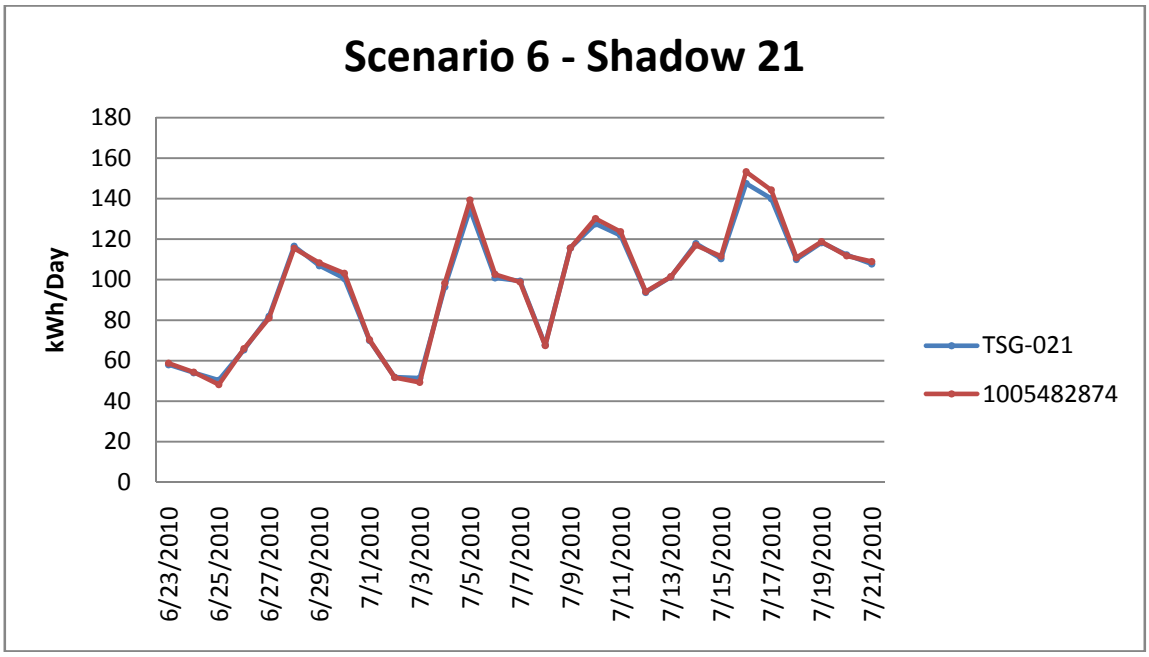
Date	TSG-019	1009137006	Delta
7/6/2010	48.1965	47.752	-0.444
7/7/2010	44.3172	44.634	0.3168
7/8/2010	45.5763	46.686	1.1097
7/9/2010	47.1834	44.984	-2.199
7/10/2010	76.6017	78.002	1.4003
7/11/2010	53.6811	53.891	0.2099
7/12/2010	64.0503	65.569	1.5187
7/13/2010	57.8529	56.86	-0.993
7/14/2010	57.5394	56.494	-1.045
7/15/2010	61.9803	64.692	2.7117
7/16/2010	37.848	38.032	0.184
7/17/2010	77.6019	75.248	-2.354
7/18/2010	63.4371	66.447	3.0099
7/19/2010	53.8944	54.063	0.1686
7/20/2010	55.1616	50.226	-4.936
7/21/2010	51.0864	56.013	4.9266
7/22/2010			
7/23/2010			
7/24/2010			
7/25/2010			
7/26/2010			
		1469.488	**6.4147**
		Deviation	**0.44%**

3.15 Field Shadow Meter Test Case #20

THIS INSTALLATION TERMINATED DUE TO INSTALLATION FAILURE

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3.16 Field Shadow Meter Test Case #21



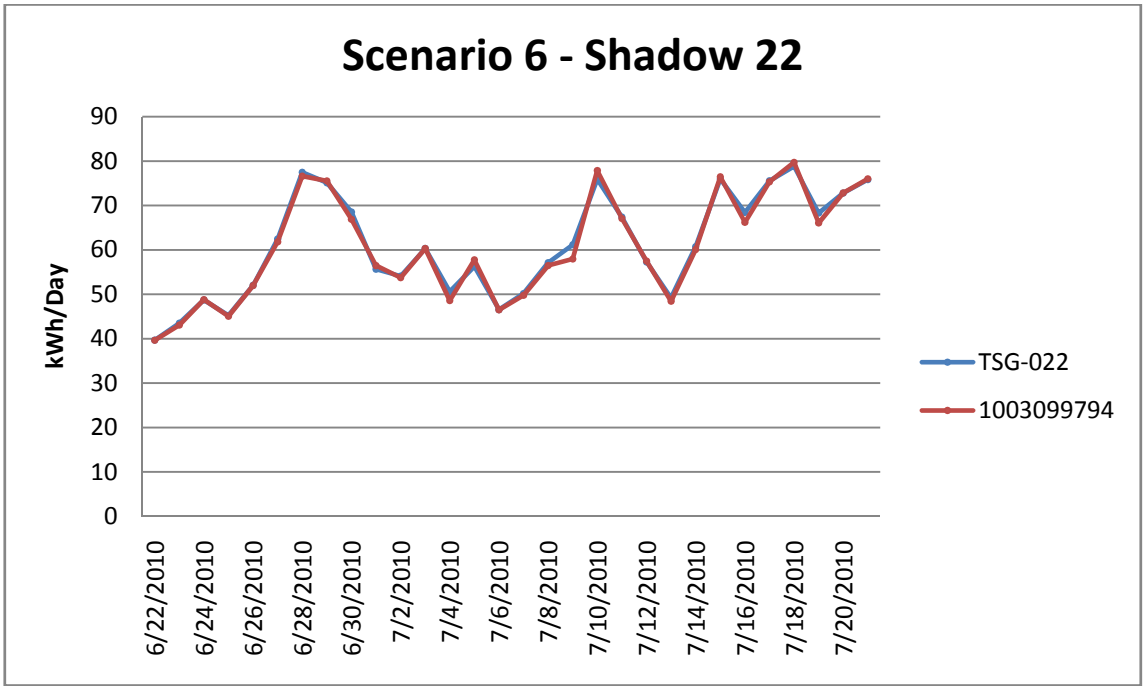
Date	TSG-021	1005482874	Delta
6/18/2010			
6/19/2010			
6/20/2010			
6/21/2010			
6/22/2010			
6/23/2010	58.0245	58.807	0.782
6/24/2010	54.0951	54.358	0.263
6/25/2010	50.3655	48.214	-2.15
6/26/2010	65.3556	65.946	0.59
6/27/2010	81.9408	81.061	-0.88
6/28/2010	116.5317	115.517	-1.01
6/29/2010	106.9509	108.324	1.373
6/30/2010	100.6236	103.181	2.557
7/1/2010	70.0515	70.35	0.298
7/2/2010	51.8538	51.776	-0.08
7/3/2010	51.3699	49.347	-2.02
7/4/2010	96.4455	98.278	1.833
7/5/2010	134.7981	139.32	4.522
7/6/2010	100.9458	102.645	1.699

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Date	TSG-021	1005482874	Delta
7/7/2010	99.3462	98.85	-0.5
7/8/2010	67.7247	67.521	-0.2
7/9/2010	115.6605	115.637	-0.02
7/10/2010	127.6422	130.208	2.566
7/11/2010	121.9026	123.73	1.827
7/12/2010	93.7557	94.114	0.358
7/13/2010	101.3883	101.465	0.077
7/14/2010	117.8988	117.052	-0.85
7/15/2010	110.4165	111.602	1.186
7/16/2010	147.5151	153.311	5.796
7/17/2010	140.0637	144.308	4.244
7/18/2010	110.0445	110.87	0.826
7/19/2010	118.3491	118.784	0.435
7/20/2010	112.2678	111.787	-0.48
7/21/2010	107.7807	108.961	1.18
7/22/2010			
7/23/2010			
7/24/2010			
7/25/2010			
7/26/2010			
		2855.324	**24.22**
		Deviation	**0.85%**

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3.17 Field Shadow Meter Test Case #22



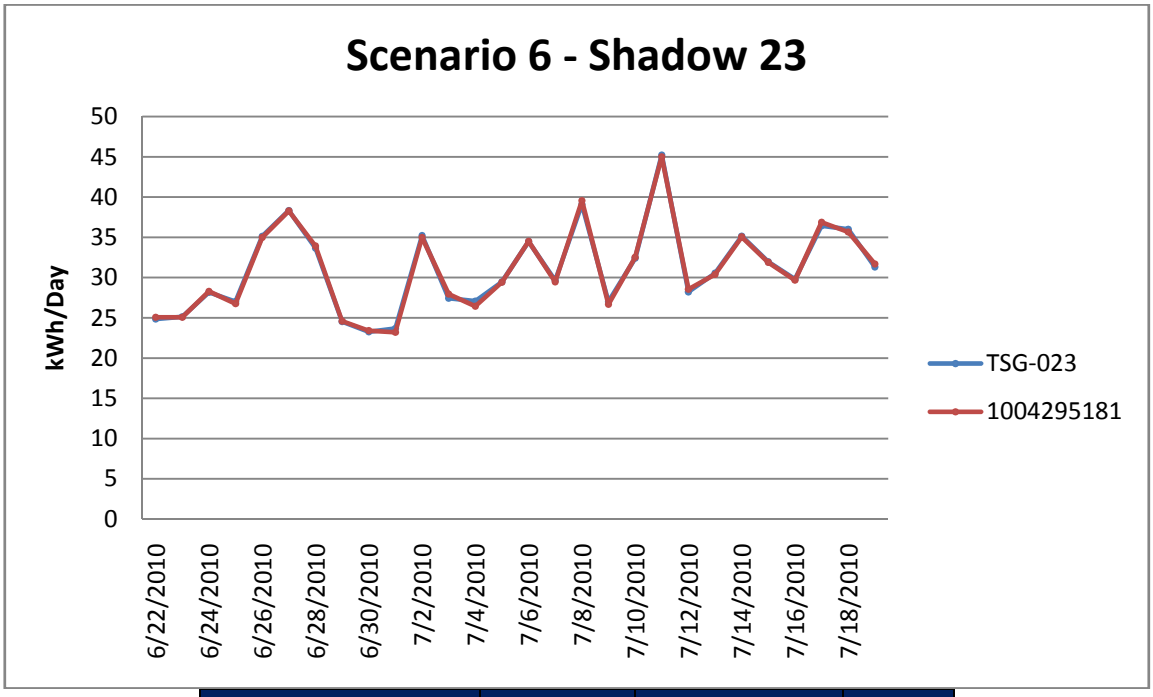
Date	TSG-022	1003099794	Delta
6/18/2010			
6/19/2010			
6/20/2010			
6/21/2010			
6/22/2010	39.6816	39.644	-0.0376
6/23/2010	43.503	43.07	-0.433
6/24/2010	48.7206	48.802	0.0814
6/25/2010	45.234	45.036	-0.198
6/26/2010	52.0203	51.976	-0.0443
6/27/2010	62.4648	61.827	-0.6378
6/28/2010	77.487	76.615	-0.872
6/29/2010	75.135	75.55	0.415
6/30/2010	68.5359	66.902	-1.6339
7/1/2010	55.6428	56.462	0.8192
7/2/2010	54.1026	53.727	-0.3756
7/3/2010	60.3141	60.336	0.0219
7/4/2010	50.5965	48.593	-2.0035
7/5/2010	56.31	57.772	1.462

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Date	TSG-022	1003099794	Delta
7/6/2010	46.5495	46.505	-0.0445
7/7/2010	50.1741	49.781	-0.3931
7/8/2010	57.1305	56.47	-0.6605
7/9/2010	61.1679	57.967	-3.2009
7/10/2010	75.9504	77.889	1.9386
7/11/2010	67.3809	67.09	-0.2909
7/12/2010	57.2922	57.492	0.1998
7/13/2010	49.2081	48.456	-0.7521
7/14/2010	60.7416	60.106	-0.6356
7/15/2010	75.9798	76.478	0.4982
7/16/2010	68.4498	66.225	-2.2248
7/17/2010	75.5664	75.334	-0.2324
7/18/2010	78.8292	79.733	0.9038
7/19/2010	68.2995	66.06	-2.2395
7/20/2010	72.8013	72.85	0.0487
7/21/2010	75.843	76.024	0.181
7/22/2010			
7/23/2010			
7/24/2010			
7/25/2010			
7/26/2010			
		1820.772	**-10.3404**
		Deviation	**-0.57%**

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3.18 Field Shadow Meter Test Case #23



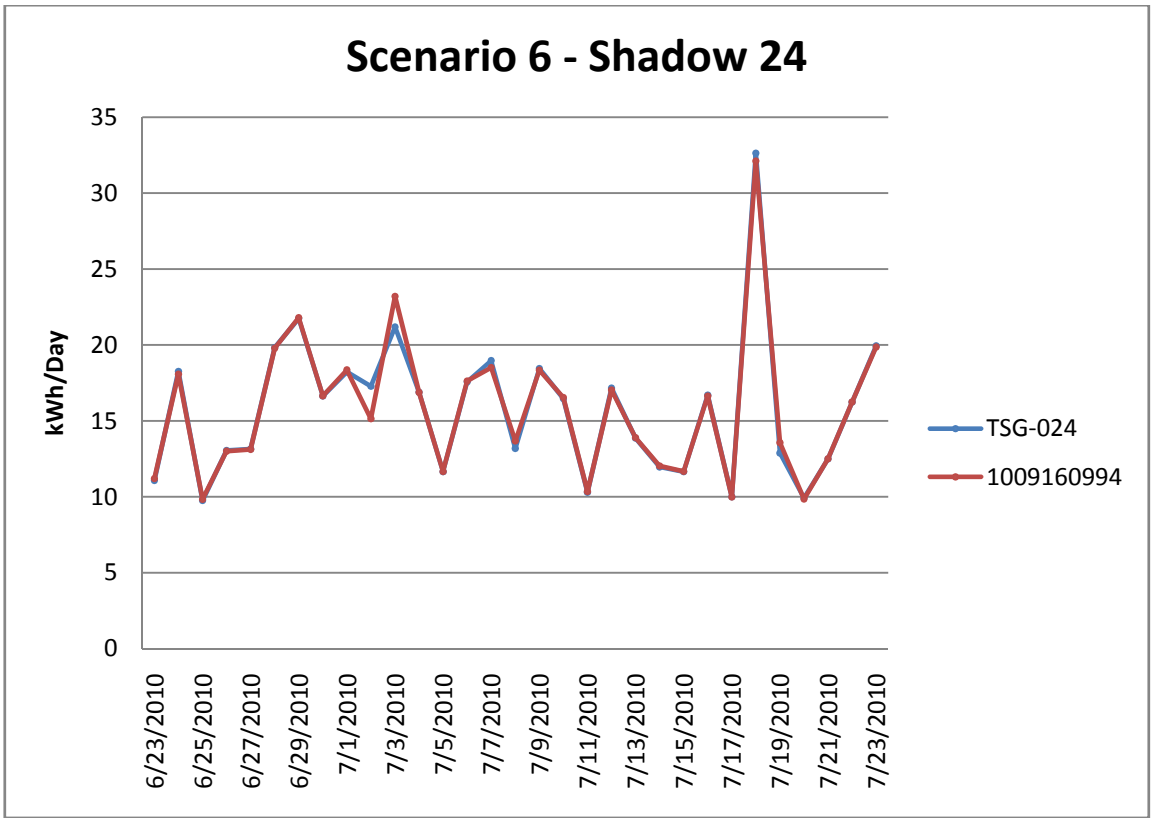
Date	TSG-023	1004295181	Delta
6/18/2010			
6/19/2010			
6/20/2010			
6/21/2010			
6/22/2010	24.852	25.075	0.223
6/23/2010	25.1265	25.067	-0.0595
6/24/2010	28.1769	28.285	0.1081
6/25/2010	27.0171	26.762	-0.2551
6/26/2010	35.1264	34.993	-0.1334
6/27/2010	38.3259	38.292	-0.0339
6/28/2010	33.66	33.926	0.266
6/29/2010	24.5379	24.593	0.0551
6/30/2010	23.265	23.413	0.148
7/1/2010	23.6841	23.208	-0.4761

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Date	TSG-023	1004295181	Delta
7/2/2010	35.2239	34.988	-0.2359
7/3/2010	27.4368	27.957	0.5202
7/4/2010	27.081	26.44	-0.641
7/5/2010	29.4618	29.422	-0.0398
7/6/2010	34.4826	34.511	0.0284
7/7/2010	29.6394	29.475	-0.1644
7/8/2010	39.1005	39.561	0.4605
7/9/2010	27.021	26.678	-0.343
7/10/2010	32.4162	32.532	0.1158
7/11/2010	45.2292	45.003	-0.2262
7/12/2010	28.2246	28.549	0.3244
7/13/2010	30.5487	30.393	-0.1557
7/14/2010	35.1474	35.057	-0.0904
7/15/2010	31.9608	31.9	-0.0608
7/16/2010	29.8056	29.68	-0.1256
7/17/2010	36.4527	36.874	0.4213
7/18/2010	36.0123	35.663	-0.3493
7/19/2010	31.3245	31.696	0.3715
7/20/2010			
7/21/2010			
7/22/2010			
7/23/2010			
7/24/2010			
7/25/2010			
7/26/2010			
		869.993	**-0.3478**
		Deviation	**-0.04%**

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3.19 Field Shadow Meter Test Case #24



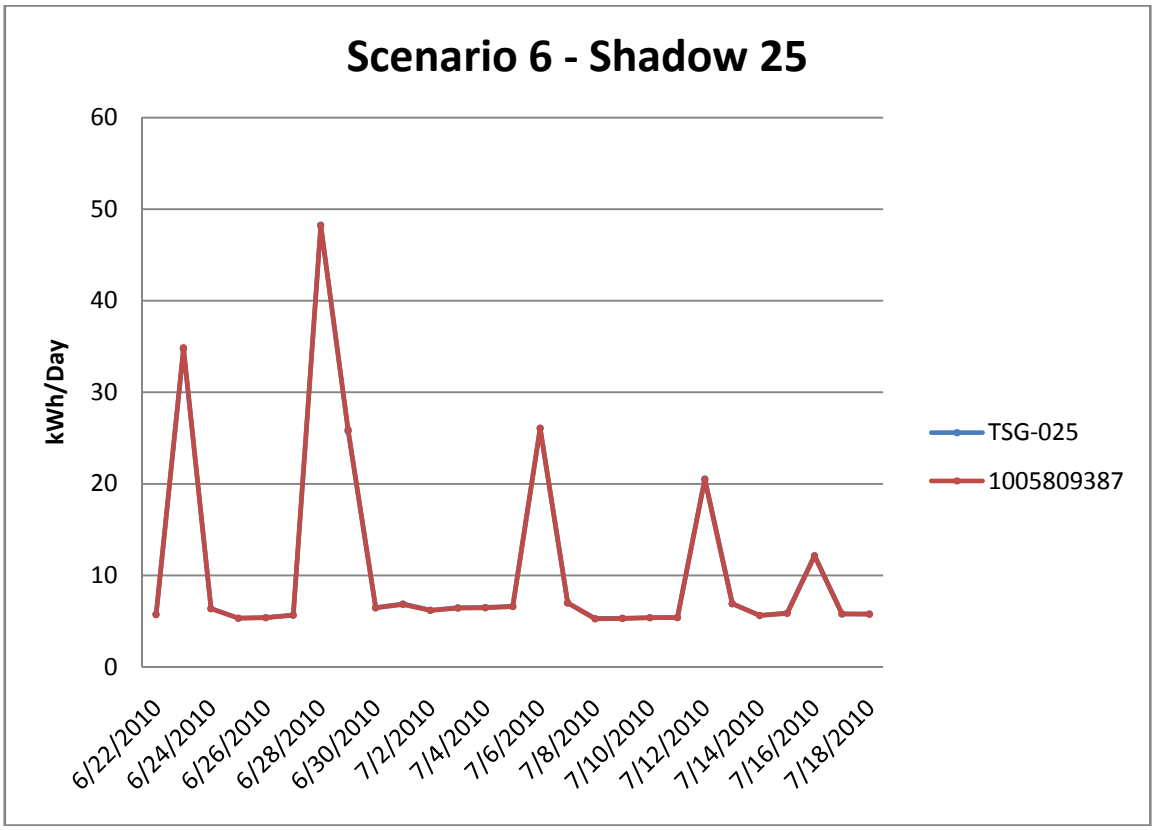
Date	TSG-024	1009160994	Delta
6/18/2010			
6/19/2010			
6/20/2010			
6/21/2010			
6/22/2010			
6/23/2010	11.0814	11.193	0.1116
6/24/2010	18.264	18.074	-0.19
6/25/2010	9.759	9.827	0.068
6/26/2010	13.0548	13.003	-0.052
6/27/2010	13.1496	13.111	-0.039
6/28/2010	19.8369	19.786	-0.051
6/29/2010	21.7518	21.795	0.0432
6/30/2010	16.6458	16.643	-0.003
7/1/2010	18.2277	18.357	0.1293

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Date	TSG-024	1009160994	Delta
7/2/2010	17.2815	15.14	-2.142
7/3/2010	21.1905	23.202	2.0115
7/4/2010	16.8942	16.874	-0.02
7/5/2010	11.6517	11.656	0.0043
7/6/2010	17.5746	17.626	0.0514
7/7/2010	18.9747	18.504	-0.471
7/8/2010	13.1874	13.673	0.4856
7/9/2010	18.4557	18.336	-0.12
7/10/2010	16.4703	16.539	0.0687
7/11/2010	10.2954	10.345	0.0496
7/12/2010	17.1609	17.038	-0.123
7/13/2010	13.8696	13.897	0.0274
7/14/2010	11.967	12.027	0.06
7/15/2010	11.658	11.67	0.012
7/16/2010	16.6995	16.637	-0.063
7/17/2010	9.9963	9.985	-0.011
7/18/2010	32.6397	32.117	-0.523
7/19/2010	12.8829	13.561	0.6781
7/20/2010	9.9198	9.853	-0.067
7/21/2010	12.495	12.505	0.01
7/22/2010	16.2369	16.247	0.0101
7/23/2010	19.9476	19.866	-0.082
7/24/2010			
7/25/2010			
7/26/2010			
		489.087	**-0.133**
		Deviation	**-0.03%**

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3.20 Field Shadow Meter Test Case #25



Date	TSG-025	1005809387	Delta
6/18/2010			
6/19/2010			
6/20/2010			
6/21/2010			
6/22/2010	5.7786	5.714	-0.065
6/23/2010	34.7124	34.875	0.1626
6/24/2010	6.4056	6.368	-0.038
6/25/2010	5.3277	5.328	0.0003
6/26/2010	5.3946	5.373	-0.022
6/27/2010	5.6685	5.657	-0.011
6/28/2010	48.273	48.227	-0.046
6/29/2010	25.7739	25.904	0.1301
6/30/2010	6.465	6.472	0.007
7/1/2010	6.8829	6.837	-0.046

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Date	TSG-025	1005809387	Delta
7/2/2010	6.1977	6.184	-0.014
7/3/2010	6.4626	6.433	-0.03
7/4/2010	6.5034	6.473	-0.03
7/5/2010	6.6195	6.604	-0.015
7/6/2010	26.0739	26.09	0.0161
7/7/2010	7.0023	6.998	-0.004
7/8/2010	5.2983	5.259	-0.039
7/9/2010	5.3196	5.298	-0.022
7/10/2010	5.3934	5.375	-0.018
7/11/2010	5.4009	5.402	0.0011
7/12/2010	20.5542	20.464	-0.09
7/13/2010	6.9036	6.912	0.0084
7/14/2010	5.6268	5.623	-0.004
7/15/2010	5.8896	5.852	-0.038
7/16/2010	12.1584	12.14	-0.018
7/17/2010	5.7867	5.803	0.0163
7/18/2010	5.7948	5.763	-0.032
7/19/2010			
7/20/2010			
7/21/2010			
7/22/2010			
7/23/2010			
7/24/2010			
7/25/2010			
7/26/2010			
		293.428	**-0.24**
		Deviation	**-0.08%**

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