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Witness: Mark L. Serrano

**SOUTHERN CALIFORNIA GAS COMPANY**  
**ADVANCED METERING INFRASTRUCTURE**  
**SUPPLEMENTAL TESTIMONY**

***\*\*REDACTED, PUBLIC VERSION\*\****

**Prepared Direct Supplemental Testimony**  
**of**  
**Mark L. Serrano**

**BEFORE THE PUBLIC UTILITIES COMMISSION**  
**OF THE STATE OF CALIFORNIA**

**February 11, 2009**

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1 **I. BACKGROUND**

2 The following direct supplemental testimony addresses questions directed to Southern  
3 California Gas Company (SoCalGas) regarding the “appropriateness of the SoCalGas choices of  
4 communications infrastructure and battery operations” by Assigned Commissioner Grueneich  
5 and Administrative Law Judge Hecht in the scoping memo and ruling (ACR) issued January 6,  
6 2009. Specifically, this chapter will address the questions pertaining to battery life (ACR, pp. 8)  
7 listed below.

- 8
- 9 1. What is the estimated life of the battery proposed for use in the SoCalGas AMI system?
  - 10 2. How was the battery tested to ensure its lifespan and ability to withstand weather and  
11 other operating conditions?
  - 12 3. What provision has been made to ensure that batteries and other replacement parts will be  
available through the expected useful life of the proposed AMI system?

13 **II. INTRODUCTION**

14 Radio (RF)-based gas AMI meter modules operate on batteries because they provide a  
15 safe and cost effective power source for the gas AMI meter module’s internal radio transmitter.  
16 The battery, or batteries, used in gas AMI meter modules are integral to the product itself and not  
17 typically replaced during the product’s useful life.

18 Gas AMI meter module battery life has been important to AMI technology vendors and  
19 of particular interest to SoCalGas as it has evaluated AMI technology vendor proposals received  
20 in response to the SoCalGas AMI technology Request for Proposal (RFP).

21 In its RFP, SoCalGas solicited vendor proposals for an AMI system that would have a [REDACTED]  
22 year operating life [REDACTED]. SoCalGas also specified that the  
23 batteries used in the gas AMI meter modules have a minimum life of [REDACTED] years. When SoCalGas  
24 issued its RFP, it was assumed that with this long an operating life, the gas AMI module failure  
25 rates might be greater the last years of their useful life.

1 **III. ESTIMATED BATTERY LIFE AND TESTING**

2 **A. THE GAS AMI METER MODULE BATTERIES PROPOSED FOR USE IN**  
3 **THE SOCALGAS AMI SYSTEM HAVE AN ESTIMATED USEFUL LIFE**  
4 **OF ■ YEARS.**

5 After determining the “short list” AMI technology vendors, SoCalGas requested that each  
6 AMI technology vendor submit a “white paper” describing the tests conducted to demonstrate  
7 the gas AMI meter module batteries used in the SoCalGas AMI system will operate for ■ years.

8 The “white papers” provided by each “short list” AMI Technology vendor asserted that  
9 their systems would operate for ■ years. Each “short list” AMI technology vendor proposal  
10 indicated that SoCalGas could expect annual gas AMI meter module failure rates, which  
11 included battery failures, of ■, or less, for the ■ year useful life of the system. Although  
12 Pacific Gas and Electric is still deploying its gas AMI meter modules, early performance results  
13 indicate failure rates are significantly less than ■.<sup>1</sup>

14 SoCalGas reviewed battery technology literature and AMI technology vendor “white  
15 papers” describing battery supplier and AMI technology vendor testing conducted to  
16 demonstrate gas AMI meter module batteries would operate for ■ years. AMI technology  
17 vendor testing included mathematical modeling, simulations and physical tests augmented with  
18 empirical data from installed units. Based upon its review of relevant information, SoCalGas  
19 concluded the “short list” AMI technology vendor’s gas AMI meter modules can be expected to  
20 operate for a ■ year period. Exhibit A contains a diagram SoCalGas prepared to depict the  
21 battery testing process used by battery suppliers and AMI technology vendors.

22 **B. BATTERY MANUFACTURERS HAVE CONDUCTED EXTENSIVE**  
23 **TESTING TO VALIDATE THE BATTERIES USED IN GAS AMI METER**  
24 **MODULES CAN BE USED AS A MAIN POWER SOURCE FOR VERY**  
25 **LONG TERM APPLICATIONS <sup>2,3,4,5</sup> SUCH AS AMI.**

26 <sup>1</sup> Pacific Gas and Electric Advanced Metering Infrastructure, January 2009 Semi-Annual Assessment Report, (A.05-  
27 06-028), January 30, 2009, Page 22, Table V-1; Gas module failure rate = 0.05% Jul '08 thru Dec '08; and 0.08%  
28 Jan '08 thru Jun '08. (Gas module failure rate: The number of installed gas modules that failed divided by the total  
gas modules installed at customer locations.)

<sup>2</sup> <http://www.tadiranbat.com/lithiumsnotalike.php>

1 The primary factors battery manufacturers used to establish the long term operating  
2 potential of the lithium thionyl chloride (Li/SoCl<sub>2</sub>) batteries used in gas AMI meter modules  
3 included: (1) Battery capacity to a predetermined cut-off voltage; (2) Battery capacity loss due  
4 to self-discharge; and (3) Battery impedance and voltage losses during the pulse current  
5 discharge.<sup>6</sup> By increasing battery capacity and decreasing the battery's self discharge rate and  
6 impedance, battery manufacturers produced batteries with long operating lives. Battery supplier  
7 test results indicate their lithium thionyl chloride batteries provide sufficient power potential to  
8 support AMI technology applications.

9 **C. AMI TECHNOLOGY VENDORS HAVE USED MATHEMATICAL**  
10 **MODELS TO CALCULATE LITHIUM THIONYL CHLORIDE**  
11 **(LI/SOCL<sub>2</sub>) BATTERY LIFE.**

12 To determine the time period in which batteries will operate under the power profiles  
13 produced by each AMI technology application, each AMI technology vendor conducted a series  
14 of calculations.

15 In performing their calculations, AMI technology vendors derated<sup>7</sup> manufacturer battery  
16 power levels. AMI technology vendor calculations included factors that accounted for: (1)  
17 Real-world operating temperature profiles; (2) Battery life characteristics under expected power  
18 profiles; (3) Power requirements for operating the gas AMI meter module over a ■-year life;  
19 and (4) Power requirements for operating the AMI transmitter, for the required number of  
20 operations, over a ■-year life.

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23  
24 <sup>3</sup> <http://www.nexergy.com/default.htm>:

25 <sup>4</sup> [http://www.saftbatteries.com/Produit\\_Li\\_SOCL2\\_civil\\_battery\\_packs\\_303\\_33/Default.aspx#CaracsTechniques](http://www.saftbatteries.com/Produit_Li_SOCL2_civil_battery_packs_303_33/Default.aspx#CaracsTechniques)

26 <sup>5</sup> <http://www.maxell.co.jp/e/products/industrial/battery/er/index.html>

27 <sup>6</sup> "Twenty-Year Operating-Life Bobbin-Type Li/SoCl<sub>2</sub> Cell for High-Pulse-Current Applications", Hersel Yamin, Michael Shlepakov, Chen Menachem & Dany Bar-Tov, Tadiran Batteries, Ltd.

28 <sup>7</sup> <http://en.wikipedia.org/wiki/Derating> ... "Derating is the technique employed in power electrical and electronic devices wherein the devices are operated at less than their rated maximum power dissipation taking into consideration the case/body temperature, ambient temperature and the type of cooling mechanism used."

1           **D. TO VALIDATE CALCULATED BATTERY LIFE, AMI TECHNOLOGY**  
2           **VENDORS PERFORMED PHYSICAL SIMULATIONS USING SAMPLES**  
3           **OF GAS AMI METER MODULE BATTERIES.**

4           AMI technology vendors performed simulations to confirm their mathematical model  
5 results were correct. AMI technology vendors first confirmed the expected maximum energy  
6 was available in a sample of batteries using measured discharge testing. After this procedure, a  
7 sample population of gas AMI meter modules was operated at an accelerated transmission rate  
8 such that [REDACTED] years of transmissions were performed in a practical time period. Upon completion  
9 of the [REDACTED] year transmission test, the remaining battery capacity was checked to confirm that  
10 sufficient energy remained to allow for the required derating margin.

11           **E. TO VERIFY GAS AMI METER MODULES WILL WITHSTAND**  
12           **WEATHER AND OTHER OPERATING CONDITIONS, AMI**  
13           **TECHNOLOGY VENDORS CONDUCTED CONTROLLED TESTS OF**  
14           **PRODUCT PERFORMANCE DURING ADVERSE CONDITIONS.**

15           AMI technology vendors performed specialized tests to simulate load and environmental  
16 conditions similar to those found in real-world conditions. Environmental chambers were used  
17 to conduct Highly Accelerated Stress Screening (HASS) and Highly Accelerated Stress Testing  
18 (HALT) studies that included shock and vibration, function across temperature extremes and the  
19 four corners of both temperature and humidity. During these tests, meters powered by  
20 compressed air had the mechanical index periodically compared with the electronic reading to  
21 ensure accuracy.

22           The AMI technology vendor SoCalGas selects will provide gas AMI meter modules that  
23 meet stringent certifications, including an extensive list of ANSI<sup>8</sup>, ASME<sup>9</sup>, ASTM<sup>10</sup> and MIL-

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24           <sup>8</sup> ANSI (The American National Standards Institute) is a private non-profit organization that oversees the  
25 development of voluntary consensus standards for products, services, processes, systems, and personnel in the  
26 United States. The organization also coordinates U.S. standards with international standards so that American  
27 products can be used worldwide.

28           <sup>9</sup> ASME (The American society of Mechanical Engineers) distributes 600 codes and standards used around the  
29 world for the design, manufacturing and installation of mechanical devices.

30           <sup>10</sup> ASTM (The American Society for Testing and Materials) is one of the largest voluntary standards development  
31 organizations in the world-a trusted source for technical standards for materials, products, systems, and services.  
32 Known for their high technical quality and market relevancy, ASTM International standards have an important role  
33 in the information infrastructure that guides design, manufacturing and trade in the global economy.

1 STD<sup>11</sup> specifications required by SoCalGas. Furthermore, the AMI technology vendor SoCalGas  
2 selects will have documented gas AMI meter module failure rates less than the [REDACTED] rate used in  
3 the SoCalGas analysis.

4 **F. AMI TECHNOLOGY SUPPLIERS HAVE USED DATA FROM**  
5 **INSTALLED UNITS TO VERIFY THAT GAS AMI METER MODULES**  
6 **PERFORM TO SPECIFICATION BASED UPON THE PERIOD OF TIME**  
7 **THEY HAVE BEEN OPERATING IN THE FIELD.**

8 AMI technology vendors have millions of battery powered AMI meter modules deployed  
9 in the United States. Periodically, AMI technology vendors either remove gas AMI meter  
10 modules that have operated under changing real world environmental conditions in the field or use  
11 information transmitted from their gas AMI meter modules (voltage, voltage under transmission  
12 and temperature) to reassess battery life. To do so, AMI technology vendors compare remaining  
13 battery life with mathematically calculated values. The product performance information drawn  
14 from these comparisons support AMI technology vendor assertions that gas AMI meter modules  
15 will operate for [REDACTED] years.

16 **IV. PROVISIONS FOR AVAILABILITY**

17 **A. SOCALGAS WILL CONTRACTUALLY REQUIRE THE SELECTED**  
18 **AMI TECHNOLOGY VENDOR PROVIDE GAS AMI METER MODULES**  
19 **COMPATIBLE WITH THE SOCALGAS AMI SYSTEM FOR THE [REDACTED]**  
20 **YEAR USEFUL LIFE OF THE SYSTEM.**

21 Although the gas AMI meter modules that SoCalGas purchases will have internal  
22 batteries, SoCalGas does not anticipate they will be replaced during the useful life of the system.  
23 Furthermore, SoCalGas does not anticipate other parts within the gas AMI meter modules will  
24 require replacement. SoCalGas anticipates the meter indexes and glass index covers used

25 \_\_\_\_\_  
26 <sup>11</sup> **MIL-STD** (A United States Defense Standard) is used to help achieve standardization objectives by the U.S.  
27 Department of Defense. Standardization is beneficial in achieving interoperability; ensuring products meet certain  
28 requirements, commonality, reliability, total cost of ownership, compatibility with logistics systems, and similar  
defense-related objectives.

1 externally on both gas AMI meter modules and on standard mechanical gas meters will continue  
2 to be available from multiple suppliers for the useful life of the system.

3 When SoCalGas negotiates its supply contract with an AMI technology vendor,  
4 SoCalGas will include terms and conditions that ensure batteries and other internal parts are  
5 available through the expected useful life of the proposed AMI system.

6 The supply contract will obligate the AMI technology vendor to ensure gas AMI meter  
7 module components, including batteries, be available for sourcing from multiple suppliers. The  
8 contract will require that the selected AMI technology vendor make gas AMI meter modules  
9 compatible with the SoCalGas AMI network available for a minimum of [REDACTED] years following  
10 AMI system deployment.

11  
12 **B. BEYOND ITS CONTRACTUAL OBLIGATION, THERE IS A**  
13 **FINANCIAL INCENTIVE FOR THE SELECTED AMI TECHNOLOGY**  
14 **VENDOR TO PROVIDE SOCALGAS WITH GROWTH AND**  
15 **REPLACEMENT GAS AMI METER MODULES AND OTHER SYSTEM**  
16 **COMPONENTS.**

17 SoCalGas expects it will purchase between [REDACTED] and [REDACTED] gas AMI meter modules  
18 annually for new growth and as replacements for failures. The AMI technology vendor sales  
19 revenue associated with this volume of SoCalGas purchases should be substantial. This being  
20 the case, it will be in the AMI technology vendor's financial interest to supply SoCalGas with  
21 AMI system components.

22 **C. SOCALGAS WILL INCORPORATE TERMS INTO ITS AMI**  
23 **TECHNOLOGY SOURCING CONTRACT THAT ADDRESS RISKS**  
24 **THAT COULD IMPACT THE [REDACTED]-YEAR USEFUL LIFE OF THE AMI**  
25 **SYSTEM.**

26 At the time SoCalGas negotiates its AMI technology supply contract; it will introduce the  
27 options presented within the various AMI Technology vendor proposals, and negotiate terms and  
28 conditions that offer maximum value. An objective will be to reduce risks associated with  
potential gas AMI meter module failure rates. Each "short list" AMI technology vendor

1 proposal presented to SoCalGas indicated that SoCalGas could expect annual gas AMI meter  
2 module failure rates of [REDACTED] or less for the [REDACTED] year life of the system. When SoCalGas  
3 negotiates its supply contract with the selected AMI technology vendor, SoCalGas will include  
4 terms and conditions that limit SoCalGas financial risk for gas AMI meter module failures,  
5 including battery failures, in excess of those specified in vendor proposals.

6 The “short list” AMI technology vendor proposals indicated product warranties on gas  
7 AMI meter modules would include full parts replacement for the first [REDACTED] years. The SoCalGas  
8 AMI analysis included the full cost for replacement of gas AMI meter modules that fail in years  
9 [REDACTED] of the post-deployment period. SoCalGas intends to explore a product warranty  
10 with the selected AMI technology vendor that reduces financial risk associated with purchase of  
11 replacement gas AMI meter modules during years [REDACTED] of the post-deployment period.

12  
13 **V. CONCLUSION**

14 Based upon technical studies and real-world field experience, the AMI system SoCalGas  
15 deploys is expected to operate for a [REDACTED] year period with failure rates at or below those specified  
16 by prospective vendors. The testing conducted by battery manufacturers and AMI technology  
17 vendors, together with real-world experience support vendor assertions that gas AMI meter  
18 modules will operate for [REDACTED] years in real world operating conditions. Furthermore, SoCalGas  
19 intends to specify terms and conditions in its AMI technology contract that: (1) Ensure gas AMI  
20 meter module components, including batteries, are sourced from multiple suppliers; (2) Ensure  
21 gas AMI meter modules compatible with the AMI network are available to SoCalGas for [REDACTED]  
22 years following deployment; and (3) Limit risk associated with gas AMI meter module failures.

23 This concludes my direct supplemental testimony.  
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**EXHIBIT A – Confidential pursuant to PUC Code Section 583 & General Order 66-C**