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SUMMARY OF THE JOINT WORKSHOP ON NATURAL GAS QUALITY STANDARDS FEBRUARY 17-18, 2005

(Dockets: CPUC R.04-01-025, CEC 04-IEP-01)

In collaboration with:

California Air Resource Board

California Department of Conservation
(Division of Oil, Gas and Geothermal Resources)

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Arnold Schwarzenegger, *Governor*

**CALIFORNIA ENERGY COMMISSION**

1516 Ninth Street
Sacramento, California 95814

**PUBLIC UTILITIES COMMISSION**

505 Van Ness Avenue
San Francisco, Ca 94102-3298

April 4, 2005

To: Parties in CPUC R.04-01-025 and CEC 04-IEP-01

Re: Natural Gas Quality Standards Workshop Report

On February 17-18, 2005, the California Public Utilities Commission (CPUC) and the California Energy Commission (Energy Commission) held a joint workshop on natural gas quality standards, pursuant to CPUC Decision (D.) 04-09-022. The workshop was also held in collaboration with the California Air Resources Board and the California Department of Conservation's Division of Oil, Gas, and Geothermal Resources. The staff prepared a summary of this workshop. That report is enclosed. It will also be available on the CPUC's and the Energy Commission's web sites, as are all presentations made at the workshop and all written comments submitted before and after the workshop. While the four agencies worked collaboratively on the workshop report, the CPUC's David R. Effross is the principal author.

Comments on the workshop report are due on or before April 25, 2005, and should be filed in CPUC Rulemaking 04-01-025 and the Energy Commission's Integrated Energy Policy Report proceeding 04-IEP-01. Those comments provide the parties an opportunity to convey their specific recommendations to the CPUC and Energy Commission on how current natural gas quality standards should be modified, if at all.

Any questions should be directed to David R. Effross at dre@cpuc.ca.gov or at (415) 703-1567, or to Mike Purcell at the Energy Commission at (916) 654-4048.

Sincerely,

____/signed/____

RICHARD MYERS
Program and Project Supervisor
Energy Division
California Public Utilities Commission

____/signed/____

DAVID MAUL
Manager
Natural Gas Office
California Energy Commission

cc: CPUC / CEC Commissioners
Administrative Law Judge John S. Wong
Administrative Law Judge Steven A. Weissman

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Report on the Joint Workshop on Natural Gas Quality Standards

I. Executive Summary

In Decision (D.) 04-09-022, the Phase 1 decision of Order Instituting Rulemaking (R.) 04-01-025, the California Public Utilities Commission (CPUC) ordered CPUC staff, in collaboration with the California Energy Commission (CEC) to conduct a workshop to thoroughly examine natural gas quality specification and related issues. Pursuant to that decision, on February 17 and 18, 2005, the CPUC and the CEC conducted a joint workshop on natural gas quality issues, in collaboration with the California Air Resources Board (ARB) and the California Department of Conservation's Division of Oil, Gas, and Geothermal Resources (DOGGR). (Collectively, the CPUC, CEC, ARB, and DOGGR are referred to as the "State Agencies".) The workshop was held in recognition of the these state agencies' objectives to assure that adequate supplies of natural gas can be provided to California in coming years, while at the same time ensuring the health and safety of gas consumers, the efficient use of natural gas, and that environmental standards are met. The natural gas "quality" (*i.e.* the chemical composition and performance characteristics of natural gas) of one of the primary new supply sources being considered for the state, liquefied natural gas (LNG), can differ from the quality of supplies that the state has traditionally received. In addition, California gas producers have long argued that they face difficulties in maximizing production due to the current gas quality specifications. The State Agencies' main interest in holding the workshop was to determine whether and how utility natural gas quality specifications, stated in utility tariffs, and the CARB Standard¹ related to natural gas quality need to be revised.

¹ The California Air Resources Board prefers that it be referred to as "ARB". However, at the workshop, participants typically referred the ARB gas quality specifications as the "CARB Standard", so that designation will be used in this report.

At the workshop, the State Agencies heard from a wide range of the affected and interested stakeholders including: natural gas producers, the major California natural gas utilities, independent storage providers, LNG developers, natural gas industry associations, researchers, electric generators, state air emissions agencies, and an engine manufacturers group. Also, written comments were submitted before and after the workshop from the above stakeholders as well as interstate pipeline operators. We did not hear from any consumer advocates or representatives due to resource constraints on their part.

Changes in natural gas quality specifications must be very carefully considered because they could affect the entire range of natural gas consumers. These consumers include operators of residential appliances, industrial engines, natural gas vehicles, and electric generating plants, among others. (Indeed, enough of California's electricity is generated from gas that the entire Western electric grid could be affected by the changes under consideration.) At the same time, efforts are under way by the Federal Energy Regulatory Commission (FERC) to determine if a national gas quality standard should be imposed. California will need to determine how its own specifications will be impacted by any such national standard.

The State Agencies believe that the main points raised at the workshop and in comments are:

- California's natural gas infrastructure and all the existing equipment that use natural gas are "legacy systems", designed to be fed natural gas conforming to historic norms of composition and performance.
- Demand for natural gas is rising faster than North American supply production, so we have to seek additional sources of supply. At the same time, we need to promote more aggressively measures that will reduce demand.
- Additional sources of supply may not conform to historical natural gas quality norms, which have been established and incorporated into CPUC tariff Rules 21 (PG&E) and 30 (SoCalGas).
- Three main sources of expanded supply are under current consideration:

- Liquefied natural gas (LNG) -- the most important of the three, in terms of potential volume. LNG tends to be both hotter (higher Btu content) and purer (less non-hydrocarbon content) than the current natural gas supply to California.
- “High Btu gas” -- tends to be associated gas, *i.e.* gas produced in conjunction with crude oil.
- “Low Btu gas” – tends to be stranded off the system because it does not contain high enough energy content. It needs to be blended to meet current quality specifications, a function that gas storage providers feel they can provide. This is the smallest supply source of the three groups, and was barely discussed in the Workshop.
- Modification of natural gas quality specifications can affect:
 - Emissions/air quality
 - Performance, durability, and safety of engine/appliance/turbine legacy systems
 - Usability of natural gas as a chemical feedstock
 - Optimal utilization of in-state petroleum resources
- Quality can be described in two ways
 - Composition – chemical breakdown of components
 - Performance – how the gas behaves in various circumstances. Some common measures of gas performance include heating value (Btu), Wobbe number, and methane number (MN). Gas performance can be managed by alteration of its content.
- Most advocates of change want standards to allow a greater range of supply to enter into the system. They therefore prescribe replacement of composition standards with performance standards, which they contend can be effectively managed. Many parties agreed that the Wobbe number should be the primary metric of natural gas performance, although there was disagreement as to what other standards, if any, should also be required as natural gas quality specifications.

- The CARB Standard for compressed natural gas (CNG) motor fuel is the most restrictive standard in the state, and is the issue that stakeholders most wished to reassess. It is not incorporated into CPUC-adopted standards contained in PG&E Rule 21 and SoCalGas Rule 30; nevertheless, it drives gas quality in the state. Given the relatively small number of CNG-powered vehicles, this standard has been described as “the tail wagging the dog.” Air quality advocates endorse the CARB Standard. Many parties held that methane number (MN) is a viable performance standard for natural gas-based motor fuel, and stakeholders interested in changing the CARB Standard almost uniformly support its adoption as a determinant of natural gas quality.
- Each modification proposed by a stakeholder would change the system, likely counter to the interests of other stakeholders. The State Agencies’ goal is to make this process as close as possible to a positive sum game with no losers, and to find ways to mitigate losses where they occur.

Participants made various recommendations that fell into the following broad categories:

1. Drop CPUC compositional standards in favor of performance standards, such as the Wobbe number. This is favored by most of the gas storage, gas marketing, gas producing, and LNG sector participants, although some LNG developers claim that their proposed LNG facilities can meet *any* reasonable standards.
2. Keep *some* compositional standards. Pipelines and generators favor this approach, particularly since it would preserve specifications on impurities and heavy hydrocarbons, both of which can cause various forms of degradation to pipeline systems and turbines. (Heavy hydrocarbons, in particular, can condense into droplets, a phenomenon known as hydrocarbon dropout. The liquid droplets are damaging to turbine blades.)
3. Mandate a minimum “methane number” instead of the CARB Standard. A number of parties argued at the workshop that this is a reasonable engineering alternative to the CARB Standard with respect to fuel anti-knock characteristics for heavy duty reciprocating piston engines. Where the minimum methane number would be set, though, is a matter of debate.

The State Agencies believe that much useful information was provided at the workshop and in comments, and that this information adequately frames the issues that the Commissions need to consider. (However, the State Agencies would still like to hear the concerns of consumer advocates.) Although no overall consensus was reached regarding whether or how CPUC specs or the CARB Standard needs to be revised, virtually all stakeholder groups were able to start the process by presenting their positions and concerns in a single forum. The State Agencies also believe that most if not all of the recommendations made by the various participants, while very informative, tend to promote the parochial interests of those who made the recommendation. Moreover, the State Agencies believe that, while additional research needs to be conducted, and the workshop did not result in any consensus on whether or how CPUC specs should be revised, the workshop provided a foundation to move ahead with a concentrated series of meetings and roundtables involving affected interests, with the aim of reaching agreement within a year. Finally, although evidentiary hearings did not appear to be the preferred approach to resolving these issues, the State Agencies believe that evidentiary hearings should not be ruled out at this time. It is possible that technical issues will not be resolved through further meetings or workshops, and the issue of who should bear the costs of any changes to gas quality specifications was not discussed at the workshop.

II. Introduction and Background

On February 17 and February 18, 2005, the California Public Utilities Commission (CPUC) and the California Energy Commission (CEC) conducted a joint workshop to address natural gas quality issues raised in the CPUC Natural Gas Order Instituting Rulemaking (R.) 04-01-025 and the Energy Commission *2003 Energy Report* dated December 2003. This workshop was conducted in collaboration with the California Air Resources Board (ARB) and the California Department of Conservation's Division of Oil, Gas, and Geothermal Resources (DOGGR). (Collectively, the CPUC, CEC, ARB, and DOGGR are referred to as the "State Agencies".)

State energy policy encourages consumer access to the broadest possible set of natural gas supplies consistent with California's energy, environmental, and public health and safety requirements. This workshop was intended to:

- Identify potential issues involving natural gas quality and related specifications affecting its use in California,
- Explore if and how issues can be resolved and still meet related policy and regulatory objectives, and
- Provide the foundation for the involved agencies to develop recommendations to resolve these issues wherever possible.

The State Agencies specifically considered whether the current natural gas quality specifications, utility rules, and standards are appropriate or whether they should be modified to meet current and future needs. Information examined was considered within existing policy and regulatory objectives, including:

- Ensuring the integrity and safety of the natural gas pipeline system,
- Ensuring that end use appliances and applications receive a stable natural gas supply within acceptable quality specifications,
- Protecting ambient air quality standards,
- Maximizing the production of California's domestic natural gas resources,
- Ensuring all imported natural gas supplies meet the appropriate quality specifications, and
- Providing a stable and predictable regulatory framework.

In brief, the State Agencies see a need to assure access to adequate, diverse sources of supply, including a potentially large influx of liquefied natural gas (LNG). Furthermore, it must be assured that natural gas can be used safely, efficiently, and in an environmentally sound manner.

Natural gas presents particular regulatory complexities because it is a single commodity utilized for multiple purposes, *e.g.* residential appliances, electric generation, industrial uses, and natural gas vehicles. Moreover, it is not a uniform commodity; natural gas from different supply sources varies in chemical composition and energy content. Furthermore, natural gas supplies generally cannot be differentiated from each other, *i.e.* gases of different compositions cannot be separated from each other for different end uses. Unlike gasoline, for example, which is available in various formulations at the pump, natural gas is supplied via pipelines in an integrated transmission and distribution (T&D) system. There also exists the phenomenon of “swing”: as gas from different suppliers moves through the T&D pipeline system, quality can change from day to day, or even moment to moment. Each end user is faced with a Hobson’s choice: take or not take whatever gas the pipeline offers at any given time, with no alternative source of supply.

The various end uses of this single, undifferentiated commodity also have different requirements, often not entirely compatible with one another. If the system were to be completely optimized for one particular end use, for example, others might suffer. Current natural gas composition and performance standards, therefore, reflect an historic compromise. This compromise, however was neither planned nor negotiated; it evolved by itself in response to the conditions as the market developed.

Only North American natural gas (*i.e.* from Canadian and U.S. gas producing areas) has been delivered to California to date, and standardization was historically market-driven. Over the course of many decades, pipeline and end-use systems developed to make best use of the natural gas that was available to them. Therefore both the pipelines that deliver natural gas and the various forms of consumption of natural gas constitute “legacy systems”.

Market conditions change over time. As the ability of North American gas production to meet demand declines, the State Agencies are faced with the task of ensuring adequate supply, within certain constraints. Two factors are largely responsible for changing the

quality of natural gas available to California, factors which will likely become even more significant with the delivery of LNG supplies:

1. Market conditions for domestically produced natural gas have changed. Once it was economically efficient for producers to strip out as much of the ethane and heavier hydrocarbons (C2+) as possible, because they were more valuable as stand-alone commodities on the secondary market. Currently selling into the C2+ market is less cost-effective, and producers realize greater profits by including as much heavier hydrocarbon content in pipeline gas as they are allowed to, delivering a gas of different quality. Optimally, from their point of view, even more C2+ would be left in.
2. Natural gas demand in the U.S. is beginning to outstrip North American production capacity, and this situation has led to increased interest in additional sources of supply, including nontraditionally sourced natural gas. Nontraditional sources include imported LNG and alternative sources of North American natural gas (e.g. coalbed methane and Alaskan production), including both “high and low Btu” North American natural gases *i.e.* gases that burn hotter or cooler than current tariff specifications dictate. LNG, unaltered, can be qualitatively different from the current domestic gas supply, depending upon its source. High Btu natural gas is often associated gas, *i.e.* gas that is produced along with crude oil from the same reservoirs. Associated gas production levels affect the ultimate recovery of oil from those reservoirs, and feed directly into the economics of the oil and gas production operations. Low Btu domestic natural gas needs to be blended with gas from other sources in order to make it comply with comparable composition and/or performance specifications.

The crux of the issue California must now deal with, in the face of changing circumstances, is that our legacy systems were not designed to utilize some of the new supplies that are anticipated to be available to the market. Both end users and T&D systems evolved to safely and efficiently utilize historic supplies, with historical specifications. If natural gas quality standards change, many legacy systems may have to be “retuned” or modified.

Given the reality that many legacy systems cannot be easily replaced, the entire natural gas economy that evolved through the years around commonly available natural gas cannot be rebuilt from the ground up. Moreover, any new standards will face the conflicting demands of various different natural gas user classes, plus the T&D system operators, each with its own needs and optimum gas characteristics. (In addition, air emissions requirements, particularly for the Los Angeles region, are a significant consideration.) The task before the State Agencies and stakeholders, then, is to evaluate current and future trends in quality of available natural gas supplies, and come to an accord with respect to adopting a set of standards that imparts the greatest benefit to the most while imposing the least hardship on the fewest.

Among the key questions addressed in the workshop, the following represent a foundation for discussing legacy systems:

- Is it possible for *all* these legacy systems (*e.g.* piston engines, turbines, appliances, chemical manufacturing processes, T&D systems) to run on natural gas that is different from what they were designed for and are currently using?
- Can these legacy systems be *adapted* to use gas of different composition? Is any of these legacy systems inextricably dependent upon current gas quality?
- Which legacy systems can be adapted, and along which parameters?
- Can such adaptation be accomplished in a cost-effective manner?

If so, can air quality requirements still be met?

An important issue that was not discussed at the workshop concerns the costs of any changes to natural gas quality specifications, and who would pay those costs.

The workshop heard from most of the affected interests about their perspectives and their recommendations. The CPUC's primary interest in the workshop concerned whether the utilities' natural gas quality specifications need to be revised. Stakeholders raised four primary issues of concern:

- Do CPUC specifications (PG&E Rule 21, SoCalGas Rule 30) need to be changed to allow a broader range of natural gas to be introduced into California's pipeline system?
- Are the CPUC gas quality specifications adequate in their current form? Do they provide a sufficiently thorough characterization of natural gas? Conversely, are they overly broad to the point of being restrictive?
- Does California need a unified statewide natural gas standard? Currently Rule 21 applies in the north and Rule 30 applies in the south. They are similar, but not identical.
- Should California follow the FERC's lead and support or acquiesce to the implementation of a nationwide standard? On this particular issue, it is yet unclear what form such a federal standard would take, and whether or not that standard would address California's concerns.

On the regulatory side, DOGGR's primary interest with regard to the workshop issues is to ensure that any new specification does not have a negative impact on the in-state producers. Most of the natural gas produced in Southern California is associated gas, *i.e.* gas that is produced along with oil. A new natural gas specification that impedes in-state natural gas production would conceivably also affect in-state oil production. Since California produces about 40 percent of the oil that it consumes (about 733,000 barrels of oil per day), any negative impact on in-state oil production would require additional imports of oil, putting upward pressure on the price of oil and gasoline. Additional increases in the price of gasoline above those which have already occurred could impose significant negative impacts upon California's economy and the welfare of the State's consumers.

The ARB affirmed that its primary interest is to ensure that any change in CPUC specifications that affect California's natural gas quality does not adversely impact the State's ability to achieve its air quality objectives. While the ARB natural gas specifications apply only to motor vehicle fuel, the effect of changing gas quality can impact the operations and emissions of stationary sources. This is significant since

greater than 99 percent of California’s demand for natural gas comes from stationary applications.

The main objective of the CEC in relation to the workshop issues is to assure all California consumers have a reliable supply of natural gas, at a reasonable price, and in an environmentally responsible manner. Applying that broad objective to the subject of this report, the CEC wants to maximize the supply of natural gas from in-state producers, and ensure out-of-state and non-traditional supply sources, such as liquefied natural gas imported from outside the lower 48 states, also meet the environmental and public health and safety standards of our state.

III. Current CPUC and ARB Natural Gas Quality Standards

Under the current California regulatory regime for utilities, two sets of natural gas quality standards apply, one for PG&E’s service territory in the northern part of the state, and one for SoCalGas’s service territory in the southern part of the state. These are CPUC-adopted standards, known respectively as PG&E Rule 21 and SoCalGas Rule 30, which are incorporated into these utilities’ tariffs.

The following table offers a quick comparison between the two standards. It should be noted that the PG&E Rule allows negotiated exceptions.

TABLE 1

COMPARISON OF PG&E RULE 21 & SOCALGAS RULE 30

	PG&E Rule 21	SoCalGas Rule 30
Carbon Dioxide	<=3%	<=1%
Oxygen	<=0.1%	<=0.2%
Hydrogen sulfide	<=0.25 grain/100scf	<=0.25 grain/100scf; no entrained hydrogen sulfide treatment chemicals (solvents) or their byproducts

TABLE 1 (cont'd.)

	PG&E Rule 21	SoCalGas Rule 30
Mercaptan sulfur	<=0.3 grain/100scf	<=0.5 grain/100scf
Total sulfur	<=1.0 grain/100scf	<=0.75 grain/100scf
Water vapor	<=7.0 lbs./1,000,000 scf	<=7.0 lbs./1,000,000 scf, for gas delivered at or below 800 psig; water dew point <=20°F for gas delivered above 800 psig
Inerts (including but not limited to carbon dioxide, nitrogen, and oxygen)	na	<=4%
Hydrocarbon dewpoint	The gas shall not have a hydrocarbon dewpoint that will allow formation of liquids under the operating conditions of the receiving pipeline.	For gas delivered at a pressure of 800 psig or less, not to exceed 45°F at 400 psig or below. For gas delivered at greater than 800 psig, not to exceed 20°F at a pressure of 400 psig.
Liquids	The gas shall contain no liquids at the Receipt Point(s).	n/a
Objectionable matter	The gas shall not contain dust, sand, dirt, gums, oils, or other substances in an amount sufficient to be injurious to PG&E facilities or which shall cause the gas to be unmarketable.	Gas shall be commercially free from dust, gums, and other foreign substances.
Hazardous substances	na	Must not contain in concentrations which would prevent or restrict normal marketing, be injurious to pipeline facilities, or present health and/or safety hazards.
Temperature	60°F<=delivered temperature<=100°F	50°F<=delivered temperature<=105°F
Gas from landfills	not accepted or transported	na
Gas interchangeability	determined in accordance with the methods and limits presented in Bulletin 36 of the American Gas Association	Must meet American Gas Association's Wobbe Number, Lifting Index, Flashback Index, and Yellowtip Index interchangeability indices for high methane gas relative to typical composition of gas in the Utility system near the points of receipt. Wobbe number for received gas must be within 10% of its spec at the producer. Lifting Index (IL) <= 1.06. Flashback Index (IF) <=1.2. Yellowtip Index (IY) >=0.8.

TABLE 1 (cont'd.)

	PG&E Rule 21	SoCalGas Rule 30
Heating value	consistent with the standards established by PG&E for each Receipt Point(s)	970 Btu<heating value<=Btu 1150

Obviously, both Rules consist largely of compositional standards.

The other major specifications that comes into play regarding natural gas quality are the motor vehicle compressed natural gas (CNG) specifications (the “CARB Standard”), promulgated by the California Air Resources Board. The CARB Standard is presented below, and is even more compositional in nature than the CPUC standards:

TABLE 2

**California Air Resources Board Specifications for Compressed Natural Gas
(13 CCR, §2292.5)**

<u>Specification</u>	<u>Value</u>	<u>Test Method</u>
	<u>Hydrocarbons (expressed as mole percent)</u>	
Methane	88.0% (min.)	ASTM D 1945-81
Ethane	6.0% (max.)	ASTM D 1945-81
C₃ and higher HC	3.0% (max.)	ASTM D 1945-81
C₆ and higher HC	0.2% (max.)	ASTM D 1945-81
	<u>Other Species (expressed as mole percent unless otherwise indicated)</u>	
Hydrogen	0.1% (max.)	ASTM D 2650-88
Carbon monoxide	0.1% (max.)	ASTM D 2650-88
Oxygen	1.0% (max.)	ASTM D 1945-81
Inert gases		
Sum of CO₂ and N₂	1.5-4.5 % (range)	ASTM D 1945-81

TABLE 2 (cont'd.)

<u>Specification</u>	<u>Value</u>	<u>Test Method</u>
Water	The dewpoint at vehicle fuel storage container pressure shall be at least 10°F below the 99.0% winter design temperature listed in Chapter 24, Table 1, Climatic Conditions for the United States, in the American Society of Heating, Refrigerating and Air Conditioning Engineer's (ASHRAE) Handbook, 1989 fundamentals volume. Testing for water vapor shall be in accordance with ASTM D 1142-90, utilizing the Bureau of Mines apparatus.	
Particulate matter	The compressed natural gas shall not contain dust, sand, dirt, gums, oils, or other substances in an amount sufficient to be injurious to the fueling station equipment or the vehicle being fueled.	
Odorant	The natural gas at ambient conditions must have a distinctive odor potent enough for its presence to be detected down to a concentration in air of not over 1/5 (one-fifth) of the lower limit of flammability.	
Sulfur	16 ppm by vol. (max.)	Title 17 CCR Section 94112

Many parties see the CARB Standard as an impediment to revision of natural gas quality standards. The ARB imposes a stricter compositional standard than either of the two CPUC standards. The CARB Standard was enacted for compressed natural gas motor fuel, and many CNG heavy duty engines currently in service in California were designed to operate within those CNG fuel specifications to ensure proper operations and to maintain the emissions benefits associated with using natural gas.

In addition to the CPUC and ARB specifications, regional air quality and emission requirements also pertain, *e.g.* those imposed by the South Coast Air Quality Management District (SCAQMD). Local jurisdictions such as SCAQMD regulate air emissions by stationary sources and may impose specifications on the fuel that those sources use.

IV. Stakeholder Perspectives

The workshop was divided into panels, generally representing different stakeholder groups, in order to allow each to present its perspective. Non-industrial/commercial consumers were not represented.

Pipeline Owners and Storage Operators

Representatives of SoCalGas, SDG&E, PG&E, and Lodi Gas Storage presented information at the workshop and provided comments on the perspectives of California natural gas utilities and independent storage operators. The Interstate Natural Gas Association of America (INGAA) also provided pertinent information and its perspective. No interstate pipeline operator made a presentation at the workshop, but Questar Southern Trails filed written comments. El Paso/Mojave, Kern River, and Wild Goose provided post-workshop written comments.

SoCalGas and PG&E generally discussed the difficulties in receiving natural gas of varying quality while also ensuring the health and safety of their customers, protecting the operational integrity of their systems, providing nondiscriminatory access, encouraging the development of new supply sources, and meeting air emissions requirements.

Representing SDG&E and SoCalGas, Joe Rivera explicated Rule 30 and the specifications it imposes. In particular, he warned against the injection of inert gases, such as carbon dioxide and nitrogen, which would pose end-use customer issues. PG&E's Joe Bronner performed much the same task regarding Rule 21. He stated that although there is no inert specification in Rule 21, there should be. Bronner tempered his statement, though, by assuring all that PG&E has never before experienced a problem of this nature that could not be managed by blending. Bronner also illustrated the adverse impact changes in natural gas quality

Gas storage operators advocated policies favorable to the utilization of gas storage facilities for blending low Btu natural gas with stored gas in order to bring the low Btu gas up to pipeline specifications.

Interstate pipeline operators resist the CARB Standard. Questar firmly stands against the CARB standards. Questar indicates that the CARB Standard is too restrictive, too expensive to implement, and could potentially cut California off from gas suppliers who would not meet them. Furthermore, Questar contends that the FERC may not approve tariffs incorporating the CARB Standard, and therefore recommends that the FERC be invited to join California's process. Kern River also stands against adoption of ARB specifications into CPUC rules, in post-workshop comments filed jointly with Questar.

El Paso states in post-workshop comments that it already has LNG experience through its subsidiary, Southern LNG, Inc., owner and operator of the Elba Island LNG terminal in Georgia. El Paso "recognizes and promotes" establishment of the Wobbe number, combined with other standards such as higher heating value (Btu), total inerts, and/or maximum C4+ (butane and heavier hydrocarbon) content.

INGAA's Terry Boss began by discussing NGC+'s hydrocarbon dropout white paper. He then proposed a maximum Wobbe number of 1400 for "right now", and endorsed usage of the methane number in addition. He also discussed methods of managing LNG's Wobbe number. Boss believes that inert injection is a viable option, and that hydrocarbon dew point analysis can be used to ensure no detrimental impacts accrue to gas turbines through its usage. Turbine operators worry that heavier hydrocarbons can liquefy, forming droplets which would damage turbine blades. Boss recommended more research, and on a policy level an alignment of inter- and intrastate interests.

SoCalGas and SDG&E state in post-workshop comments that it has no problems with the incorporation of the CARB Standard into Rule 30. In fact, SoCalGas already imposes the existing CARB Standard on natural gas in its pipeline system. SoCalGas and SDG&E recommended that its tariff rules incorporate research regarding the Wobbe number, with

an interim range of 1290 to 1400; the ARB spec should be changed to an MN 80 standard, and possibly lower on a regional basis; agencies should work with stakeholders to make further changes; and, additional research is needed. Finally, SDG&E and SoCalGas advocate a uniform statewide natural gas quality specification.

PG&E supports national interchangeability standards, and promotes the idea of collaborative research on both the national and local levels to promote such research. It also holds Rule 21's quality standards sacrosanct, although it does state that it tries to work with in-state producers, "where reasonably possible", to blend low Btu gas for introduction into its pipeline system. In post workshop comments, PG&E addresses this subject by stating, "...we do our best to be reasonable." With regard to independent gas storage providers' role, PG&E would like to see them develop and introduce a proposal "beyond the concept stage" for blending. It also wants to see research proving the efficacy of gas storage reservoir blending. Furthermore, PG&E is concerned that it may be forced to subsidize blending operations. Finally, in its written comments PG&E also indicated that it intends to work cooperatively with SoCalGas to develop uniform gas quality rules, to the extent such uniformity is possible.

California Producers

The perspectives of in-state natural gas producers and suppliers were presented at the workshop and in comments by the California Independent Petroleum Association (CIPA), the Western States Petroleum Association (WSPA), and Occidental of Elk Hills (Occidental). Occidental and ExxonMobil also provided post-workshop comments.

Tom Umenhofer, of CIPA/WSPA, discussed the impact of the CARB Standard and, as an alternative, a methane number specification on California producers, proposing that ARB drop its specification to at least MN73, and opining that legacy fleet issues are "short term". The CARB Standard poses problems for California producers because it strands off the system gases that fall outside its strict compositional limits, mostly hot-burning associated gas containing excess levels of C2+. WSPA holds that ARB specifications do

not apply to pipeline gas, only to compressed natural gas delivered in the vehicles fueling market, and stands against the ARB specs being applied to natural gas supplies introduced into the pipeline system. CIPA/WSPA would like the CPUC to amend its Phase II OIR (04-01-025) issues to address gas quality separately from all other issues.

CIPA and WSPA argue, in post-workshop comments, that emissions might actually be raised, counterintuitively, through the extraction of C2+ from natural gas streams. They point out that the extraction process is not free, and that there are financial, energy, and emissions costs associated with the extraction process.

CIPA and WSPA further wish the CPUC/CEC expressly to incorporate NGC+ recommendations into its current proceedings, and report back on such incorporation. (See Section VI for a description of the NGC+ Working Group and its recommendations.)

CIPA/WSPA also request a 2-year lead time to prepare for any system changes.

Finally, CIPA and WSPA propose the imposition of statewide research and analysis protocols, “as opposed to separate ‘boutique’ approaches that may be initiated by individual air districts.”

Bill Boyer, of Occidental, wished to “complain” about the CARB Standard. According to Boyer, because SoCalGas imposes the CARB Standard for natural gas introduced into its pipeline system, the CARB Standard keeps associated gas out of the system, causes gas processing expenses, and is not necessary for “today’s natural gas vehicles.” Methane number can effectively be brought down to the 73-65 range.

Natural Gas Vehicle Operators and Engine Manufacturers

The impact of natural gas quality specs on natural gas vehicle operation and emissions was discussed at the workshop by SoCalGas/SDG&E, PG&E, the Engine Manufacturers

Association, the Southwest Research Institute (SWRI), the Gas Technology Institute (GTI), and Bevilacqua-Knight Incorporated (BKI), a consulting group.

Mark Gaines, of Sempra Utilities, discussed the problems inherent in conversion of heavy duty automotive engines to run on hotter gas. Sempra has contracted with Southwest Gas Research Institute (SWRI) to perform studies and analysis. Sempra Utilities believes that the methane number is an important gauge of natural gas performance in that it is a predictor of engine knock. Knock, otherwise known as predetonation, is a condition where fuel and air in an engine's combustion chamber ignite prematurely, to the detriment of the engine's performance and durability. Severe enough knock can cause catastrophic engine failure.

Roger Gault, of the Engine Manufacturers Association of America (EMA) pointed out that many of the CNG engines on the road today will not complete their life cycles until 2019. He also pointed out that engine manufacturers do not agree on the best predictor of knock. Some favor methane number, while some generate their own knock indices, the details of which may be proprietary.

James Chiu of SWRI expressed concern that Wobbe number management through inerts injection does not necessarily lower methane number. Moreover, he pointed out that a low methane number can cause emissions problems by effectively advancing ignition timing through changing flame speed in the combustion chamber. Chiu then discussed methods of rating methane number. Two exist, the ARB method and the AVL method. AVL is a private company that develops and sells this evaluation tool. ARB's method, according to Chiu, yields a methane number about 8% higher, and he feels that the AVL method is more accurate. Finally, Chiu discussed costs associated with motor vehicle upgrades.

GTI's Bill Liss indicated that "the time seems to be ripe for a modification of the CARB Standard." In his view, all new and future CNG vehicles will be able to function under less restrictive fuel standards.

Steve Sokolsky, of Bevilacqua-Knight Incorporated (BKI), presenting on behalf of Occidental Petroleum, told the workshop that the number of California's legacy CNG vehicles was approximately 25,000-30,000. These are the vehicles that are tied to the current CARB Standard fuel. He also offered that richer fuel produced better fuel economy and lower particulate emissions numbers.

Joe Bronner, representing PG&E, supported moving to a new specification from the current CARB Standard.

Lee Stewart of SDG&E and SoCalGas cautioned that the usable lifetimes of legacy fleets is longer than some estimate, and that those vehicles will be around for quite some time.

Both SoCalGas/SDG&E and PG&E also wish for a commitment to securing funding for upgrading of older CNG engines, and wish CPUC and CEC to join with ARB to compel engine manufacturers to cooperate with research efforts dedicated to allowing heavy duty CNG engines to burn natural gas with a methane number of 73.

Stationary Equipment (Electric Generation Plants and Industrial Customers)

The impact of natural gas quality specifications on operators of stationary equipment (such as electric power plants or industrial engines) was discussed at the workshop and in written comments by Calpine, Southern California Edison Company, SoCalGas/SDG&E, PG&E, GTI, and Daniel Olson, a researcher from Colorado State University.

Calpine's Craig Chancellor discussed Calpine's concerns about the effects of new gas standards on turbine operation. Calpine does not see ethane content as an issue, although propane becomes more of a concern regarding hydrocarbon dropout. Heavier hydrocarbons raise greater concerns. Operating issues of concern for Calpine include flashback, burnout, vibration, and turbine damage, particularly with newer equipment. Calpine does not have operating experience using newer equipment with a range of fuels.

He concludes by stating that, for the present, natural gas needs to stay within Original Equipment Manufacturer (OEM) specifications for his equipment, with some nitrogen injection. These specs are: Wobbe 1153-1391, Btu 900-1200, ethane maximum of 15%, propane maximum, 2.5%, C4+ limited to 1%, and nitrogen limited to 15%.

Instantaneous variation in quality within these specifications, swing, must also be kept down to a manageable rate.

Calpine expresses in its post-workshop comments that there is limited headroom for nitrogen oxide (NO_x) and particulate matter (PM) emissions to increase under its permits. It also notes that CARB standards do not apply to pipeline gas, only to CNG vehicle fuel.

Calpine states that its position regarding interchangeability management is that the best point of management is near the regasification facility, where operations can be centralized.

Calpine takes issue with Rule 30 for not applying compositional standards for ethane, propane, and butane+ (C₃+) components, which can damage turbines and affect emissions. The CARB Standard, by contrast, is within equipment manufacturers' standards, but even stricter than necessary.

INGAA's Terry Boss discussed heavy duty reciprocating piston engines used to power pipeline compressors, and how units up to 70 years old are still in service, but not retrofittable.

SDG&E/SoCalGas's Larry Sasadeusz brought up the same issue with relation to piston-engine-powered peak-shaving generators. He also discussed the deleterious effects of nitrogen injection on natural gas used as chemical feedstock. He also discussed SoCalGas's appliance testing effort, which has resulted in a white paper's being generated. He concludes that Rule 30 needs to be updated to a maximum Wobbe number of 1400.

In joint written comments, SDG&E and SoCalGas also recommend that the CPUC divorce gas quality issues from the rest of the Phase II OIR and that the CEC separate these issues from its Integrated Energy Policy Report (IEPR). The two utilities support abolition of the CARB Standard if CPUC replaces it with a methane number specification, or an interim statewide imposition of a methane number standard of 80.

GTI's David Rue, on behalf of Oxy, discussed performance metrics, and proposed that the Wobbe number is the single most important metric. Other parameters which might be applied in addition are, in his opinion, application-specific. He also cautioned that standards must be robust, because most appliances have limited control systems and inexperienced operators, unlike power plants, for example.

Southern California Edison's Luis Pando suggested that while most of the LNG would not pose problems for turbines, gas with a methane number down to 80 might, and that it would have to be looked into more closely. He also expressed concerns about swing, which he said could cause catastrophic damage to a gas turbine. In its written comments, Edison also stressed that requiring additional capital investment to accommodate changing gas quality standards would pose an unreasonable burden on electric ratepayers.

Daniel Olsen of Colorado State University discussed technical effects of natural gas quality on reciprocating piston engines. He concluded that as engines become more modern and efficient, there is less leeway for variation in gas quality.

LNG Developers and Suppliers

LNG interests were represented at the workshop and in written comments by BHP Billiton, Shell Trading, Chevron/Texaco, Sempra LNG, and Sound Energy Solutions (SES). SoCalGas/SDG&E also provided pertinent information. Crystal Energy also provided written comments.

BHP Billiton's Greg Klatt voiced concerns over regulatory uncertainty. He was particularly concerned with what he considered loose language in the Sempra utilities' operational balancing agreements regarding additional governmental rules and regulations, and desires a single set of rules approved by CPUC for the whole state. While Klatt anticipates that the LNG which BHP imports will be able to meet both CPUC and ARB specs, he did not offer any details on how BHP is planning to conform to these standards, and he still wishes all standards to be imposed by one organization, the CPUC.

Shell Trading's Edgar Kuiper vigorously opposed the extraction of ethane as being uneconomic, and supported use of the Wobbe number as the key indicator of natural gas quality, with methane number as the second most important metric. The Wobbe number, according to Kuiper, addressed NOx and CO emissions, whereas the CARB Standard, in his view, does not properly address NOx emissions. Shell advocates nitrogen injection as a method of Wobbe management for regasified LNG.

Shell also advocates a single statewide natural gas standard. In its post-workshop comments Shell also recommends a Wobbe number range of 1290-1400, and methane number of 80, to decline to 73 by January 1, 2008. Shell wants an expedited collaborative process to finish deliberations on natural gas quality so that new standards can be adopted by June 2005.

Chevron/Texaco's Bob Dimitroff also supported a maximum Wobbe number of 1400, with a Btu limit of 1110, but declared Rules 21 and 30 to be adequate to their tasks, with no need for alteration. He, as well, focused on the issue of regulatory certainty as being critical to investors.

Sempra LNG's Les Bamberg decried the CARB Standard as not serving the interests of California consumers. He proposed that lower overall emissions could be achieved by promotion of natural gas over diesel oil as a motor fuel, and that regional or local air quality requirements be imposed through equipment specifications, not fuel specifications. He sees little emissions impact of LNG on gas turbines, and declares that

appliances account for less than 2% of California's NOx emissions, and are thus minimal contributors to air quality problems. Bamburg also indicated that ethane extraction is uneconomical.

Kevin Shea, of SDG&E and SoCalGas, expressed lack of concern with swing. He said that his systems today experience swings of the same magnitudes that are expected when LNG will be introduced.

Sound Energy Solutions' Jean Armstrong averred that SES's proposed Long Beach facility will be able to comply with both Rule 30 and the CARB Standard, and strip ethane and heavier hydrocarbons. SES believes that it can comply with any standard California imposes. It does, however, desire regulatory certainty so that it can build proper facilities to comply with whatever rules are imposed.

Benedict Ho, of BP Exploration, discussed the need for regulatory certainty. He also put forth the hypothesis that unless California allowed hotter gas into its natural gas utility pipeline systems, it would not be able to compete with the Far East for LNG supplies. He further averred that hydrocarbon dropout is not an issue relevant to LNG because LNG contains no C6+ (hexanes and heavier hydrocarbons). Ho agreed, in the name of NGC, that Wobbe number is not comprehensive enough to be the sole metric of natural gas quality, and advocated adding another standard, such as methane number.

Government Agencies

ARB

Air Resources Board's Dean Simeroth informed the Workshop that the ARB specifications were intended to be a consensus standard when they were developed and that at that time they indeed fulfilled that intent. ARB has recognized that the standard is likely outdated, and has been working with industry for the past five years with that in mind. ARB has approved research exemptions to its standard, to allow the siting of new fueling facilities for CNG vehicles while collecting data on vehicle performance using varying natural gas quality. ARB seeks to be flexible going forward, and its current

thought at the staff level is that a combination specification including, but not necessarily limited to, the Wobbe and methane numbers, as “the best way to go.”

SCAQMD

Chung Liu, of South Coast Air Quality Management District, strongly expressed his opposition to any standards that would allow *any* increase in emissions. In SCAQMD’s view, air quality standards are not being met now, and allowing any further incremental emissions is unthinkable. Liu linked high Btu gas with high NOx emissions. Inerts injection might help, he added, but cautioned that SCAQMD would have problems with any gas whose Wobbe number exceeded the current 1325 national average. In SCAQMD’s view, GTI and the other organizations need to look more closely at large appliances in terms of emissions, and involve SCAQMD in the process. He also expressed concerns regarding the potential impact on air quality of the importation of high Btu LNG in large quantities to southern California.

In post-workshop written comments, SCAQMD stated that Rule 30 only applies to customer-owned gas, and not to natural gas that SoCalGas purchases and supplies to its core customers.

California Air Pollution Control Officer’s Association (CAPCOA)

CAPCOA submitted post-workshop written comments. CAPCOA supports efforts to address the “long-standing issue of high BTU-content (“Hot Gas”) natural gas supplies found primarily in southern California-produced gas supplies.” However, it expressed concern about adopting an MN80 specification alone because MN is independent of CNG inert content and it may lead to stationary source impacts. CAPCOA notes that “With the introduction of Liquefied Natural Gas Supplies (“LNG”) into the southern California natural gas supply system in the future, the hot gas problem can be exacerbated.”

V. Analysis of Stakeholder Issues

The stakeholders fall into several major groups, with several subgroups:

1. End users, including
 - a. Generators (utilizing both turbines and piston-engined peakers)
 - b. Industrial users
 - c. Small businesses and residential users
 - d. Chemical feedstock users
 - e. Natural gas vehicle users (who face many of the same issues as piston-powered generators)
2. Suppliers and potential suppliers
 - a. California producers – conventional, low Btu, and high Btu (associated gas)
 - b. Traditional North American producers -- Domestic interstate and Canadian
 - c. LNG (foreign or Alaskan)
3. Natural gas marketers
4. Transmission and distribution operators, *i.e.* utilities and pipeline companies
5. Independent storage providers
6. Natural gas and electric ratepayers affected by cost/rate impacts
7. Citizens affected by impacts to air quality

The staff's analysis of the issues considered two basic alternatives: no change to existing standards, and changes to the existing standards.

Who benefits and who is harmed if we follow the null hypothesis (*i.e.* do nothing)? In other words, if we maintain the current system as it is, unchanged, who is affected and how are they affected? If, hypothetically, there were no regulatory changes, the *status quo* would be preserved. The greatest impact of such a scenario could be to limit the supply to that supply already included in California's current portfolio. Although this would probably not prove disastrous in the immediate future, it is likely that the availability and price of significant supplies of natural gas, including LNG and California-produced natural gas, would be adversely affected.

The two important classes of new potential natural gas supply are liquefied natural gas (LNG) and nontraditional native gas. LNG *could* compositionally differ from the current pipeline standards. Some native gas not currently being exploited *definitely* does not meet those standards, which is why it is currently stranded off the system.

Liquefied natural gas is generally cryogenically liquefied at the source, then transported in oceangoing tanker vessels to terminals, where it is regasified and introduced to the transmission and distribution system. During the liquefaction process, the natural gas is purified to a certain extent. Many of its heavier hydrocarbon constituents are left behind, as is any water and inert content. Carbon dioxide “boils” off during the voyage to market. In a sense, though, LNG can be viewed as too “pure” for the California and North American markets.

When LNG is delivered to U.S. receiving terminals, it generally has a higher Btu content than standard domestic natural gas. This is because its ratio of methane to ethane, propane, and heavier hydrocarbons (C2+) is lower, and no volume is taken up by inert compounds, which do not burn. This results in a hotter burning gas. Such gas is ideal for consumption in Asian markets, where appliances and end uses are tuned for it, but not for the California or U.S. markets, which evolved around cooler-burning “domestic” natural gas supplies.

In California, some natural gas supplies have not been readily exploited because their heat contents differ from historical norms. Natural gas that is produced in association with oil often has a higher Btu content. In contrast, some gas produced in the dry gas fields of Northern California has a lower Btu content and consequently has needed to be blended up to spec with higher Btu gas before it is distributed to end users.

The core of the discussion around natural gas quality standards is precisely this: How far can the constraints imposed by current specifications be relaxed in order to accommodate delivery into our systems from these potential new sources, and what

efforts can be made to mitigate incompatibilities with current legacy systems and possible air quality impacts?

PG&E Rule 21 and SoCalGas Rule 30

Stakeholders expressed several types of views on CPUC-adopted specifications contained in PG&E Rule 21 and SoCalGas Rule 30:

1. Current standards are adequate, as in a view put forth by Chevron/Texaco.
2. Some modifications are necessary, as recommended by the utilities, or “minor” modifications are necessary, as espoused by the Western States Petroleum Association (WSPA).
3. Tariffs should be consistent with federal quality standards, the position set out by Sempra LNG.
4. Suppliers should be provided with regulatory certainty. In particular, Chevron/Texaco’s Bob Dimitroff, Shell North America’s Edgar Kuipers, and BHP Billiton’s Greg Klatt all remarked upon the need for regulatory certainty as a necessary prerequisite for investor confidence and rational decision making related to the development of LNG projects. (This issue is distinct from the debate over exactly which natural gas specifications should be adopted. The proponents of this issue are concerned that decisions on specifications be made as soon as possible and set for as long a term as possible.)
5. Any reasonable standard can be met, but standards must be consistent, as advocated by Sound Energy Solutions (SES). Some parties advocated statewide, uniform CPUC specifications.

Many stakeholders take issue with the use of compositional standards (*i.e.* minimum and maximum concentrations of various chemical constituents), expressing the belief that only performance indices (such as the Wobbe number and methane number) are appropriate. Most advocates of change insisted on adoption of performance standards over strict compositional standards. As the Gas Technology Institute’s (GTI’s) Bill Liss opined, compositional specifications can be too restrictive. With a diversity of

scientifically acceptable methods to characterize natural gas, the goal is to find a set of metrics that responds to the needs of stakeholders and solves their problems.

Several ongoing research efforts are currently trying to address these issues at both the national and state levels, including an effort to establish national standards. Whether or not California natural gas standards should fall in line with FERC-proposed national specifications is a debatable proposition among stakeholders. Indeed, depending upon the proposed federal standard, California may not be able to incorporate it in California specs without undue hardship.

Wobbe Number as a Specification

Consensus developed around the use of the Wobbe number (also known as Wobbe index) as a primary metric, the best single gauge of gas performance, although there is debate over which other indices, if any, should be used in conjunction with it. The Wobbe number is used as a natural gas performance standard virtually everywhere else in the world, and provides an accurate gauge of the heating value of gas as it passes through an orifice.

According to the American Gas Association's Bulletin No. 36: "the Wobbe number, or Wobbe index, of a fuel gas is found by dividing the high heating value of the gas in Btu per standard cubic foot [scf] by the square root of its specific gravity with respect to air. The higher a gases' Wobbe number, the greater the heating value of the quantity of gas that will flow through a hole of a given size in a given amount of time. It is customary to give a Wobbe number without units—even though it has the dimensions Btu per scf—because to do so would lead to confusion with the volumetric heating value of the gas."

The Wobbe number is also regarded as an adequate gauge of carbon monoxide (CO) and NO_x emissions, according to Shell's Kuipers. NO_x and CO emissions are of particular concern with hot burning applications, but adjustment of the Wobbe numbers should be able to resolve these problems. Particulate matter (PM), though, is another concern

regarding higher Btu gas, according to Bevilacqua-Knight's Steve Sokolsky, and it was not clear from the workshop whether or not a Wobbe number adjustment would address this concern as well.

Various opinions were expressed, as to whether or not the Wobbe number is sufficient in and of itself to evaluate natural gas quality, and/or which other metrics should be used in conjunction with it. GTI's Bill Liss and David Rue, and BP's Benedict Ho asserted that the Wobbe number alone was not a comprehensive enough specification. Rue maintained that although the Wobbe number is the best single parameter for interchangeability, emissions, appliance performance, and knock, all require secondary parameters, perhaps targeted to specific applications.

California's current system average Wobbe number is 1325. SCAQMD's Chung Liu averred that anything higher would cause emissions problems for his agency. The Interstate Natural Gas Association of America's (INGAA's) Terry Boss and Chevron/Texaco's Bob Dimitroff favored a maximum Wobbe number of 1400.

Methods for managing the Wobbe number downwards include:

- Blending
- Inert injection
- Stripping of C2+ natural gas components

According to PG&E's Joe Bronner, blending is not practical. He maintained at the workshop that high Btu LNG would not come into California at locations and in quantities suitable for blending with lower Btu gas. Lodi Gas Storage's Chris Hilien countered in his statement that gas storage operations do not have to take place proximate to LNG terminals to facilitate blending. Facilities geographically removed from LNG terminals can balance gas storage loads, allowing blending operations to be carried out in gas storage facilities closer to the terminals.

SCAQMD's Chung Liu agreed that inert injection would help mitigate emissions impacts of higher Btu gas. Southwest Research Institute's (SWRI's) James Chiu commented that lowering the Wobbe number in this manner would not necessarily affect the methane number of the gas in question. Calpine's Craig Chancellor favored nitrogen injection as a viable way to lower Wobbe for turbine usage. INGAA's Boss, however, reported that although inert injection could lower Wobbe numbers, turbine manufacturers are sensitive to this solution because they can't live with higher butane limits that inert injection would allow. Butane and heavier hydrocarbons could liquefy, forming droplets that would destroy the turbines' blades. He continued that a hydrocarbon dew point specification would provide a solution to this problem.

Sempra Utilities' Larry Sasadeusz, however, took issue with nitrogen injection, as did Joe Rivera. (SDG&E and SoCalGas are also Sempra affiliates.) Sasadeusz cited a feedstock issue: many reformers don't react well to nitrogen. Rivera also brought up end user issues: nitrogen can affect the heat-treating of alloys, as well as the annealing process for glass. Carbon dioxide injection, according to Rivera, is also not a viable option: it causes the formation of corrosive carbonic acid, which is damaging to pipeline system.

PG&E's Joe Bronner suggested that although there is no inerts standard in Rule 21, there should be. Nevertheless, he maintained, PG&E has never had a problem with inert content before that couldn't be managed by blending.

Shell's Kuipers maintained that nitrogen injection is more efficient at lowering a gas's Wobbe number than extraction of ethane and natural gas liquids, and that nitrogen injection equipment can be retrofitted to LNG regasification terminals if necessary. Natural gas liquids (NGLs) are also known as liquefied propane gas, or LPG, and consist of mostly of propane (C3), and butane (C4).

The primary and most outspoken opponent of LPG removal from LNG was Sempra LNG's Les Bamburg. One major objection was economic: Bamburg pointed out that there exist no ethane or LPG market on the West Coast, so removing that component

from natural gas would create an unwanted commodity. Combined with issues of complexity and reliability associated with ethane extraction, he found the prospect very impractical. He added that "Probably one-half the facilities out there...have no capability for LPG recovery," intimating that such capabilities would be too expensive to retrofit.

In addition to all of the foregoing, Bamburg pointed out that ethane extraction is illegal in Mexico, and thus any such mandates would not apply to LNG imported across the Mexican border. Both Bamburg and Kuipers stated that technically ethane removal was always possible at the LNG liquefaction end of the process, but that this was also uneconomical, because there is no international ethane market.

Furthermore, several parties, including Texaco's Bob Dimitroff, argued that high Btu gas made the pipeline transportation system more efficient at delivering energy.

Calpine's Chancellor pronounced ethane not to be an issue for turbines, and propane/butane not to be a problem for all gas mixes, even though it could exceed OEM (original equipment manufacturer) specifications. SES's Armstrong declared that her company's proposed LNG facility would have the capacity to extract ethane and meet the current SoCalGas Rule 30 and CARB Standard.

SCAQMD's Chung Liu cautioned that high Btu gas yields high NO_x emissions.

CARB Standard

The ARB would support modification of its compressed natural gas motor vehicle specifications, if the modifications provide compliance flexibility while being protective of air quality and end-user applications (e.g. maintain engine performance and durability).

While addressing possible changes in the ARB compressed natural gas motor vehicle fuel specifications, it should be noted that these specifications apply only to motor vehicle

fuel. Consequently, it is necessary that these specifications address the fuel characteristics that are necessary for safe operation of the engines as well those that maintain the air quality benefits of the fuel. The change from a prescriptive compositional specification to a performance based specification could allow more flexibility in providing motor vehicle fuel. At this time it would appear that two different performance indices may be appropriate, one that addresses engine performance (methane number) and the other to address air emissions (Wobbe number) in combination with other indices such as heating value or limits on heavier hydrocarbon content.

Advances in vehicle engine technology since the adoption of the ARB specifications over ten years ago could also allow a broader quality of fuel to be specified. However, there are legacy vehicles in multiple locations throughout California, primarily school and transit buses, which still require a more stringent fuel specification than the newer technologies allow. Therefore any changes in the specifications must be accompanied by some provision for these legacy vehicles.

While the ARB compressed natural gas specifications apply only to motor vehicle fuel, the specifications have been used by SoCalGas as a standard for entry of domestic natural gas product into the pipeline. This has caused considerable concern for California natural gas producers. The ARB natural gas motor vehicle fuel specifications are applicable at the point of fueling the vehicle. Since the fraction of natural gas product used for motor vehicle fuel is considerably less than one percent of the natural gas consumed in California, applying the ARB standard broadly may be unnecessarily burdensome to the California producers. However, the impact of changing gas quality on the air emissions of stationary sources should be a factor in setting specifications for pipeline natural gas quality. Specifications based on the Wobbe number, possibly in combination with other indices such as heating value are likely to be considered. Also, it may be necessary to consider some form of compositional specification as indicated by the power generation industry.

The CARB Standard is the single issue that stakeholders most wished to reassess.

Its compositional restrictions are viewed by many as a regulatory roadblock to the introduction of natural gas from new sources. Moreover, its detractors indicate that the standard exists for the express and sole purpose of serving a very small class of end users in the transportation segment. Semptra LNG's Bamburg declared that for this reason, "Existing CNG fuel specs do not serve the interest of California consumers."

Shell's Kuipers disparaged the CARB Standard because it would force the removal of ethane from the natural gas stream. Such extraction would be uneconomic, in his opinion, and keep LNG out of the US market. SES's Armstrong, however, reported that SES's proposed Long Beach facility would have the capability to strip ethane, thus meeting the current CARB Standard, as well as SoCalGas Rule 30's standards.

WSPA's Joe Sparano labeled the CARB Standard an "unreasonable burden on California producers." Moreover, he stated that WSPA "believe[s] CARB vehicle specs don't apply to our producers."

CNG Vehicles

Much discussion took place about the necessity of current CNG-powered vehicles to be fueled by current-spec gas. While virtually all agreed that newer generation engines with "closed loop" engine control systems (*i.e.* those which electronically monitor knock, emissions, *etc.* and adjust themselves accordingly) could operate well on CNG outside of the CARB Standard, two questions remained:

1. What about the legacy fleets requiring CARB Standard fuel?
2. How much could the CARB Standard be realistically changed without causing damage to the legacy fleet or increasing air emissions?

Service lifetimes of the legacy fleets are estimated to expire as late as 2019. Changing fuel standards could require upgrades of those vehicles, where possible, or their premature removal from California roads. Regarding disposition of these fleets, there are

three options: engine replacement, engine retrofit, and vehicle replacement. According to James Chiu of the Southwest Research Institute, engine replacement, where viable, would take a \$75,000 one-time development charge per application, and then \$30,000-35,000 per unit. Engine replacement might also necessitate axle gearing replacement at additional cost in some applications. Chiu estimates retrofitting of new engine control systems, where applicable, at \$150,000 per application one-time development cost and \$12,000 per engine, if retrofits were to be developed *de novo*. Aftermarket kits are available for some applications that would substantially reduce these costs. Nevertheless, Chiu warns, engine retrofits may void manufacturer warranties, a nontrivial consideration.

Dave Maul, of the California Energy Commission, advanced the idea of selling legacy fleets outright to other states, which may not currently be facing California's concerns.

Methane Number

Consensus held that methane number is a viable performance standard for natural gas-based motor fuel, and stakeholders interested in changing the CARB Standard almost uniformly support its adoption as a determinant of quality. Methane number (MN) is largely an anti-knock measurement in internal combustion engines, similar to octane number in gasoline engines.²

² Methane Number (according to the CARB standard) is determined by the following calculation according to the American Society for Testing and Materials (ASTM) standard D 1945-96:

$$MN = 1.624 * (-406.14 + 508.04 * RHCR - 173.55 * RHCR^2 + 20.17 * RHCR^3) - 119.1$$

Where RHCR = (% methane*4 + % ethane*6 + % propane*8 + (% isobutane + % n-butane)*10 + (% isopentane + n-pentane)*12 + (% hexane and longer hydrocarbon chains) *14) / (% methane*1 + % ethane*2 + % propane*3 + (% isobutane + % n-butane)*4 + (% isopentane + % n-pentane)*5 + % (hexane and longer hydrocarbon chains)*6).

SoCalGas/SDG&E's Lee Stewart and INGAA's Terry Boss both advocate an immediate reduction in the minimum methane number to MN80, with subsequent reductions to follow as technology allows. Future engines should be viable utilizing fuels between MN 73 and MN65, according to Oxy's Bill Boyer and CIPA/WSPA's Tom Umenhofer.

It should also be noted, though, that heavy duty reciprocating piston engines also see non-automotive service, and any plans affecting motor fuel would also affect this equipment. INGAA's Boss discussed pipeline compressor engines, some units 50-70 years old still in service. Sempra Utilities' Sasadeusz discussed piston-driven peak shaving generators as well.

Shell's Kuiper views the methane number as the next most important natural gas metric after the Wobbe number. The Natural Gas Council's NGC+ White paper concurred, and consensus among the stakeholders started to form that a new standard should include both Wobbe and methane number specifications.

VI. FERC/NGC+

As part of its ongoing assessment of natural gas quality issues, the FERC has encouraged industry to provide recommendations. To that end, a group of stakeholders, some of whom also participated in the CPUC/CEC Workshop, formed under the auspices of the Natural Gas Council to form two technical working groups. These are known as the NGC+ Working Groups. One addressed interchangeability issues associated with high Btu LNG imports, and the other focused on hydrocarbon liquid dropout issues specific to domestic supply. Both issued white papers on February 28, 2005, the interchangeability one of which is particularly relevant to this discussion.

Among its significant findings, the NGC+ Working Group on Natural Gas Interchangeability determined:

- The heating value specification alone is not an adequate measure for gas interchangeability, although it may be appropriate if used in conjunction with other specifications.
- The Wobbe number provides the most efficient and robust single index and measure of gas interchangeability, although additional specifications are necessary to address combustion performance, emissions and noncombustion requirements.
- With regard to combustion turbines, constituent limits (*i.e.* compositional standards) may be necessary.
- At least two interchangeability specifications are required adequately to address end use effects.

VII. Observations and Assessment by Staff

Each solution proposed by a stakeholder would change the system, perhaps counter to the interests of other stakeholders. The State Agencies' goal is to make this process as close as possible to a positive sum game with no losers. Unsurprisingly, since this workshop was one of the first to bring a diversity of stakeholders together, little compromise was evident in their presentations. Most participants simply took this opportunity to identify their positions. Consensus seemed to emerge that the workshop adequately framed the issues, but negotiations were left to future stages in the process.

There are at least three classes of proposed actions to be taken:

1. Drop CPUC compositional standards in favor of performance standards, such as the Wobbe number. This is favored by most of the storage, gas marketing, gas producing, and LNG stakeholders, although both SES and BHP Billiton claim that their proposed LNG facilities can meet *any* reasonable standards.
2. Keep *some* compositional standards. Pipelines and generators favor this approach, particularly because it would preserve specifications on impurities and

heavy hydrocarbons that could liquefy in droplets (hydrocarbon dropout) and damage turbine blades in generators and compressors.

3. Mandate a minimum methane number instead of the current CARB Standard.

This is a reasonable engineering alternative to the CARB Standard with respect to fuel anti-knock characteristics for heavy duty reciprocating piston engines.

Where that number would be set, though, is a matter of debate.

CPUC staff has no objection to the utilization of the Wobbe number in future natural gas quality specifications. Nevertheless, staff realizes that the Wobbe number, by itself, does not describe the entire range of performance characteristics necessary to satisfy the concerns of all stakeholders from all segments. If performance-based metrics were to be adopted, methane number would also need to be included, as would perhaps certain others as yet to be determined.

Furthermore, CPUC staff recognizes the necessity to maintain certain compositional standards. Impurities are not adequately accounted for through performance standards. Furthermore, hydrocarbon dropout is still an issue of great concern, and can be best addressed through setting maximum limits on non-methane (*i.e.* heavier than methane) concentrations in natural gas.

With respect to emissions, CPUC staff recognizes the importance of air quality and the need not to see it degraded by any increment. Any change in standards, therefore, must take into account environmental and health impacts upon California's inhabitants.

Some parties supported statewide, uniform specifications and tariffs. The State Agencies do not oppose efforts to develop statewide, uniform natural gas quality specifications, but do not see this as a primary objective, and several parties argued at the workshop for regional flexibility. The State Agencies believe it is more important to develop specifications that parties can broadly work with, and that ensure safety, efficiency, and high air quality standards.

Some parties also asserted that California specifications would need to conform to federal standards. On this particular issue, it is yet unclear what form such a federal standard would take, and whether or not that standard would address California's concerns. While the State Agencies and affected stakeholders certainly need to monitor federal developments, the State Agencies do not see a need to wait for the development of a federal standard before moving to modify, if necessary, California specifications.

VIII. What Are the Next Steps in the Process?

The issues raised during the workshop and in comments certainly do not appear to be insurmountable. While more research is clearly needed on natural gas quality, the workshop and comments adequately provided enough of a foundation to now proceed with a series of roundtables, meetings, and technical workshops intended to reach a consensus on whether and how CPUC and ARB natural gas quality specifications should be revised. Consideration of the CARB Standard should be included in that process.

While the State Agencies do not oppose informal meetings of stakeholders, generally these meetings should be held jointly under the auspices of the State Agencies. Many parties seemed to believe that the issues should be resolved as quickly as possible, and the State Agencies believe that resolution is possible within a year. As parties and the State Agencies go through this process, it will be important to keep in mind potential cost impacts on natural gas consumers due to any changes in natural gas quality standards.

A near-term, important step in the process will be the filing of comments on this workshop report on April 25, 2005. The State Agencies expect to receive specific recommendations from parties on how CPUC and ARB natural gas specifications should be revised, if at all. The State Agencies would greatly appreciate recommendations that accommodate the broadest range of interests. The comments should also indicate the procedural method by which the recommendation could be achieved. Finally, the comments should indicate what additional research is needed.

While informal meetings may proceed prior to and after the filing of comments, the State Agencies then expect to convene a more formal meeting in the late spring or early summer.

Although evidentiary hearings did not appear to be the preferred or a viable approach to reaching consensus, the staff believes that some issues may need to be addressed in evidentiary hearings, so they should not be ruled out at this time. However, the need for hearings may only become clear after some of the informal meetings have been held.

Glossary

Btu (British Thermal Unit)	The amount of energy required to raise the temperature of 1 pound of water 1 degree Fahrenheit when the water is near 39.2 degrees Fahrenheit.
C2, C3, C4, etc.	Refers to the number of carbons in hydrocarbon molecule. C2 denotes ethane, C3 denotes propane, C4 denotes butane, <i>etc.</i>
FERC	Federal Energy Regulatory Commission
grain	1 grain equals 0.0647989 grams.
heating value	Heating Value is defined as the amount of energy released when a fuel is burned completely in a steady-flow process and the products are returned to the state of the reactants.
hydrocarbon dewpoint	Temperature at which various heavier hydrocarbon components in a gas stream condense.
hydrocarbon dropout	Temperature at which various heavier hydrocarbon components in a gas stream condense, and accumulate as liquids inside the pipeline.
inerts	Compounds that do not react readily with other elements.
methane number	Methane number is a measure of a natural gas fuel's resistance to engine knocking. Its is calculated by: methane*1+% ethane*2+ % propane*3+(% isobutane + % n-butane)*4+(% isopentane + % npentane)*5+% (hexane and longer hydrocarbon chains)*6).
NGC+	Natural Gas Council-led group studying the issue of gas interchangeability.

specific gravity

Specific gravity is a comparison of the density of a substance to the density of water.

Wobbe number, or Wobbe index

Wobbe number is the Btu content of a gas divided by the square root of the specific gravity.