Overview of California Utilities Renewable Gas Quality

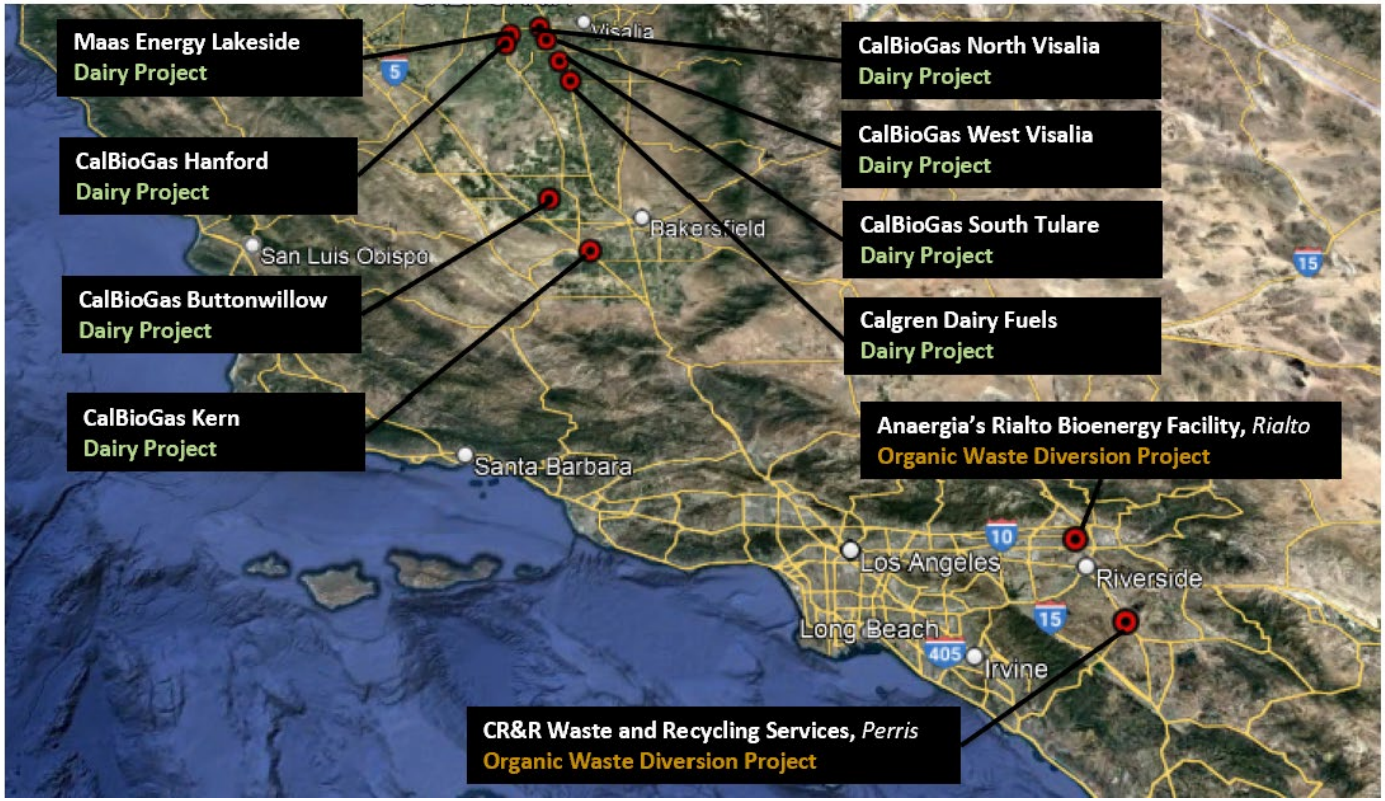
Outline

- Introductions and Status of Renewable Gas Supplies
- History of Biomethane Gas Quality Standards
- California Joint Utility Standard for Renewable Gas Interconnection Standards
- Status of Renewable Gas Limits
- Q&A

Status of renewable gas supplies

- PG&E:
  - Two Projects are currently injecting RNG into pipeline: 1 Dairy Cluster and 1 Dairy gas.
  - One Dairy Biogas Project expected to start by Q3 2022
- Southwest Gas:
  - Three projects are currently injecting RNG into the pipeline: 2 WWTPs (1 in CA) and 1 Dairy.
  - Three Dairy projects expected to be in service in 2022.
- SDG&E:
  - Two projects are currently injecting RG into pipeline: 1 WWTP, 1 other organic sources
- SoCalGas:
  - Ten projects are currently injecting RG into pipeline: 2 other organic solids, 8 Dairy

SoCalGas RNG interconnection projects



History of Biomethane Gas Quality Standards

Biomethane Guidance Document SCG published in 2009

Initial Biomethane Standards based on California Air Resources Board (ARB) and Office of Environmental Health Hazard Assessment (OEHHA) Report: *"Recommendations to the California Public Utilities Commission Regarding Health Protective Standards for the Injection of Biomethane into the Common Carrier Pipeline"*, submitted in **OIR 13-02-008**

Constituents of Concern in Biogas: ARB and OEHHA did a comprehensive evaluation and identification of the constituents of concern in biogas focusing on the larger sources of biogas – landfills, dairies, and sewage treatment plants (POTWs).

Trigger and Action Levels: ARB staff recommended a risk management strategy[1] wherein trigger levels and lower and upper action levels for potential cancer risk and total non-cancer hazard indexes are identified and evaluated ***to ensure that health protective levels are adequately maintained***.

CPUC DECISION 14-01-034 concluded that if biomethane meets the gas quality standards and testing protocols adopted in R. 13-02-008, then it may be injected into the California jurisdictional gas utility pipeline systems. File every 5 years review and update standards for constituents of concern commencing no later than 1/22/2019

Biomethane Quality Specification

» In 2014, the **CPUC D14-01-034 adopted concentration standards for 17 constituents** of concern found in biomethane, and adopted certain monitoring, testing, reporting, and recordkeeping protocols that the biomethane producers and gas utilities must comply with.

SoCalGas/SDG&E Rule 45
PG&E Rule 29
SWG Rule 22

Constituent	Trigger Level mg/m^3 (ppm_v)[i]	Lower Action Level mg/m^3 (ppm_v)	Upper Action Level mg/m^3 (ppm_v)
Health Protective Constituent Levels			
	Carcinogenic Constituents		
Arsenic	0.019 (0.006)	0.19 (0.06)	0.48 (0.15)
p-Dichlorobenzenes	5.7 (0.95)	57 (9.5)	140 (24)
Ethylbenzene	26 (6.0)	260 (60)	650 (150)
n-Nitroso-di-n-propylamine	0.033 (0.006)	0.33 (0.06	0.81 (0.15)
Vinyl Chloride	0.84 (0.33)	8.4 (3.3)	21 (8.3)
	Non-Carcinogenic Constituents		
Antimony	0.60 (0.12)	6.0 (1.2)	30 (6.1)
Copper	0.060 (0.02)	0.6 (0.23)	3 (1.2)
Hydrogen Sulfide	30 (22)	300 (216)	1500 (1080)
Lead	0.075 (0.009)	0.75 (0.09)	3.8 (0.44)
Methacrolein	1.1 (0.37)	11 (3.7)	53 (18)
Toluene	904 (240)	9000 (2400)	45000 (12000)
Alkyl Thiols (mercaptans)	(12)	(120)	(610)
Pipeline Integrity Protective Constituent Levels[ii]			
Siloxanes	0.01 mg Si/m^3	0.1 mg Si/m^3	-
Ammonia	0.001vol%	-	-
Hydrogen	0.1vol%	-	-
Mercury	0.08 mg/m^3	-	-
Biologicals	4×10^4/scf (qPCR per APB, SRB, IOB[iii] group) and commercially free of bacteria of >0.2 microns	-	-

Biomethane Quality Specification

» In 2021-2, the **CPUC approved updated concentration standards for Integrity Protective Constituents** found in biomethane, and adopted certain monitoring, testing, reporting, and recordkeeping protocols that the biomethane producers and gas utilities must comply with.

SoCalGas/SDG&E Rule 45
PG&E Rule 29
SWG Rule 22

Table 1 (Continued)
Maximum Constituent Concentrations

Integrity Protective Constituents (IPC) [3]			
	Trigger Level	Lower Action Level	Upper Action Level
Ammonia	3mg/m^3 4 ppm_v	7 mg/m^3 10 ppm_v	18 mg/m^3 25 ppm_v
Hydrogen	0.10%	TBD [5]	TBD [5]
Mercury	0.08 mg/m^3	TBD [5]	TBD [5]
Siloxanes	0.05 mg Si/m^3	0.1 mg Si/m^3	0.3 mg Si/m3
Biologicals	Commercially free, ≤4x10^4/scf		

Notes:

1. Base Utility Gas Specifications are identified in K1.
2. Health Protective Constituents (HPC) are shown in Table V-3 of the CARB/OEHHA Report.
3. Integrity Protective Constituents are shown in Section 4.4.3.3 of D.14-01-034 and identified as pipeline integrity protective constituents.
4. Other organic sources, includes all Biogas sources other than landfill and dairy manure, including but not limited to, a sewage treatment plant or wastewater plant ("Publicly Owned Treatment Works" or “POTW”).
5. The Lower and Upper Action Levels will be established in the next update proceeding.
6. Testing requirement will be the stricter of the stated Renewable Gas values or other tariff requirements.
7. The Interconnector that meets this Rule’s Section K.4.b certification requirements shall have reduced siloxanes testing requirements. Utility, at its discretion and at its own cost, may still test pursuant to Utility’s applicable tariff rules. If the Utility test results show the siloxanes levels exceed the Lower Action Level, the full siloxanes testing requirements will apply as described in this Rule.
8. The Interconnect will test for total bacteria including Acid-producing Bacteria (APB), Sulfate-reducing Bacteria (SRB), and Iron-oxidizing Bacteria (IOB) by quantitative polymerase Chain Reaction (qPCR) method during pre-injection testing.

Status of renewable gas limits

Health Protective Constituents

- OEHHA recommendation was issued in January 2020 to the CPUC. Lowered levels: Antimony, Arsenic, Lead, Ethylbenzene, N-nitro-di-n-propylamine, Vinyl Chloride
- Added Constituents: Cadmium, Chlorocarbons, Fluorocarbons, Chromium, Silicon, Total Sulfur
- Eliminated: Copper, Methacrolein, Toluene
- CARB may have public workshop in Summer 2022.

OEHHA/CARB Recommended Risk Management Levels (shareable?)

Constituent of Concern (mg/m3) or (ppm)	Trigger Level	Cancer Risk Lower Level	Cancer Risk Upper Level	Non-Cancer Risk Lower Level	Non-Cancer Risk Upper Level
1,4-Dichlorobenzene	4.2	42	100	N/A	N/A
Alkyl Thiols (ppm)	17 (ppm)	N/A	N/A	170	860
Antimony	0.062	N/A	N/A	0.62	3.1
Arsenic	**0.0020**[(b)]	0.0040	0.010	N/A	N/A
Cadmium	**0.0020**[(b)]	0.0032	0.0080	N/A	N/A
Chlorine (organic)	5.0	N/A	N/A	50	250
Chromium (2% Cr VI)	**0.0020**[(b)]	0.0048	0.012	N/A	N/A
Ethylbenzene	19	190	490	N/A	N/A
Fluorine (organic)	7.8	N/A	N/A	78	390
Hydrogen Sulfide [(a)]	63	N/A	N/A	860	4,300
Lead	0.047	N/A	N/A	0.47	2.3
N-nitroso-di-n-propylamine	**0.028**[(b)]	0.24	0.61	N/A	N/A
Silicon (organic)	1.0	N/A	N/A	10	52
Sulfur (compounds)	25	N/A	N/A	250	1,200
Vinyl Chloride	0.63	6.3	15	N/A	N/A

(a) The HPL concentration for hydrogen sulfide is based on the chronic worker-exposure scenario as displayed in Table I-1 of the 2020 OEHHA update (86.8 mg/m3).

(b) The recommended value was set to the lowest detectable concentration. As technology improves this value will decrease until it reaches the OEHHA 2020 health protective level

New COC highlighted in yellow

Status of renewable gas limits

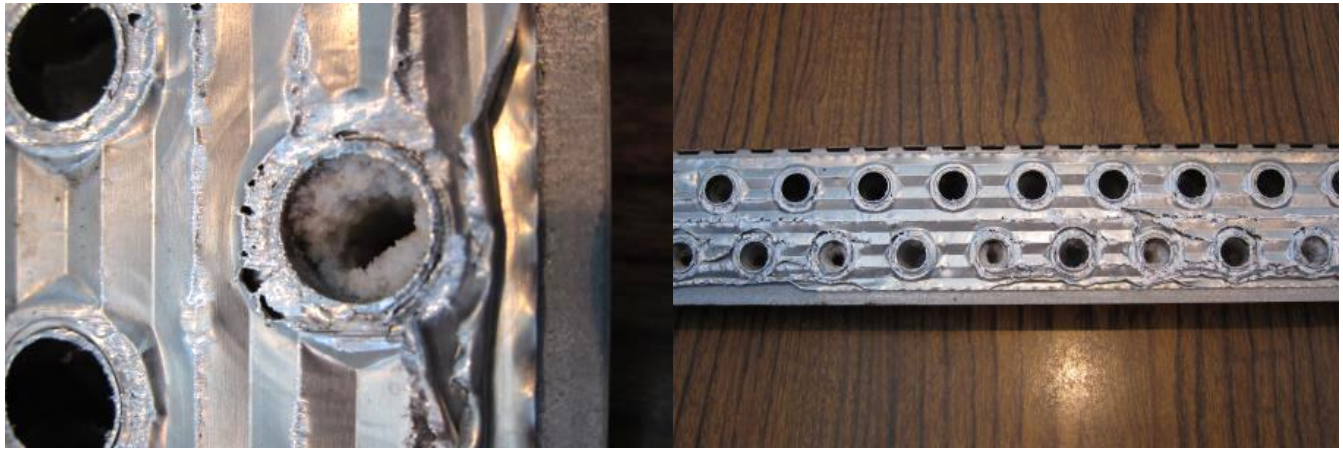
Integrity Protective Constituents:

- **CPUC DECISION 20-12-031** Provide upper (UAL) and lower action levels (LAL) for biologicals (by 4/1/21), ammonia, mercury and siloxanes (by 1/1/22). Hydrogen levels will be established in Phase 4.
- **CPUC DECISION 22-02-025** Interim limit of 0.03% Carbon Monoxide (CO). Procure from gathering lines ≤10 ppm H_2S
- Need more studies or specific data on constituent impact on natural gas pipeline facility under various conditions (e.g., pressures).

Siloxanes

- Integrity Risk:
  - Premature failure of industrial equipment and appliances when siloxanes are burned/combusted and form a sand-like material (silica) deposits on equipment surfaces.

USC - Furnace



Condenser coil assembly (7.6-76 mg Si/m^3, end of the test, 186 hrs.)

Flame sensor (7.7 mg Si/m^3, approximately 71 hours, equivalent to 0.5 month of normal operation)

Siloxanes

- Integrity Risk:
  - Premature failure of industrial equipment and appliances when siloxanes are burned/combusted and form a sand-like material (silica) deposits on equipment surfaces.
- Research project:
  - Appliance Study completed
  - ASTM Standards for Siloxane analysis, now working on ILS (Interlaboratory study)
  - Online siloxane analyzers
- Updated Specifications for Siloxanes:
  - Raised the Trigger level to 0.05 mg Si/m^3
  - Kept the Lower Action Level of 0.01 mg Si/m^3
  - Introduced the Upper Action Level of 0.3 mg Si/m^3
  - Reduction of Siloxane testing for certified dairies and agricultural waste

Ammonia

- Integrity Risk/Concerns: Corrosion,
- Research project on ammonia impact on GC and end use completed by USC. Odor mask.
- Updated Specifications for Ammonia
  - Lowered the Trigger Level to 4 ppm_v
  - Introduced the Lower Action Level of 10 ppm_v
  - Introduced the Upper Action Level of 25 ppm_v

Mercury

- Integrity Risk:
  - Corrosion
- Research:
  - USC literature study – not available under NG pipeline conditions
- Updated Specifications for Mercury
  - 0.01 ug/m^3 for Cryogenic applications
  - Annual progress updates to CPUC.

Biologicals

- Integrity Risk:
  - Corrosion
- Research/Study:
  - GTI data shows no difference between RG and pipeline natural gas
- Updated Levels for Biologicals:
  - Test at pre-injection
  - Propose: No biologicals >0.2 microns

Hydrogen

- Refer to the work done for Hydrogen Injection standard

Test Preparation Procedure

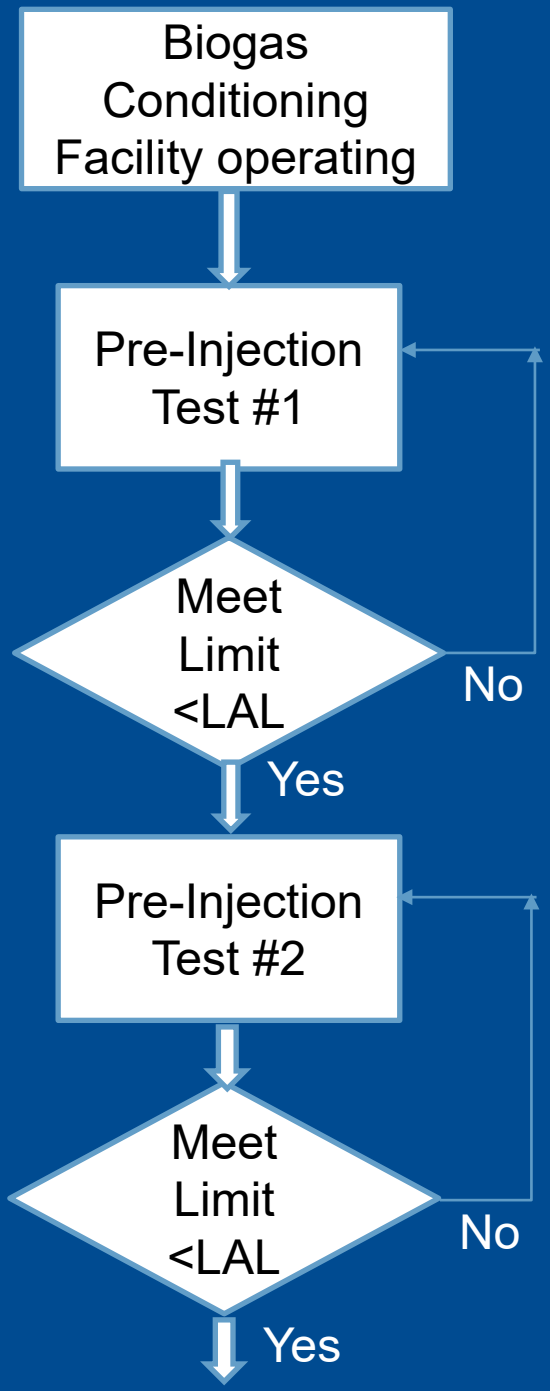
1. Determine compounds to be tested by source
2. Determine reporting limits for each compound
3. Contact outside labs.
4. Labs will provide test apparatus, turn around time, cost, sampling instructions and shipping info.

Biomethane	CAS #	Trigger Level		Testing by Biogas Source		
Constituents		mg/m3	ppmv	Landfill	Dairies	Other
Arsenic	7440-38-2	0.019	0.006	x		
p-Dichlorobenzene	106-46-7	5.7	0.95	x		x
Ethylbenzene	100-41-4	26	6	x	x	x
n-Nitroso-di-n-propylamine	621-64-7	0.033	0.006	x	x	
Vinyl Chloride	75-01-4	0.84	0.33	x		x
Antimony	7440-36-0	0.6	0.12	x		
Copper	7440-50-8	0.06	0.02	x		
Hydrogen Sulfide	7883-06-4	30	22	x	x	x
Lead	7439-92-1	0.075	0.009	x		
Methacrolein	78-85-3	1.1	0.37	x		
Alkyl thiols (mercaptans)		NA	12	x	x	x
Toluene	108-88-3	904	240	x	x	x
Siloxanes		0.05	NA	x	i	x, i
Ammonia	7664-41-7	3	4	x	x	x
Hydrogen			1000	x	x	x
Mercury	7439-97-6	0.08		x	x	x
Biological	MICs	4×10^4	copies/scf	x	x	x

Sampling Method

1. Select sample tap on top of flowing pipeline downstream of plant
2. Build sample line: tubing, valve or regulator, test apparatus, and flow meter.
3. Collect samples at specified flow, test duration or volume. If instructed, shield from sun and keep cool.
4. Label samples and complete Chain of Custody (COC).
5. Ship samples with COC to lab within the sample hold time and temperature conditions.

Constituent	Examples of:	
	Sampling Method	Test Method
Arsenic	Impinger, Filter	ICP/MS (EPA 6010B)
p-Dichlorobenzene	Summa Canister	GC/MS (EPA TO-15)
Ethylbenzene	Summa Canister	GC/MS (EPA TO-15)
n-Nitroso-di-n-propylamine	Sorbent Tube	GC/MS (EPA 8270)
Vinyl Chloride	Summa Canister	GC/MS (EPA TO-15)
Antimony	Impinger, Filter	ICP/MS (EPA 6010B)
Copper	Impinger, Filter	ICP/MS (EPA 6010B)
Hydrogen Sulfide	Bag, Canister	GC/SCD (ASTM D5504)
Lead	Impinger, Filter	ICP/MS (EPA 6010B)
Methacrolein	Cartridge, tube	HPLC (EPA TO-11)
Alkyl thiols (mercaptans)	Bag, Canister	GC/SCD (ASTM D5504)
Toluene	Summa Canister	GC/MS (EPA TO-15)
Siloxanes	Anasorb Tube	GC/MS (EPA TO-15)
Ammonia	Anasorb 747 Tube	ISE (OSHA ID-164)
Hydrogen	Summa Canister	GC/PDD
Mercury	Impinger, Tube	AA (EPA 7470A)
Biological	Filter	qPCR for MICs



Pre-injection Testing

- Supplier conducts two tests over a two to four week period downstream of their Processing Plant
- If the Health Protective Constituents total potential cancer risk and non-cancer risk and Pipeline Integrity Protection Constituents are below the Lower Action Level, the biomethane may be injected into the pipeline.
- And, total bacteria test results ≤ $4x10^{\wedge 4}$/scf during pre-injection.
- Utility has option to observe test. Supplier notifies them of test in 5-10 calendar days.
- Reduced Siloxane Testing for dairy+ sources and not allow products containing siloxanes to enter biomethane in their facilities.

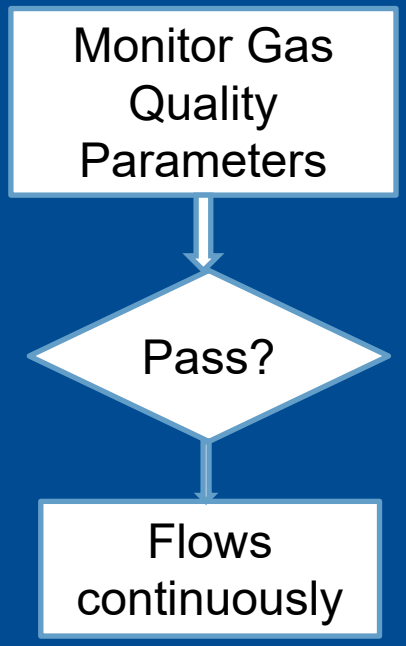
Protecting Pipeline from non-compliant gas

- Corrosive Compounds
  - Liquids
  - Sulfur
- Temperatures
- End-use

Flow Test into Utility Pipeline

Parameters	PG&E	SCG/SDGE	SWG
Heating Value (BTU/cf)	Not specified	970-1150	970-1150
Water (lb/MMscf)	7	7	7
Hydrogen Sulfide (Gr/100scf)	0.25	0.25	0.25 (4 ppmv)
Mercaptan Sulfur (Gr S/100scf)	0.5	0.3	-
Total Sulfur (Gr S/100scf)	1.0	0.75	5 (85 ppmv)
Carbon Dioxide	1%	3%	2%
Oxygen	0.1%	0.2%	0.2%
Nitrogen	Not specified		3%
Inerts	Not specified	4%	4%
Hydrocarbons	45ºF	45°F	20°F
Temperature	60 – 100°F	50-105°F	40-120°F
Interchangeability	AGA 36	1279-1385 AGA36	1280 min

Protecting Pipeline from non-compliant gas

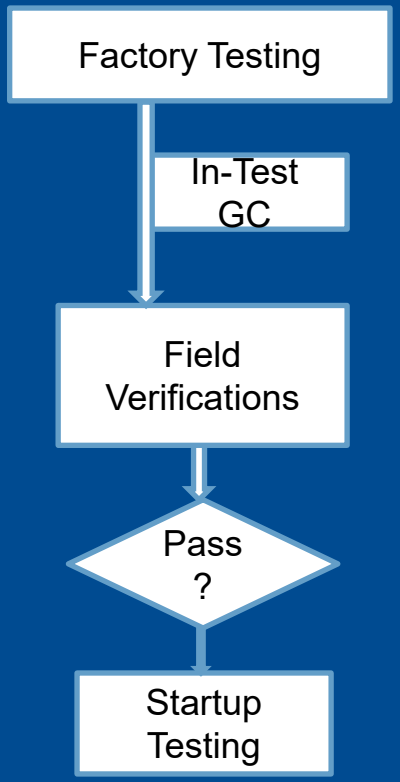


Analyzers can continuously monitor the biomethane at utility interconnection point:

- Energy Content (HHV, WI)
- Carbon Dioxide (CO_2)
- Hydrogen Sulfide (H_2S)
- Oxygen (O_2)
- Moisture (H_2O) analyzers
- Total Sulfur

These analyzers can send data and alarms to Gas Control or programable logic controller (PLC)

Commissioning



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- Total Sulfur
- Oxygen (O_2)
- Moisture (H_2O)

These analyzers can send data and alarms to Gas Control or programable logic controller (PLC)

Startup testing

24 hour monitoring gas quality parameters

Spot test RG constituents

Pass ?

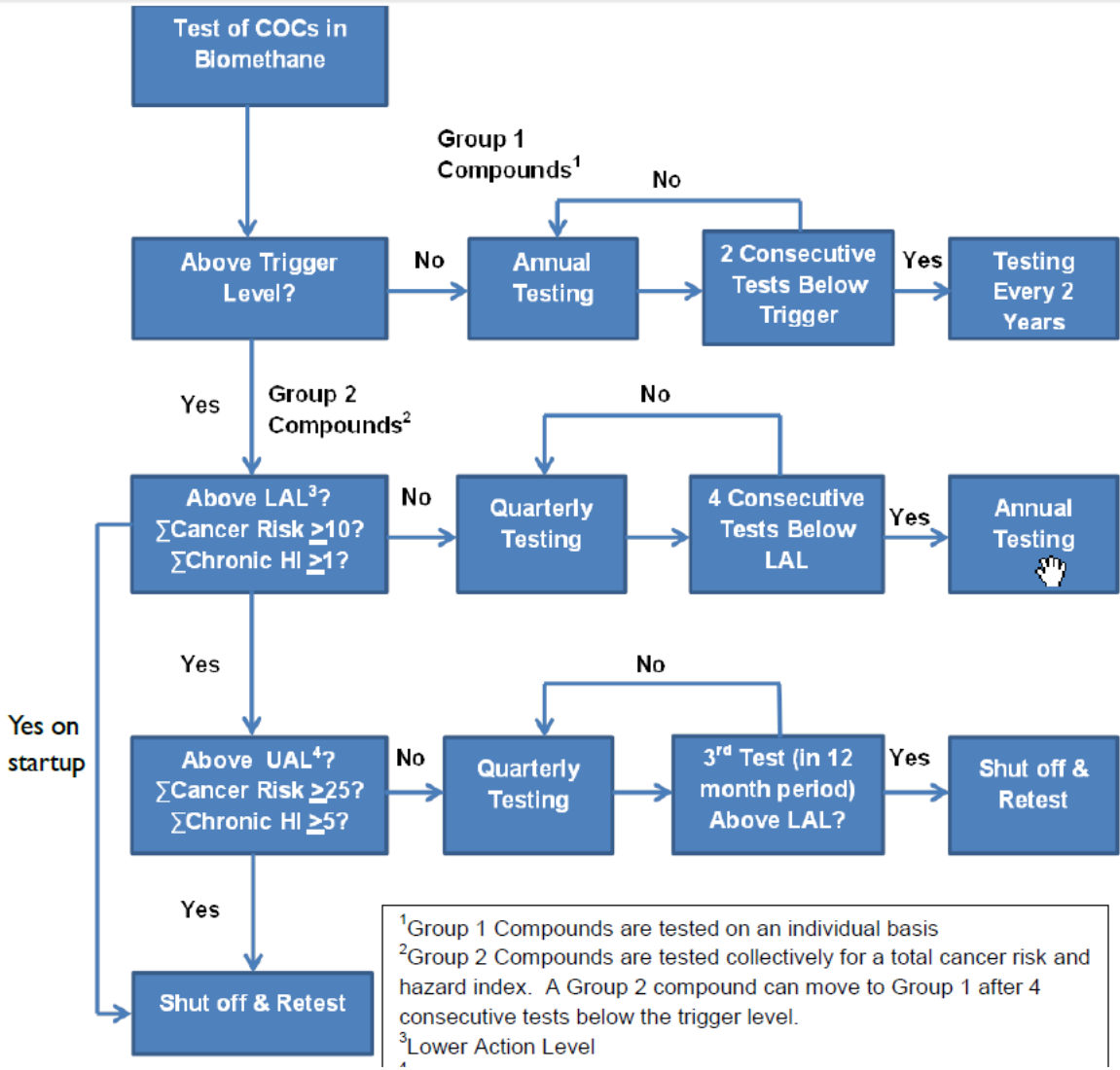
Flows continuously

Biomethane Test Frequency

- Below Trigger – Annually or Biannually
- Above Trigger – Quarterly
- Above LAL – Quarterly
- Shut offs
- LAL – 3 tests
- UAL - Immediate

CARB Flow chart on frequency of the monitoring for constituents of concern

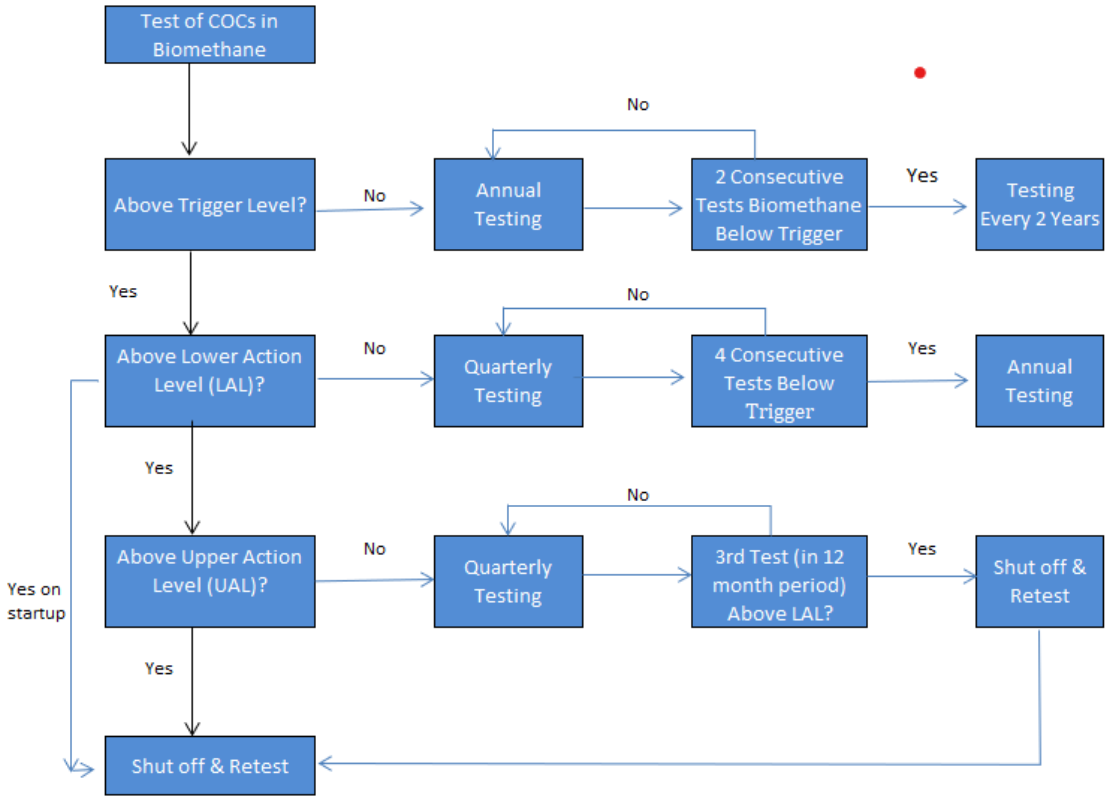
http://www.arb.ca.gov/energy/biogas/documents/errata2014.pdf



Biomethane Test Frequency

- Below Trigger – Annually or Biannually
- Above Trigger – Quarterly
- Above LAL – Quarterly
- Shut offs
- LAL – 3 tests
- UAL - Immediate

Tariff Flow chart on frequency of the monitoring for IPC constituents of concern



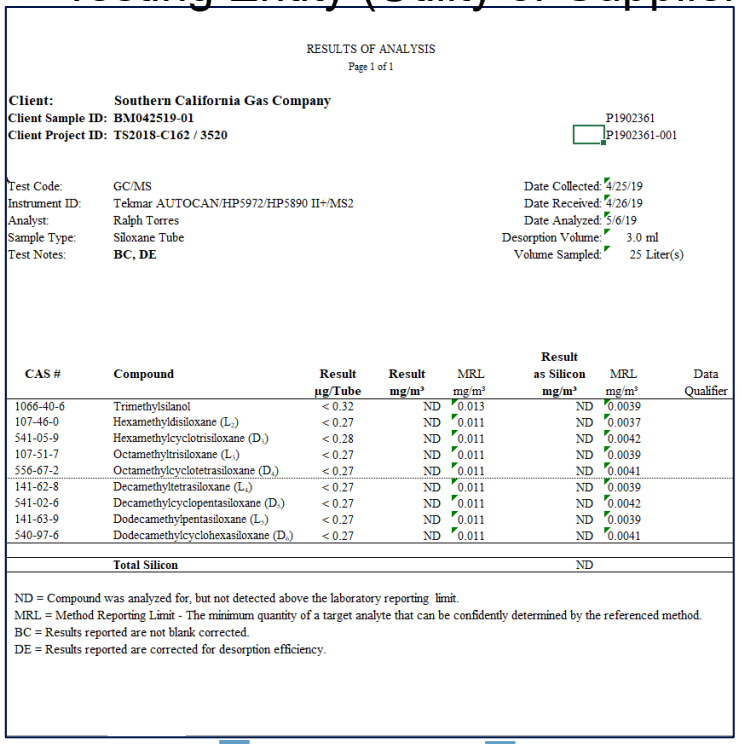
Test Reports

1. Lab will send test reports in 1-2 weeks after sample receipt by Lab.
2. Enter the Health Protective Constituents results in the calculator.
3. Calculator or chart will determine the action and test frequency.
4. Lab reports sent to utility or supplier within 5 days of receiving report.
5. Pre-interconnection test report sent to CPUC in 30 days.
6. Test data resulting in shutoffs are provided to supplier and CPUC within 24 hours of receiving report.
7. Biomethane test reports sent annually to CPUC.
8. CPUC sends reports to California Air Resources Board (ARB) and Office of Health Hazard Assessment (OEHHA)

3rd Party Labs

1-2 weeks

Testing Entity (Utility or Supplier)



RESULTS OF ANALYSIS

Page 1 of 1

Client: Southern California Gas Company
Client Sample ID: BM042519-01
Client Project ID: TS2018-C162 / 3520

P1902361
P1902361-001

Test Code: GC/MS
Instrument ID: Tekmar AUTOCAN/HP5972/HP5890 II+/MS2
Analyst: Ralph Torres
Sample Type: Siloxane Tube
Test Notes: **BC, DE**

Date Collected: 4/25/19
Date Received: 4/26/19
Date Analyzed: 5/6/19
Desorption Volume: 3.0 ml
Volume Sampled: 25 Liter(s)

CAS #	Compound	Result µg/Tube	Result mg/m³	MRL mg/m³	Result as Silicon mg/m³	MRL mg/m³	Data Qualifier
1066-40-6	Trimethylsilanol	< 0.32	ND	0.013	ND	0.0039	
107-46-0	Hexamethyldisiloxane (L_2)	< 0.27	ND	0.011	ND	0.0037	
541-05-9	Hexamethylcyclotrisiloxane (D_3)	< 0.28	ND	0.011	ND	0.0042	
107-51-7	Octamethyltrisiloxane (L_3)	< 0.27	ND	0.011	ND	0.0039	
556-67-2	Octamethylcyclotetrasiloxane (D_4)	< 0.27	ND	0.011	ND	0.0041	
141-62-8	Decamethyltetrasiloxane (L_4)	< 0.27	ND	0.011	ND	0.0039	
541-02-6	Decamethylcyclopentasiloxane (D_5)	< 0.27	ND	0.011	ND	0.0042	
141-63-9	Dodecamethylpentasiloxane (L_5)	< 0.27	ND	0.011	ND	0.0039	
540-97-6	Dodecamethylcyclohexasiloxane (D_6)	< 0.27	ND	0.011	ND	0.0041	
	Total Silicon				ND		

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.
BC = Results reported are not blank corrected.
DE = Results reported are corrected for desorption efficiency.

5 workdays (Pre-interconnection)

14 days

24 hours (*shut-off)

Utility/Supplier

Utility/Supplier
CPUC
ARB

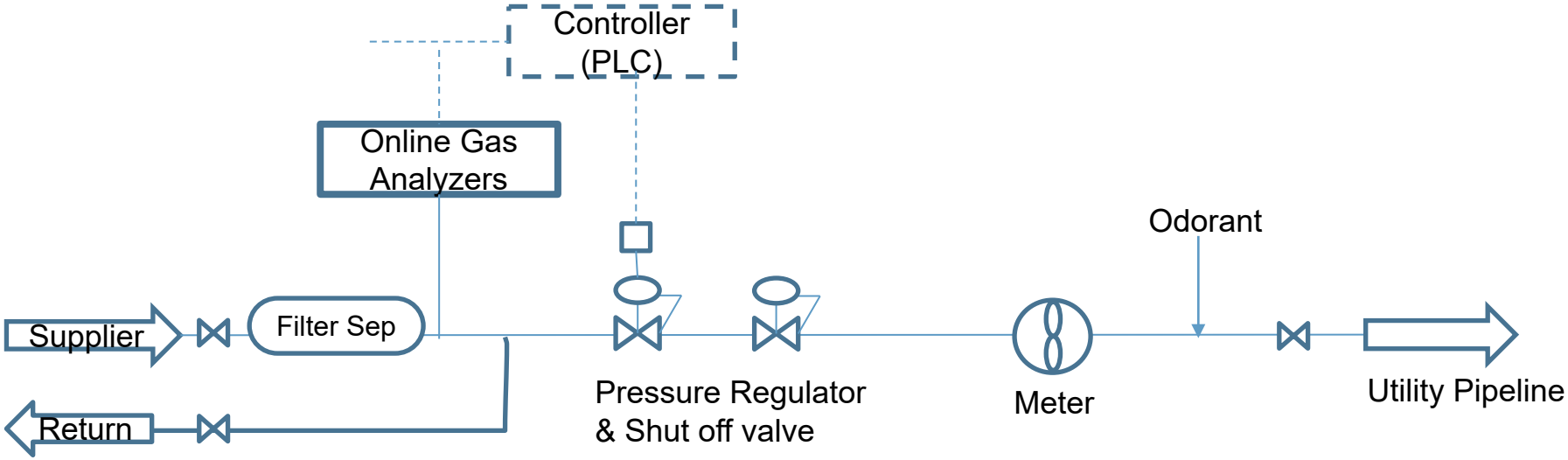
30 days (Startup)

Annual

CPUC
ARB and OEHHA

On-going Gas Quality Monitoring and Enforcement

- Continuous online gas analyzers will alarm and the controller will automatically shut off valve if not compliant.
- Gas is rejected back to be recycled through the supplier's process plant.
- Shut off valve will be opened once alarm is cleared.



Examples of RNG Meter Site

Questions