

Biogas Acceptance Evaluation

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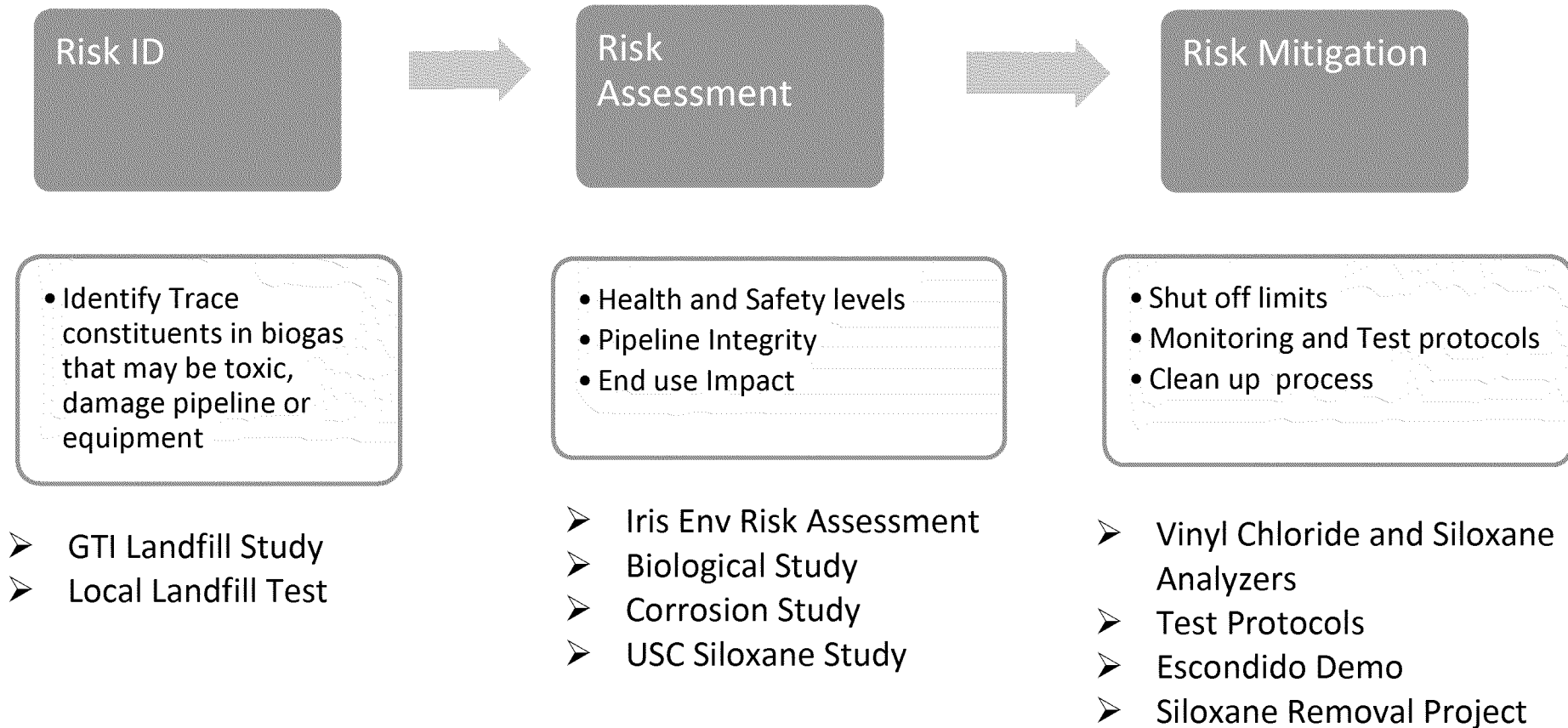
Southern California Gas Company

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Biogas Evaluation for Acceptance Plan



Note: These items are examples of studies that have been performed by GTI, outside consultants, and SoCalGas to date. IT should be noted that although data obtained from these studies is not conclusive, it does provide valuable information to identify, assess, and mitigate the risks associated with the biogas acceptance

Identification of Trace Constituents

- From GTI Landfill Study of Conditioned Biogas:
 - 10 landfill sites in the US tested between 2009-2011 (locations are unknown due to confidentiality)
 - New Constituents – Not found in Natural Gas
 - Trace Constituents (at higher concentrations than found in Natural Gas)

- From 4 Local Landfill testing of Raw Biogas
 - Age of landfill: 52 to 56 years
 - New Constituents (Trace)
 - No PCBs and Pesticides detected

Health and Safety Definition of Terms

- Action Level – SoCalGas levels listed in SoCalGas Biomethane Guidance document used to test for presence in gas. If above this level, then it triggers additional tests and risk assessment.
- Shut-Off Limit – Levels to be developed by CPUC with deference to OEHHA/CARB



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Identification of Trace Constituents Not found in Natural Gas

Compounds in Raw Biogas	Compounds in Raw Biogas and Conditioned/Biomethane
Chloroethane (ethyl chloride)	Dichlorodifluoromethane (CFC-12)
Tetrachloroethene (PCE)	Decamethylcyclopentasiloxane
Vinyl Chloride	Chromium
Propene	Copper
Trichloroethene (TCE)	Manganese
1,4 Dichlorobenzene	Zinc
Antimony	

Source of data: GTI Landfill, Wastewater, Dairy Gas Studies, SCG Landfill and Wastewater studies

Identification of Trace Constituents At Higher Concentrations than in Natural Gas

Compounds in Raw Biogas with higher concentration than in Natural gas	Compounds in Raw Biogas and Conditioned/Biomethane with higher concentrations than in Natural Gas
Naphthalene	Acetaldehyde
1,2,4-Trimethylbenzene	
1,3,5-Trimethylbenzene	
p-Isopropyltoluene	

Risk Assessment – Health and Safety

- The health and safety acceptable levels for trace constituents identified are calculated:
 - Recently identified trace constituents from GTI Landfill testing and other studies were sent to Iris Environmental consultants to determine health protective levels
 - Biological consultant –Evaluate potential presence of microorganisms in biogas/biomethane and evaluate associated potential health risks

Risk Assessment – Pipeline Integrity

- Pipeline Integrity Impacts
 - Identified potentially corrosive constituents from landfill and wastewater biogas studies and test results.
- Evaluate equipment pieces that have been already exposed to landfill gas
- Install metallic pipeline material (corrosion coupons) at Landfill

Risk Assessment – End use Equipment

- Siloxanes upon combustion will convert to silica deposits on end-use equipment, including vehicle components, resulting in potential failures.

- USC kinetics study of siloxane decomposition to silica
- USC testing of furnace
- USC testing of engine and catalyst

- GTI testing of waterheater
 - Test in progress
- GTI testing of stove – concerns on particulates in air
 - Test in progress

Risk Mitigation – Biogas Testing and Monitoring

- Historically, SoCalGas has demonstrated a very robust testing and monitoring process whereby each biogas supplier's source gas is evaluated for potential pipeline injection.
- On a case by case basis SoCalGas develops a testing and monitoring program for specific constituents of concern
- ✓ This process will ultimately control which constituents have a likelihood, if any, of entering the SoCalGas pipeline Distribution or Transmission system.

Risk Mitigation – Monitoring and Testing

- To control the risk, on-line analyzers can be used to monitor the levels and deny access as required
 - Currently no real-time analyzers available. SoCalGas is evaluating:
 - Vinyl Chloride Analyzers
 - Siloxanes Analyzers
- Other on-line analyzers necessary for biogas
 - Gas chromatograph (hydrocarbons, inerts, sulfurs)
 - H₂S, CO₂, H₂O, O₂ analyzer
- Limits for siloxanes and 'constituents of concern' that have potential for health and safety risk are currently being evaluated by Iris Environmental.

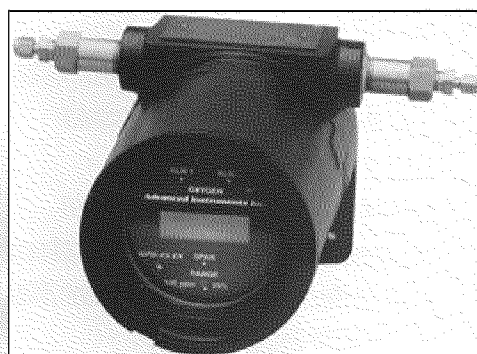
Risk Mitigation – Health and Safety Facility Start up Testing - Methodology

- **The 1st step** in the process is SoCal Gas determines how the raw biogas is generated and processed at the biogas supplier's site. We evaluate the process for consistency and repeatability.
- **The 2nd step** is to test/screen both the raw and processed/conditioned biogas for various constituents to identify which constituents exist and what concentrations are being measured in order to obtain baseline gas quality information.
- **The 3rd step** in this process is to require the biogas conditioning vendor to design/develop a biogas conditioning system that is fully capable of conditioning the raw biogas to meet Rule 30 limits and SoCalGas' established constituents' action levels.

Risk Mitigation – Health and Safety Facility Start up Testing - Methodology



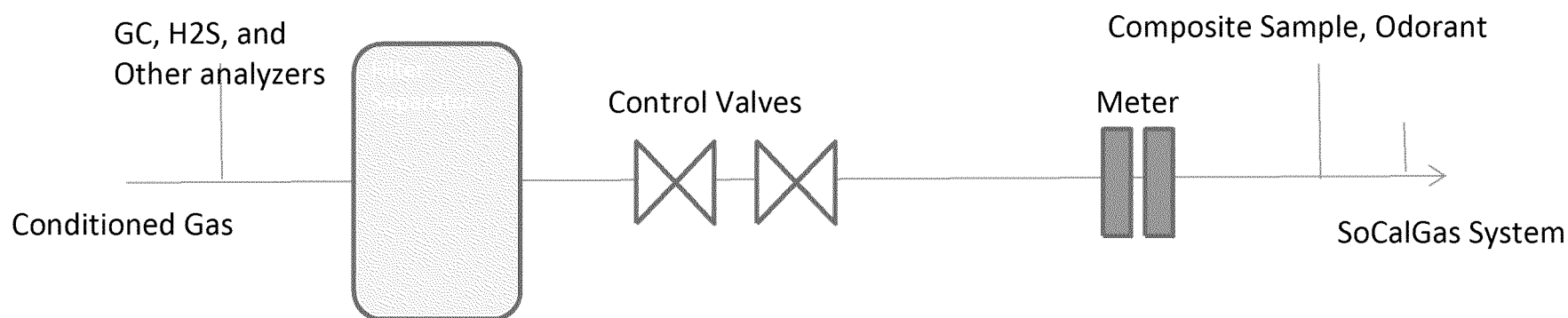
- » **The 4th step** is SoCalGas installs appropriate GC, carbon dioxide, oxygen, moisture, and hydrogen sulfide continuous monitors downstream of the conditioned biogas production point for direct monitoring and control.



Risk Mitigation – Health and Safety Facility Start up Testing - Methodology

The 4th step ...

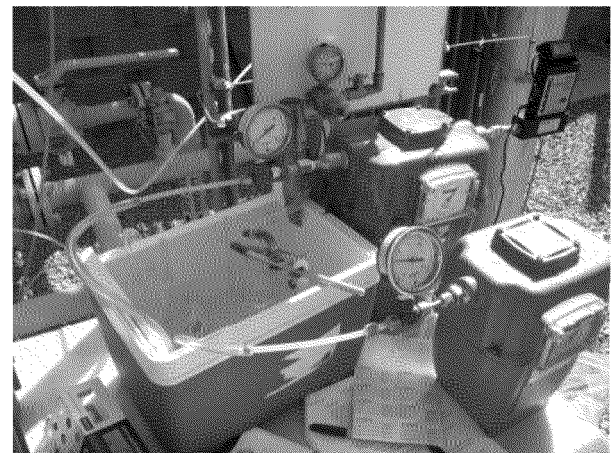
If an upset occurs at the biogas supplier's plant and/or in the conditioning system and the aforementioned compounds exceed the set limits, the supplier will be shut off and it is highly unlikely that these constituents present in the conditioned gas would enter into the SoCalGas system at unacceptable levels.



Risk Mitigation – Health and Safety Facility Start up Testing - Methodology

- **The 4th step ...**

In addition, before the conditioned biogas flows into our system, SoCalGas conducts continuous 24-hours startup testing to ensure that conditioned/biomethane meets Rule 30 limits including 'constituents of concern' action levels.



Risk Mitigation – Health and Safety Facility Start up Testing - Methodology

- **Finally**, during the 24-hours testing window, if constituents are detected at or near the SoCalGas' established action level, the biomethane will be routinely tested for those suspected constituents on a frequent basis (at a cost borne by the biogas supplier).
- SoCalGas may install additional on-line analyzers that will be programmed to alarm at the shut off limits and trigger the supplier valve to close, thus preventing suspected constituents from entering into SoCalGas distribution or transmission system.

Risk Mitigation / Assessment

Risk Impact (vertical axis)

High	Annually	Periodic (Monthly)	Online Monitor, Periodic (Daily, Weekly)
Medium	Start up	Periodic (Quarterly)	Periodic (Monthly)
Low	Spot	Startup	Periodic (Quarterly)
	Low	Medium	High

Probability of Occurrence (horizontal axis)

Risk Mitigation / Assessment

