

**GEYSERS POWER COMPANY
UNIT 12**

**TITLE V PERMIT RENEWAL EVALUATION
STATEMENT OF BASIS**

INTRODUCTION:

Title V of the 1990 Clean Air Act Amendments requires all major stationary sources of air pollution to apply for a federal operating air permit which consolidates all applicable regulations and requirements into one document. In the state of California implementation of the Title V program has been delegated to the local air pollution control districts.

Geysers Power Company, LLC (GPC) has 12 geothermal power plants located in the Northern Sonoma County Air Pollution Control District (NSCAPCD) which are subject to the Title V permitting requirements. This Title V permit renewal evaluation is for GPC Power Plant Unit 12 which was issued an initial Title V Permit on June 18, 1998 and was renewed on April 8, 2008. Under the Title V program, permits are renewed every 5 years.

There have been no changes to the facility since the last Title V permit renewal.

PROCESS DESCRIPTION:

Geothermal steam, a naturally occurring resource in the Geysers area of Sonoma County, is collected from wells drilled from three to ten thousand feet into the geothermal reservoir and transported via pipelines to the power plants where the steam is expanded across turbines to produce electricity. The steam passes from the turbines through condensers and is condensed into water. The condensed water is sent to a cooling tower where residual heat is transferred to the ambient air, cooling the water. The cooled water is used to condense steam once again completing the cycle. More steam is condensed than is needed in the cooling water cycle. This additional condensate is referred to as "blowdown" and is reinjected into the ground to replenish the steam field.

Geothermal steam consists of a small amount of gasses which do not condense with the steam. The non-condensable gasses include hydrogen sulfide (H₂S), an odorous gas, which is treated at the power plants and CO₂ which is released to the atmosphere as part of the process.

Unit 12 utilizes several abatement systems to treat H₂S emissions from the process. The primary system consists of a burner/scrubber which oxidizes the H₂S in the non-condensable gas stream to sulfur dioxide (SO₂). The SO₂ is scrubbed in the after condenser (scrubber) with cooling tower water to reduce SO₂ emissions to the atmosphere. The treated gas stream is vented through the cooling tower to the atmosphere. Approximately 50% of the H₂S is removed in the non-condensable gas stream. The remaining 50% is absorbed in the steam condensate. In order to minimize H₂S offgassing in the cooling tower an abatement solution, iron chelate, is added to the condensate to convert the H₂S in the condensate to sulfur salts. These sulfur salts are not volatile and are ultimately reinjected with the excess cooling water into reinjection wells.

Oxygen enhances the efficiency of the reaction between the iron chelate and H₂S. An air compressor injects air into the circulating cooling water as it leaves the condenser in order to increase the oxygen content in the condensate and accelerate the reaction between the iron chelate and H₂S.

Unit 12 is equipped with a backup H₂S vent gas abatement system which automatically starts in the event the burner/scrubber system trips off line. The backup H₂S system operates by pumping sodium hydroxide (NaOH) to the after condenser. The NaOH increases the pH of the water sufficiently to scrub H₂S from the gas stream. The treated gas stream is vented to the cooling tower where it is released to the atmosphere.

PERMITTING STRATEGY

Unit 12 was issued two local District Authorities to Construct and corresponding Permits to Operate under Applications 76-7 and 87-09. Application 76-7 covered the original power plant construction. In 1987 a hydrogen sulfide abatement system, the burner/scrubber, was added to the power plant to allow more efficient abatement of H₂S in order to comply with District Regulation 1 Rule 455; limitations on H₂S concentrations and emission rates from geothermal power plants. The Title V Operating Permit incorporates permit conditions from the two local Air Pollution Control District Permits to Operate and all applicable requirements, including those federally enforceable into one document. All requirements in the Title V Operating Permit have been labeled either locally (L), State (S) or federally (F) enforceable. Neither Authorities to Construct triggered federal New Source Review (NSR) or the Prevention of Significant Deterioration (PSD) at the time the permits were issued. The plant is not subject to any New Source Performance Standards (NSPS) or the Title IV Acid Rain Program.

EMISSION CALCULATIONS AND ASSUMPTIONS

The maximum emissions allowed from the plant are based on the emission limitations stipulated in the Title V Operating Permit. For the purposes of calculating emissions, the plant is assumed to be operating 24 hours per day, 365 days per year. Historically emissions from the plant are lower than the allowed maximum. All non fugitive

emissions are vented through the cooling tower. Emissions of CO₂e are a consequence of the naturally occurring CO₂ and methane present in the incoming geothermal steam and combustion emissions from the burner unit used to treat the hydrogen sulfide emissions. The burner unit combusts over 99% of the methane to CO₂.

H₂S:

H₂S emissions from the plant are based on the mass emission limits stipulated by Regulation 1 Rule 455(b); 22 kg/hr.

$$(22.0 \text{ kg/hr})(2.2 \text{ lb/kg})(24 \text{ hr/day})(365 \text{ days/yr})(\text{ton}/2000 \text{ lb}) = \mathbf{212 \text{ TPY}}$$

PM:

PM emissions from the plant are based on the mass emission limits stipulated by Regulation 1 Rule 420(d); 40 lb/hr.

$$(40 \text{ lb/hr})(24 \text{ hr/day})(365 \text{ days/yr})(\text{ton}/2000 \text{ lb}) = \mathbf{175 \text{ TPY}}$$

Grain Loading:

Maximum allowed particulate emission rate = 40 lb/hr

Design mass air flow through cooling tower = 61,375,000 lb/hr

$$\text{Grain Loading} = (40 \text{ lb/hr})(7000 \text{ gr/lb}) / (61,375,000 \text{ lb/hr})(\text{lb-mole-air}/28.9 \text{ lb air})(379 \text{ ft}^3/\text{lb-mole air}) \\ 3.5 \times 10^{-4} \text{ gr/ft}^3$$

SO₂:

SO₂ emissions are based on the mass emission limitation stipulated for the burner/scrubber, the lone source of SO₂ from the plant.

$$(9.1 \text{ lb/hr})(24 \text{ hr/day})(365 \text{ days/yr})(\text{ton}/2000 \text{ lb}) = \mathbf{39.9 \text{ TPY}}$$

CO:

CO emissions are based on the mass emission limitation stipulated for the burner/scrubber, the lone source of CO from the plant.

$$(22.3 \text{ lb/hr})(24 \text{ hr/day})(365 \text{ days/yr})(\text{ton}/2000 \text{ lb}) = \mathbf{97.7 \text{ TPY}}$$

NO_x:

NO_x emissions are based on the mass emission limitation stipulated for the burner/scrubber, the lone source of NO_x from the plant.

$$(9.1 \text{ lb/hr})(24 \text{ hr/day})(365 \text{ days/yr})(\text{ton}/2000 \text{ lb}) = \mathbf{39.9 \text{ TPY}}$$

CO_{2e}:

There are no limits for CO_{2e}. Annual CO_{2e} emissions are less than 5,500 tons per year based on material balance.

APPLICABLE REQUIREMENTS

The proposed permit conditions stipulate that the following applicable requirements, including all applicable federal requirements, will be satisfied. All referenced District rules are applicable federal requirements except Rule 455(b) which is an applicable state and local requirement and has been listed in italics.

1. Regulation 1 Rule 400(a) General Limitations-Public Nuisance prohibits a person from discharging from any source whatsoever such quantities of air contaminants or other material which cause injury, detriment, nuisance or annoyance to any considerable number of persons or to the public or which endanger the comfort, repose, health or safety of any such persons or the public or which cause or have the natural tendency to cause injury or damage to business or property. Operation of the power plant within the H₂S limitations stipulated in Regulation 1 Rule 455 precludes the source from becoming a public nuisance.
2. Regulation 1 Rule 410- District Rule 410 limits emissions from any source to Ringelmann 2.0 for a period or periods aggregating more than 3 minutes in any hour. The volume of air and water vapor leaving the cooling tower, the exit point for all emissions from the power plant under normal operating conditions, is 13,414,720 cfm; exceedance of this limit is extremely improbable.
3. Regulation 1 Rule 420- A person shall not discharge particulate matter into the atmosphere from any non-combustion source in excess of 0.2 grains per cubic foot or in total quantities in excess of the amount shown in Table I; 40 lb/hr, whichever is the more restrictive condition. For this source, the 40 lb/hr limitation is the more restrictive condition. The grain loading is calculated to be $3.5 \times 10^{-4} \text{ gr/ft}^3$.

Compliance with this limitation is based on collecting and analyzing the steam condensate for total dissolved and suspended particulates (TDS) and (TSS). The particulate emission rate is calculated by multiplying the total dissolved and suspended particulate concentrations by the cooling tower water flowrate and the drift rate from the cooling tower. "Drift" is the amount of water vapor which is released to the atmosphere from the cooling tower during operation.

4. Regulation 1 Rule 430- Fugitive Dust Emissions are not an issue. The area around the power plant has been paved with asphalt to minimize dust from vehicular activity.
5. Regulation 1 Rule 440-A person shall not discharge into the atmosphere, from any single source of emissions whatsoever sulfur oxides in excess of 1,000 ppm. (See Rule 455(a) for cooling tower exit stack concentration calculations).
6. Regulation 1 Rule 455(a)-No person shall discharge into the atmosphere from any geothermal operation sulfur compounds, calculated as sulfur dioxide, in excess of 1,000 ppmv. The treated "sweet gas" is vented to the cooling tower where it is mixed with the incoming cooling tower air prior to release to the atmosphere. H₂S source test results of the cooling tower indicate H₂S concentrations less than 1 ppmv.

Plant design precludes the release of H₂S in concentrations exceeding the limits of rule 455a and Rule 440.

The Cooling Tower Stack is the emission compliance point for normal operation. The design of the facility is such that it cannot be in violation of conditions 1.3 and 1.4 at the cooling tower stack during normal operations and during any likely or unlikely upset condition.

For example if the abatement system (burner) were to be bypassed (such as in the event of a burner tip transition period or during chemical scrubbing and secondary abatement when the burner is not being operated) any untreated vent gas would be released into the cooling tower, the emission from the cooling tower based on Unit 11 conditions are such that the maximum concentration of H₂S would be only 5 ppm_v. The margin of compliance is 0.5%.

Taking this example a step further (to illustrate a scenario that is not even likely) subsequently shutting down half of the cooling tower cells results in an emission of only 10 ppm_v.

(Example based on Unit 11, which consists of the most extreme case plant conditions):

9 cell tower.

Air flow per cell = 1,500,000 cfm (plant data book)

Total tower flow = 1,500,000 ft³/min * 60 min/hr * 9 cell/tower = 810,000,000 ft³/hr

Molar tower air flow = (810,000,000 ft³/hr) / 359 ft³/lbmol = 2,256,000 lbmol/hr Air

Average vent gas flow = 11,000 lb/hr

Vent gas MW = 32 lb/lbmol

Vent gas molar flow = 11,000 lb/hr / 32 lb/lbmol = 344 lbmol/hr

Vent gas flow divided by cooling tower air flow = 344 / 2,256,000 = 0.00015 =

153 ppm_(v) Vent Gas concentration in cooling tower stack.

Average vent gas [H₂S] = 33,000 ppm_(v)

153 ppm_(v) Vent gas * 33,000 ppm_(v) H₂S in vent gas = 5 ppm_(v) H₂S in cooling tower stack.

Unit 12 has only 1100 lb/hr vent gas flow and only 7500 ppm_(v) Vent gas H₂S.

Unit 12 conditions are such that the maximum concentration of H₂S would be only 0.1 ppm_v. The margin of compliance is 0.01%.

7. *Regulation 1 Rule 455(b)*-No person shall discharge into the atmosphere from any geothermal operation greater than 200 g/MW. For Unit 12, 110 MW, this corresponds to 22.0 kg/hr. A monthly source test of the cooling tower for H₂S emissions is used to verify compliance with this emission limitation.
8. *Regulation 1 Rule 492 (40 CFR part 61 Subpart M)*-Asbestos. In the event asbestos containing material must be removed from the plant, the procedures listed in 40 CFR part 61 Subpart M will be followed.
9. *Regulation 1 Rule 540-Equipment Breakdown*. The operator of this source shall follow the procedures stipulated in Rule 540 in order to petition for breakdown relief.
10. *Regulation 2-Open Burning*. Any type of open burning at the facility shall comply with the requirements of Regulation 2.
11. *Regulation 5-Federal Operating Permit*. Application for and issuance of this operating permit fulfills the requirements of Regulation 5 and 40 CFR part 70, Title V.

12. 40 CFR part 68- Accidental Release Prevention and Management Program. In the event that this stationary source becomes subject to part 68 the operators of the source shall submit a risk management plan (RMP) by the date specified in part 68.10
13. 40 CFR Part 82-Chlorinated Fluorocarbons. The operator of this source shall use proper procedures in recycling chlorofluorocarbons.
14. Regulation 1 Rule 221-Federal Permitting for Greenhouse Gas Emissions. Application for and issuance of this operating permit fulfills the requirements of Regulation 1 Rule 221.

PERIODIC MONITORING AND COMPLIANCE ASSURANCE MONITORING

A combination of periodic monitoring and compliance assurance monitoring (CAM) has been applied to the source in order to assure that the emission limits in the permit are being met and are summarized in the table, "Applicable Emission Limits and Compliance Monitoring Requirements Summary".

The main pollutant of concern is hydrogen sulfide (H₂S). Since early on in the development of the Geysers as an energy source exceedances of the ambient air quality standard for H₂S were common. The 1000 ppmv emission limit of Regulation 1 Rule 455 is continuously monitored when the burner is in operation by means of the continuous compliance monitor (CCM). The CCM reads and records the exit concentration of H₂S from the burner/scrubber. Typical exit concentrations from the burner/scrubber are less than 50 ppmv H₂S. The same monitor reads and records emission concentrations of SO₂. Typical exit concentrations for SO₂ are less than 50 ppmv, well below the limit of 1000 ppmv stipulated in Regulation 1 Rule 400.

In order to demonstrate compliance with Regulation 1 Rule 455(b) for H₂S, a source test is conducted monthly to demonstrate that H₂S emissions are less than the permitted limit of 22 kg/hr. In addition weekly main steam H₂S samples are taken which are used to set the abatement targets at the plant.

Particulate emissions from the cooling tower are calculated every month to verify compliance with Regulation 1 Rule 420. The total dissolved and suspended solids in the cooling tower water are multiplied by the circulating water rate and the drift eliminator rate to determine the particulate emission rate. The particulate emission rate is well below 40 pounds per hour.

Combustion emissions from the burner/scrubber are verified using periodic monitoring. A source test for particulate matter, sulfur dioxide, carbon monoxide and nitrogen oxides is conducted prior to the Title V permit renewal. Emissions of CO2 were included in this year's renewal. Emissions of PM, SO2, CO, NOx and CO2 were 0.39, 0.01, 0.01, 0.05 and 1,108 pounds per hour. Emissions of each pollutant were well below the emission limit for each corresponding pollutant.

Pollutant	Source Test Emission Rate	Emission Limit
PM	0.39 lb/hr	1.8 lb/hr
SO2	0.01 lb/hr	9.1 lb/hr
CO	0.01 lb/hr	22.3 lb/hr
NOx	0.05 lb/hr	9.1 lb/hr
CO2	1,108 lb/hr	N/A

RECOMMENDATION

Issue a Title V Operating Permit Renewal to Geysers Power Company for Geysers Power Plant Unit 12.

By: Alex Saschin, Air Quality Engineer

Date: April 8, 2013

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