

RULE 425 Cogeneration Gas Turbine Engines (Oxides of Nitrogen) - Adopted 8/16/93

I. Purpose

The purpose of this Rule is to require retrofit of oxides of nitrogen (NOx) Best Available Control Technology (BACT) to cogeneration gas turbine engines subject to California Health & Safety Code Section 40918 (b) and compliance with Reasonably Available Control Technology (RACT) NOx limits for cogeneration gas turbine engines subject to 1990 Federal Clean Air Act Section 182(f).

II. Applicability

The provisions of this Rule shall apply to any cogeneration gas turbine engine with a rating equal to or greater than 10.0 megawatts (MW).

III. Definitions

- A. Cogeneration Gas Turbine Engine - an internal combustion gas or liquid-fueled device consisting of compressor, combustor, and power turbine used to power an electrical generator and generate steam (or useful heat).
- B. Dry Low-NOx Combustor - any gas turbine engine combustor using staging, air/fuel premixing or other design features to reduce NOx emissions.
- C. Engine and/or emissions control system operating parameters - key indicators of gas turbine engine and/or emissions control system performance, including ammonia injection rate and catalyst bed temperature for SCR; water (or steam) injection rate; or operating conditions of a dry low-NOx combustor.
- D. Gas-Fired - using gaseous fuel as normal (not standby) fuel.
- E. HHV - higher heating value of fuel.
- F. LHV - lower heating value of fuel.
- G. NOx Emissions Concentration - oxides of nitrogen concentration calculated using the equation in Section VI (or an EPA-approved correlation).
- H. Oil-Fired - using liquid fuel as normal (not standby) fuel.
- I. Rating - manufacturer's continuous electrical output megawatt (MW) specification for a gas turbine-powered cogeneration system.
- J. SCR - Exhaust gas NOx control system utilizing ammonia and a reducing catalyst to convert NOx to nitrogen and oxygen.

K. Thermal Stabilization Period - start up time necessary to bring a cogeneration system heat recovery device up to design temperature, not exceeding two hours.

IV. **Requirements**

The NOx emissions concentration (ppmv) from any cogeneration gas turbine engine subject to this Rule shall not exceed the following limit while operating under load and after the thermal stabilization period:

A. Gas turbine using SCR for NOx control:

| | <u>Gas-Fired</u> | <u>Oil-Fired</u> |
|--|---------------------------|----------------------------|
| RACT limit until January 1, 1997: | 10 | 40 |
| BACT limit on and after January 1, 1997: | $9 \times \frac{EFF}{25}$ | $25 \times \frac{EFF}{25}$ |

B. Westinghouse 251B10 gas turbine with Authority to Construct issued before 1/1/83 using dry low-NOx combustor(s) to meet January 1, 1997 limit:

| | <u>Gas-Fired</u> | <u>Oil-Fired</u> |
|--|----------------------------|----------------------------|
| RACT limit until January 1, 1997: | 96 | 114 |
| BACT limit on and after January 1, 1997: | $20 \times \frac{EFF}{25}$ | $42 \times \frac{EFF}{25}$ |

Percent EFF (efficiency) shall be the higher of EFF₁ or EFF₂ below. An EFF less than 25 shall be assigned a value of 25.

$$EFF_1 = 3412 \text{ Btu/kw-hr} \times 100\% / \text{Actual Heat Rate at HHV, Btu/kw-hr}$$

EFF₁ is the demonstrated percent thermal efficiency of the gas turbine engine only, calculated from the actual heat input (using HHV) without consideration of any downstream energy recovery; calculated at ISO conditions; and measured at peak load.

$$EFF_2 = EFF_{mfr} \times LHV/HHV$$

Where EFF_{mfr} is the manufacturer's continuous rated percent thermal efficiency of the gas turbine engine with air pollution control equipment in operation and using fuel LHV. EFF₂ is EFF_{mfr} after correction from LHV to HHV at peak load.

V. Administrative Requirements

A. Emission Control Plan

The owner or operator of any existing cogeneration gas turbine engine subject to this Rule shall submit to the APCO for approval an emissions control plan, including a schedule of increments of progress to be taken to meet or exceed requirements of Section IV. to comply with the compliance schedule prescribed by Section VII.

An emissions control plan shall be submitted for each cogeneration gas turbine engine subject to this Rule, including:

1. KCAPCD Permit number,
2. Gas turbine manufacturer's name,
3. Gas turbine model number,
4. Rated electrical energy output (MW) and rated heat recovery (Btu/hr),
5. Type of fuel (gas, and/or liquid),
6. HHV for each fuel,
7. Last year's fuel consumption (cubic feet of gas or gallons of liquid per hour),
8. Last year's hours of operation,
9. Heat rate (Btu/kw-hr) calculated using HHV for each type of fuel,
10. Type of emissions control to be applied to engine, and
11. Documentation showing current NO_x emissions concentration.

B. Monitoring and Recordkeeping

The owner or operator of any cogeneration gas turbine engine subject to the provisions of this rule shall:

1. Install, operate and maintain in calibration, equipment approved by the Control Officer, capable of continuously measuring and recording the following:
 - a. Engine and/or emissions control system operating parameters as correlated to NO_x emissions,
 - b. Elapsed time of operation,
 - c. NO_x emissions concentration. The NO_x monitoring system shall meet EPA requirements as specified in 40 CFR Part 60, App. B, Spec. 2, or other systems approved by EPA. The owner or operator shall submit to the Control Officer information demonstrating the emission monitoring system has data gathering and retrieval capability. When this system is not operational, data gathered for Subsection a., above, shall be used to establish NO_x emissions concentration. Continuous NO_x monitoring for gas turbines not using SCR shall not be required until January 1, 1997.

2. Maintain a cogeneration gas turbine engine operating log, including, on a daily basis, actual start-up and stop times, total hours of operation, and type and quantity of fuel used (liquid/gas).
3. Maintain and make available for District inspection at any time all records for a period of two years.

C. Compliance Testing

The owner or operator of any cogeneration gas turbine engine subject to provisions of this rule shall conduct annual testing showing NO_x emissions concentration as defined in Subsection III.G, and demonstrated percent efficiency (EFF) of the gas turbine engine.

D. Compliance Test Methods

1. Oxides of nitrogen emissions shall be determined using EPA Method 7E.
2. Exhaust gas oxygen content shall be determined using EPA Method 3A.
3. HHV and LHV of liquid fuels shall be determined using:
 - a. ASTM D240-87, Standard Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter, or
 - b. ASTM D2382-88, Standard Test Method for Heat of Combustion of Hydrocarbon Fuels by Bomb Calorimeter (High-precision Method).
4. HHV and LHV of gaseous fuels shall be determined using:
 - a. ASTM D3588-91, Standard Practice for Calculating Heat Value, Compressibility Factor, and Relative Density (Specific Gravity) of Gaseous Fuels, or
 - b. ASTM 1826-88, Standard Test Method for Calorific (Heating) Value of Gases in Natural Gas Range by Continuous Recording Calorimeter, or
 - c. ASTM 1945-81, Standard Method for Analysis of Natural Gas by Gas Chromatography.

5. Percent efficiency of the gas turbine engine shall be determined using actual field measurements for gas turbine fuel consumption and power output.

VI. Calculations

NOx emissions concentrations shall be calculated using the following equation:

$$\text{NOx} = (\text{NOx}_{\text{obs}})(P_{\text{ref}}/P_{\text{obs}})^{0.5}(288 \text{ K}/T_{\text{amb}})^{1.53}(e^{19(\text{H}_{\text{obs}}-0.00633)})$$

where:

| | | |
|--------------------|---|---|
| NOx | = | NOx emissions concentration (ppmv) corrected to 15 percent oxygen and ISO standard conditions on a dry basis. |
| NOx _{obs} | = | Measured stack gas NOx emissions concentration (ppmv) corrected to 15 percent oxygen on a dry basis. |
| P _{ref} | = | standard atmospheric pressure (14.7 psia). |
| P _{obs} | = | atmospheric pressure measured at site during testing, psia. |
| H _{obs} | = | absolute ambient humidity measured at site during testing, pounds water per pound dry air. |
| e | = | transcendental constant (2.718) |
| T _{amb} | = | ambient air temperature in K and measured at site during testing. |

VII. Compliance Schedule for Section IV BACT Limits

An owner or operator of a cogeneration stationary gas turbine engine subject to Section IV BACT limits and not currently achieving such limits shall comply with requirements of Section IV in accordance with the following schedule:

- A. By (18 months after rule adoption date), submit to the Control Officer a compliance plan, and a complete application for Authority to Construct for all necessary equipment modifications subject to Rule 201.
- B. By January 1, 1997, demonstrate full compliance.