

Solar Turbines

A Caterpillar Company



Permitting Gas Turbine CHP

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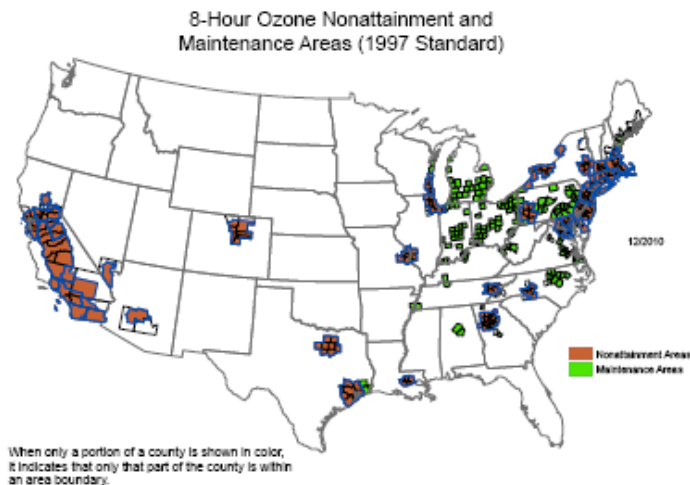


- **Permitting Natural Gas Combustion Should Be Easy!**

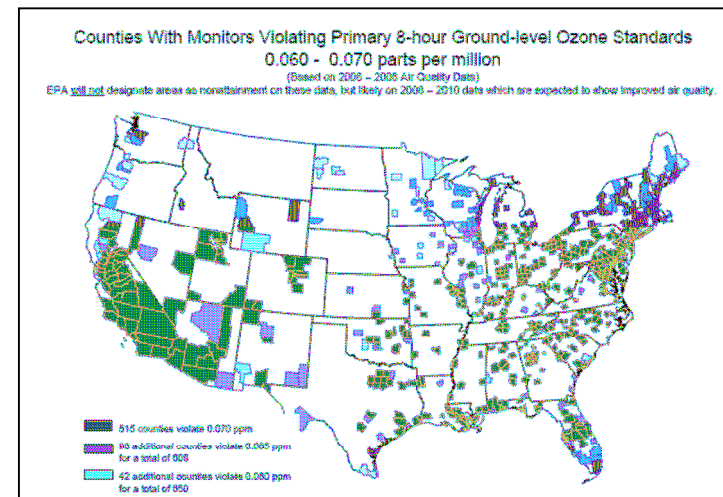




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- Permitting Considerations
 - PSD/Non-Attainment Review/State NSR



The following multi-state nonattainment area, Chicago-Gary-Lake County, IL-IN 8-hr Ozone area, has some states in the area that have been redesignated, but it is not considered a maintenance area until all states in the area are redesignated. The counties for this area are displayed as nonattainment areas.

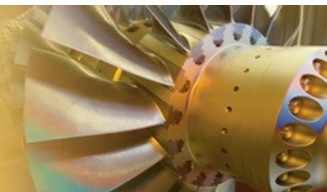




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 - BACT/LAER



Rules of Thumb for Gas Turbines (<25 MW)



Federal

- New Source Performance Standards (NSPS)
 - **25 ppm NOx for NG** and 74 for Other Fuels
- Best Available Control Technology (BACT)
 - **15 to 25 ppm NOx Natural Gas**
 - 60 to 74 ppm NOx Liquid Fuel
 - 15 to 74 ppm NOx on Landfill
 - 15-25 ppm on Landfill Gas
- Lowest Achievable Emission Rate (LAER)
 - **2 - 2.5 ppm NOx Natural Gas**
 - 6 ppm NOx Liquid Fuel
 - 15-25 ppm on Landfill Gas

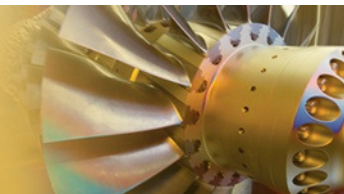
State/Local BACT

- **15 to 25 ppm NOx on Natural Gas**
- 25 to 74 ppm NOx on Liquid Fuel
 - 65 ppm NOx Level Common
- 15 to 74 ppm NOx on Landfill
- CA: 2 to 5 ppm, Natural Gas
- MA: 2 or 2.5 ppm NOx, Natural Gas
- CT: "...We Want Control On Everything..."

SCR Total Capital Investment (TCI) and Cost Effectiveness Estimate

(Purchased Equipment, Direct Installation, CEMs, Indirect Costs)

Turbine Size (MW)	SCR TCI (\$MM)	~\$/ton NOx Removed w/o Duct Firing	~\$/ton NOx Removed w/Duct Firing
~5.7	\$3.2	\$61,000	\$19,000
~7.9	\$3.5	\$56,000	\$17,000
~14.6	\$4.5	\$39,000	\$12,000
~21.7	\$5.2	\$36,000	\$11,000



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 - Tailoring Rule Impact

	PSD Major Source	Title V Major Source	Tailoring Rule Major Source
NOx	250 tpy	100 tpy	45 tpy
CO2e	555,000 tpy	222,000 tpy	100,000 tpy
MW	110	44	19.8

PSD Significance Level (NOx)	Tailoring Rule Major Modification
40 tpy	34 tpy
89,000 tpy	75,000 tpy
17.6	14.9

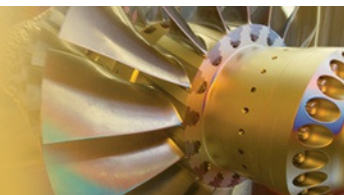
 Program Level

Factor of 5.5!!!

Calculation Basis

	Titan 250 (15 ppm NOx, 38.8% eff, no duct firing)
NOx	49.3 tpy
CO2e	109,400 tpy
MW	21.7

Typical CHP Gas Turbine Emissions Signatures



Turbine Size (MW)	~Unfired Steam (lb/hr)	NOx (tpy)	CO (tpy)	PM (tpy)	CO2e* (tpy)	~Max Fired Steam† (lb/hr)	NOx (tpy)	CO (tpy)	PM (tpy)	CO2e* (tpy)
~4.6 Mercury 50	13,700	3.5	4.3	3.5	23,400	100,000	40	41	12	76,800
~5.7 Taurus 60	29,700	16	16	5.3	35,200	125,000	56	56	14	93,500
~7.9 Taurus 70	36,400	20.4	20.7	6.8	43,500	155,000	70	70	18	115,800
~14.6 Titan 130	64,500	37.4	37.9	12.6	83,200	295,000	130	131	33.5	218,600
~21.7 Titan 250	77,600	49.3	50	16.6	109,400	405,000	180	181	45.9	300,100

* Note CO2e in short tons. Permitting is based on short tons. Reporting programs based on metric tons.

† Assumed 0.08 lb/MMBtu (HHV) duct burner.



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 - Netting
 - Dispersion Modeling
 - NSPS/MACT

NO/NO2 Ratios

SoLoNOx	0.3
Conventional	0.15
Mercury 50	0.15



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- **The CHP Catch 22**
 - Executive Orders and Incentive Programs Encouraging CHP Development
 - GHG Cap and Trade Impacting CHP Use and Development
 - Tailoring Rule Impacting Industrial Development ...including CHP
- **Texas “Gets It”**
 - Permit by Rule for Natural Gas Fired CHP





- **CHP Saves on Energy Costs:** CHP helps U.S. manufacturers be more competitive by efficiently generating electricity and thermal energy on-site (distributed generation). CHP is up to 80% efficient versus historic grid efficiencies well below 50%
- **CHP Lowers the cost of New Generation Capacity:** CHP is a low-cost approach to efficient new generation capacity and does not require additional power transmission investments (power lines).
- **CHP has Low GHG Emissions:** CHP is highly efficient and operates on natural gas or renewable fuels like landfill methane and biogas. With efficiencies up to 80%, CHP minimizes the amount of GHG produced per unit of useful energy. CHP is the most efficient method of burning natural gas to product electric and thermal power.
- **CHP Strengthens Grid Security and Reliability:** CHP is "on-site" power which shelters its users from grid outages caused by natural or human events. CHP can also export electricity to the grid to help supplement central power station capacity.