State of Florida
DEPARTMENT OF ENVIRONMENTAL REGULATION

INTEROFFICE MEMORANDUM

For Routing To District Offices And/Or To Other Than The Addressee	
To:	Loctn.:
To:	Loctn.:
To:	Loctn.:
From:	Date:

TO: Walter Starnes

FROM: Victoria Martinez V.M.

DATE: August 11, 1978

SUBJECT: BACT Determination for FPC Gas Turbines Suwannee River Plant Site - Suwannee County

The study group recommendations considered the four criteria given in the BACT rule: (a) EPA's determinations, (b) technical material available, (c) other state's BACT determinations, and (d) social, economic and energy impacts.

As regards criteria (a) EPA proposed in October, 1977, applicable NSPS for gas turbines. These standards are expected to be promulgated as proposed, in January, 1979. The proposed standards would limit the concentration of nitrogen oxides (NO_x) in the exhaust gases from stationary gas turbines to .0075 percent by volumes (75 ppm) at 15 percent oxygen on a dry basis. The standard would include an upward adjustment factor for gas turbines with thermal efficiencies greater than 25 percent, and also an upward adjustment factor for turbines burning fuels with a nitrogen content greater than .15 percent by weight. Measured NO_x levels would be adjusted to ISO reference conditions (see attached FR).

In addition, the proposed standards would limit the SO_2 emission to 150 ppm by volume corrected to 15 percent oxygen or a fuel content limit of .8 percent by weight. There would be no efficiency adjustment factor or ambient condition correction factor for SO_2 emission, since SO_2 emissions are not affected by gas turbine efficiency or ambient atmospheric conditions (see attached FR).

With respect to criteria (b), the study group relied mainly on the information in the BACT application. Steve Smallwood and the BACT coordinator had the benefit of EPA's (SSEIS) document on gas turbines, EPA 450/2-77-017. Ray Dinardo quoted the February 1977, volume of the APCA Journal on control strategies for emission reductions for gas turbines.

In reference to criteria (c), no other state's BACT's for gas turbines have been reported to EPA's BACT Clearinghouse in Research Trinagle Park.

With respect to criteria (d), the applicant provided information only on the economics of the wet method for NO_x control. The dry method also described is not commercially available. The only control technology listed for SO_2 was distillate fuel not exceeding .5% by weight. The comparative economic impact of other technologies such as lime or soda scrubbing for SO_2 removal or ammonia scrubbing for NO_2 removal were not discussed by the applicant, probably because they are prohibitively expensive.

The study group and the applicant's proposed BACT's are attached.

After carefully examining the study group's recommendations and EPA's proposed standards, I suggest we determine BACT as follows:

NO_x

Emission to be limited according to EPA's proposed NSPS. The emission limit would be 75 ppm by volume corrected to 15 percent oxygen and ISO ambient atmospheric conditions. The standard includes an upward adjustment factor for turbine efficiencies greater than 25% and another for fuel bound nitrogen. NO_x emissions would be limited according to the following equation given in EPA's proposed NSPS,

$$STP = (.0075\ E) + F$$

where:

STP= allowable NO_x emissions (percent by volume at 15 percent oxygen)

E = efficiency adjustment factor = $\frac{14.4 \text{ kilo joules/watt} \cdot \text{hr}}{\text{Actual ISO heat rate}}$

The high efficiencies normally achieved by increasing combustor operating pressure and temperature are accompanied by exponential increases in NO_x. However, as explained in detail on page 10 of Steve Smallwood's recommendation, it is not reasonable to select an exponential efficiency adjustment factor since it would allow for very large increases in NO_x emission for small increases in efficiency, thus the EPA's linear adjustment factor given above. The 14.4 kilojoules per watt-hr corresponds to the heat rate of a gas turbine operating at 25% efficiency.

F = Fuel-bound nitrogen allowance

Fuel-Bound Nitrogen (percent by weight)	F (NO_x - percent by volume)
$N \leq 0.015$	0
$0.015 < N \leq 0.1$	0.04 (N)
$0.1 < N \leq 0.25$	0.004 + 0.0067 (N -0.1)
$N > 0.25$	0.005

The fuel bound nitrogen allowance was included in EPA's NO_x NSPS to provide gas turbine owners the flexibility to fire either premimum or heavy and residual fuel oils. However, unlimited allowance in the NO_x emission limit dependent on fuel-bound nitrogen level could permit extremely high NO_x emissions when firing high nitrogen-containing fuels. Thus EPA had developed the above fuel bound nitrogen allowance which allows a maximum of 50 ppm for fuel with .25 percent nitrogen by weight or above. To adjust measured NO_x emissions at 15 percent oxygen to ISO ambient atmospheric conditions, EPA gives the following correction factor.

$$NO_x = (NO_{x_{obs}}) \left(\frac{P_{ref}}{P_{obs}} \right)^{0.5} e^{19(H_{obs} - 0.00633)}$$

Where:

NO_x = emissions of NO_x at 15 percent oxygen and ISO standard ambient conditions.

$NO_{x_{obs}}$ = Measured NO_x emissions at 15 percent oxygen, ppmv.

P_{ref} = Reference combustor inlet absolute pressure at 101.3 kilopascals (1 atmosphere) ambient pressure

P_{obs} = Measured combustor inlet absolute pressure.

H_{obs} = Specific humidity of ambient air.

e = Transcendental constant (2.718)

Two members of the study group, Robert Kappelmann and Steve Smallwood, suggested a lower standard for NO_x emissions (50 and 60 ppm respectively). The SSEIS document does show in Figure 8-1, 3 simple cycle peaking gas turbines for which these limits are attainable (at water/fuel ratios or 0.52, 0.43 and 0.6). However, only test on 8 simple cycle peaking units or various design configurations are documented in the SSEIS report; Two of these turbines were tested using natural gas only. In setting the emission limit at 75 ppm we allow as EPA has done, for the uncertain valibity of the limited test data available in the SSEIS report.

SO_2

The only available and economically feasible technique for sulfur dioxide control is low sulfur oil. Other techniques for tail gas clean-up cost two to three times as much as the turbine itself. In view of this, I suggest we adopt Florida Power's proposed .5% sulfur oil. This would be equivalent to a 95 ppm by volume standard, 37% below EPA's proposed NSPS of 150 ppm and the sulfur limit on fuel of .8% by weight.

Two members of the study group, Robert Kappelmann and Frank Darabi, recommended use of fuel with .3% S by weight. An economic evaluation of employing lower sulfur oil, 0.30% S rather than the 0.5% S proposed, indicates an increased cost of power produced by the gas turbines. Based on EPA's SSEIS document, a fuel cost increase of about $.27/bbl could be expected. Other private communications indicate it could be higher: 0.42¢/bbl. Using the $.27/bbl differential, the cost of fuel for producing electricity increases by about 1.8%, or about $53.500/unit per year. This cost is equivalent to about 0.6 mills/KW.hr.

The selection of the standard 0.5% S is supported by the previous cost factors. In addition, ambient air SO_2 concentration increases estimated to result from the turbines do not indicate the need of the more stringent standard and increased expense.

HC, CO, Particulates

No standards are proposed for these pollutants. The SSIES document (Chapter 6) shows insignificant impact on ambient air from these pollutant emissions.

Opacity

An opacity standard of less than 20% is proposed. This standard is consistent with the SSIES document and agrees with the recommendation of two of three members of the goup proposing an opacity standard.