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TECHNICAL NOTE:

AIR QUALITY IMPACTS OF VARYING INDIVIDUAL TURBINE HORSEPOWER AT SITES OF PROPOSED NEW TURBINE CAPACITY IN THE PRUDHOE BAY OIL FIELD

Submitted by:

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ARCO OIL AND GAS COMPANY
ON BEHALF OF THE PRUDHOE
BAY UNIT OWNERS

Submitted to:

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION X
AND THE
STATE OF ALASKA DEPARTMENT OF
ENVIRONMENTAL CONSERVATION

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1.0 INTRODUCTION

Sohio Petroleum Company and ARCO Oil and Gas Company recently submitted to EPA Region X, on behalf of the Prudhoe Bay Unit Owners, two PSD applications. The first is entitled PSD Permit Application For The Prudhoe Bay Unit Produced Water Injection, Low Pressure Separation and Artificial Life Projects (The LPS/AL report) and the second, PSD Permit Application For The Prudhoe Bay Waterflood Project (the Waterflood Report).

As discussed in the LPS/AL PSD Permit Application submitted in October 1979, additional combustion turbine power will be required at the three SOHIO gathering centers (GC-1, GC-2, and GC-3), at the Central Compressor Plant (CCP) and at the three ARCO flow stations (FS-1, FS-2, and FS-3) at Prudhoe Bay. Specific turbine ratings and quantities are proposed in the LPS/AL report for each of these seven facilities. (Table 1 reproduces the list of sources, their capacities, and their quantities as listed in the LPS/AL report.) However, for turbines in the 22.6 thousand horsepower (MHP) to 36 MHP range, the Unit Operators may elect to install turbines in quantities and with rated capacities which deviate from those reported in the LPS/AL report. These deviations from the specific turbine capacities reported in the permit application will not, however, result in any changes in the reported overall new turbine capacity required at each of the gathering centers, flow stations, and at the Central Compressor Plant, nor will the total NO_x emissions from the proposed new turbines at each facility change.

The purpose of this report is to determine if variations in individual turbine capacities at the seven Prudhoe Bay Oil Field facilities will cause predicted pollutant concentrations to vary noticeably. Since NO_x is the pollutant emitted in the largest quantities by the proposed new turbines,

TABLE 1

LIST OF ANTICIPATED NEW EMISSIONS SOURCES

Location	Equipment	Rating	Quantity
SOHIO Gathering Center 1	Combustion Turbines	3.5 MHP	2
		1.4 MHP	1
		22.6 MHP	4
	Gas Heaters	42.5 mm Btu/hr	2
		5.0 mm Btu/hr	1
		310.5 mm Btu/hr	1
SOHIO Gathering Center 2	Combustion Turbines	3.5 MHP	2
		1.4 MHP	1
		22.6 MHP	4
		26.6 MHP	3
	Gas Heaters	42.5 mm Btu/hr	3
		310.5 mm Btu/hr	1
		5.0 mm Btu/hr	1
SOHIO Gathering Center 3	Combustion Turbines	3.5 MHP	2
		1.4 MHP	1
		22.6 MHP	4
	Gas Heaters	42.5 mm Btu/hr	2
		5.0 mm Btu/hr	1
		310.5 mm Btu/hr	1
SOHIO Well Pads A, B, C, D, E, F, G, H, J, M, N, Q, R, S, X, Y.	Gas Heaters	10.0 mm Btu/hr	16 (1 per pad)
Central Compressor Plant	Combustion Turbine	25.0 MHP	1
	Gas Heater	26.0 mm Btu/hr*	1
ARCO Flow Station 1	Combustion Turbines	5.0 MHP	2
		36.0 MHP	3
ARCO Flow Station 2	Combustion Turbines	36.0 MHP	4
		5.0 MHP**	2
	Gas Heater	100.0 mm Btu/hr	1
ARCO Flow Station 3	Combustion Turbines	36.0 MHP	4
		5.0 MHP**	2
SOHIO Gathering Centers	Fuel Oil Storage Tanks	42,000 gallons	3 (1 per center)

* Previously permitted by State in June 1979.

**One of these units was previously permitted by the State in June 1979.

differences in predicted annual average NO_2 levels were compared to perform the determination.

2.0 CASES EXAMINED

Annual average NO_2 concentrations predicted for four different turbine capacity cases and for two different pollutant receptors were examined to determine the impact of varying individual turbine capacities at the gathering centers, flow stations and at the Central Compressor Plant. The pollutant source cases examined in the annual modeling analyses are defined below and illustrated in Table 2.

- Case 1 - All sources (existing, previously permitted and new LPS/AL and Waterflood sources) except the 27 new LPS/AL turbines in the 22.6 to 36 MHP range were modeled separately to obtain a "base" concentration.

- Case 2 - All sources in Case I including all proposed new LPS/AL turbines were modeled with stack exit parameters reported in the LPS/AL and Waterflood reports. Modeling results for this case are those reported in the Waterflood permit application.

- Case 3 - All sources in Case 2 were modeled. However, the NO_x emissions from the new LPS/AL turbines in the 22.6 to 36 MHP range at each facility were assumed to be vented through a single turbine stack with a stack height, an exit velocity and a temperature corresponding to a 22.6 MHP unit. Modeling results for this case illustrate the impact on predicted NO_2 levels of the lowest possible effective plume rises expected for the range of turbines examined.

TABLE 2 -- STACK AND EMISSIONS PARAMETERS FOR 27 PROPOSED LPS/AL TURBINES (22.6-36 MHP RANGE) FOR FOUR CASES EXAMINED

Case	Turbine Locations	Stack Height (m)	Volumetric Flow Rate (m^3/s)	Exit Temp (°K)	NO_x EMISSION RATE (g/s) For Proposed LPS/AL Turbines	NO_x EMISSION RATE (g/s) For all Sources
1*	-	-	-	-	-	858.46
2	Gathering Centers	16.7	195 (228)**	830	260.92	
	Flow Stations	26.8	266	768	294.39	1432.35
	Central Compressor Plant	26.8	237	768	18.58	
3	All locations	16.7	195	830		1432.35
4	All locations	26.8	266	768		1432.35

* The 27 proposed LPS/AL turbines not examined for this case.

** Number outside parenthesis applies to 22.6 MHP turbines, number inside parenthesis applies to 26.6 MHP turbines.

- Case 4 - All sources in Case 2 were modeled. However, the NO_x emissions from the new LPS/AL turbines in the 22.6 to 36 MHP range at each facility were assumed to be vented through a single turbine stack with a stack height, an exit velocity, and a temperature corresponding to a 36 MHP unit. Modeling results for this case illustrate the impacts on predicted NO_2 levels of the highest possible effective plume rises expected for the range of turbine sizes examined.

Annual NO_2 concentrations predicted for each of the four cases above are reported for two different pollutant receptor locations. The first is that of the maximum impact due to all existing, previously permitted, and proposed sources, and the second is that of the maximum due to proposed (LPS/AL and Waterflood) sources only.

3.0 ANALYTICAL METHODS

The modeling methods discussed in the LPS/AL and Waterflood permit applications were those used to predict the annual NO_2 concentrations reported here. The Texas Climatological Model (TCM) was used and concentrations were predicted for rectangular receptor grids with 0.25 km grid spacings. Meteorlogical inputs to this model consisted of a joint frequency distribution of stability, wind speed and wind direction developed from surface meteorological observations taken at Barter Island, Alaska for the period, 1958-1964. In this modeling exercise all NO_x was assumed to be emitted as or converted to NO_2. In addition, it was assumed for each facility (gathering centers, flow stations, Central Compressor Plant) that the new LPS/AL combustion turbines were collocated. For consistency with the previous modeling done for the LPS/AL and Waterflood PSD applications Briggs calculated plume rise was reduced to 70% of the calculated level for the turbines.

4.0 RESULTS

The results of the analyses performed are presented in Table 3. Examination of this table shows that maximum predicted annual NO_2 concentrations will not vary significantly due to variations in the individual new turbine sizes proposed for the LPS/AL project. Predicted maximum NO_2 concentrations (excluding background) vary from 68.79 $\mu g/m^3$ (assuming that these turbines are all 22.6 MHP units) to 68.62 $\mu g/m^3$ (assuming that these turbines are all 36 MHP units). Similarly, at the location of maximum impact from proposed (LPS/AL and Waterflood) sources alone predicted maximum annual NO_2 levels range from only 13.71 $\mu g/m^3$ to 13.44 $\mu g/m^3$ for the two different turbine capacity cases. It is also noteworthy that when the 27 proposed LPS/AL combustion turbines in the 22.6 to 36 MHP range are not considered, the maximum predicted annual NO_2 concentrations are only about 1 $\mu g/m^3$ lower at both locations reported in Table 3.

TABLE 3

MAXIMUM PREDICTED ANNUAL NO_2 CONCENTRATIONS ($\mu g/m^3$)

Case	Pollutant Sources Modeled	Concentration at Location of Maximum Impact Due to All Sources*	Concentration at Location of Maximum Impact Due to Proposed Sources Only*
1	All sources except the proposed PWI turbine sources in the 22.6 to 36 MHP range	67.89	12.44
2	All sources (including the proposed LPS/AL turbine sources modeled with stack parameters according to the LPS/AL and Waterflood reports)	68.71	13.56
3	All sources (assuming the proposed LPS/AL turbine sources modeled with 22.6 MHP turbine stack parameters)	68.79	13.71
4	All sources (assuming the proposed LPS/AL turbine sources modeled with 36 MHP turbine stack parameters)	68.62	13.44

* Does not include 1 $\mu g/m^3$ background.

5.0 CONCLUSIONS

The Prudhoe Bay Unit Operators may elect to install at Prudhoe Bay large turbine units (22.6 to 36 MHP range) whose individual horsepower ratings differ from those reported for the large turbines proposed for the three gathering centers, the three flow stations, and for the Central Compressor Plant. However, as long as the total turbine capacity does not change significantly at each of these seven locations, variations in the individual turbine capacities should not significantly effect predicted maximum pollutant levels reported in the LPS/AL and Waterflood permit applications.