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FORT PIERCE UTILITIES AUTHORITY
H. D. KING UNIT 9

PREVENTION OF SIGNIFICANT DETERIORATION (PSD) APPLICATION

B&V PROJECT 16589.070
AUGUST 1990

Black & Veatch
Engineers-Architects

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1.0 INTRODUCTION

On May 1, 1990, the Fort Pierce Utilities Authority (FPUA) was issued a permit (AO 56-175955) by the Florida Department of Environmental Regulation (FDER) for the operation of a 31.6 MW combined cycle gas turbine at the H. D. King power plant in Fort Pierce, Florida. This combined cycle system (Unit 9 and 5) consists of a 23.4 MW natural gas fired combustion turbine generator, steam generator, and an 8.2 MW condensing steam turbine. Unit 9 commenced operation in early 1989; the final operating permit was issued in early 1990.

In the Unit 9 construction permit, the operating hours for the existing H. D. King Units 6, 7, and 8 were restricted such that the net increase of all regulated pollutants were below Prevention of Significant Deterioration (PSD) significant emission increases. Therefore, Unit 9 was previously not subject to PSD regulations. Due to increased electricity demands, it is now necessary to remove the operational limitation for Units 6, 7, and 8 that were imposed in the original Unit 9 permit. If the Unit 9 permit operational restrictions on Unit 6, 7, and 8 are removed, then Unit 9 requires repermitting subject to PSD regulations.

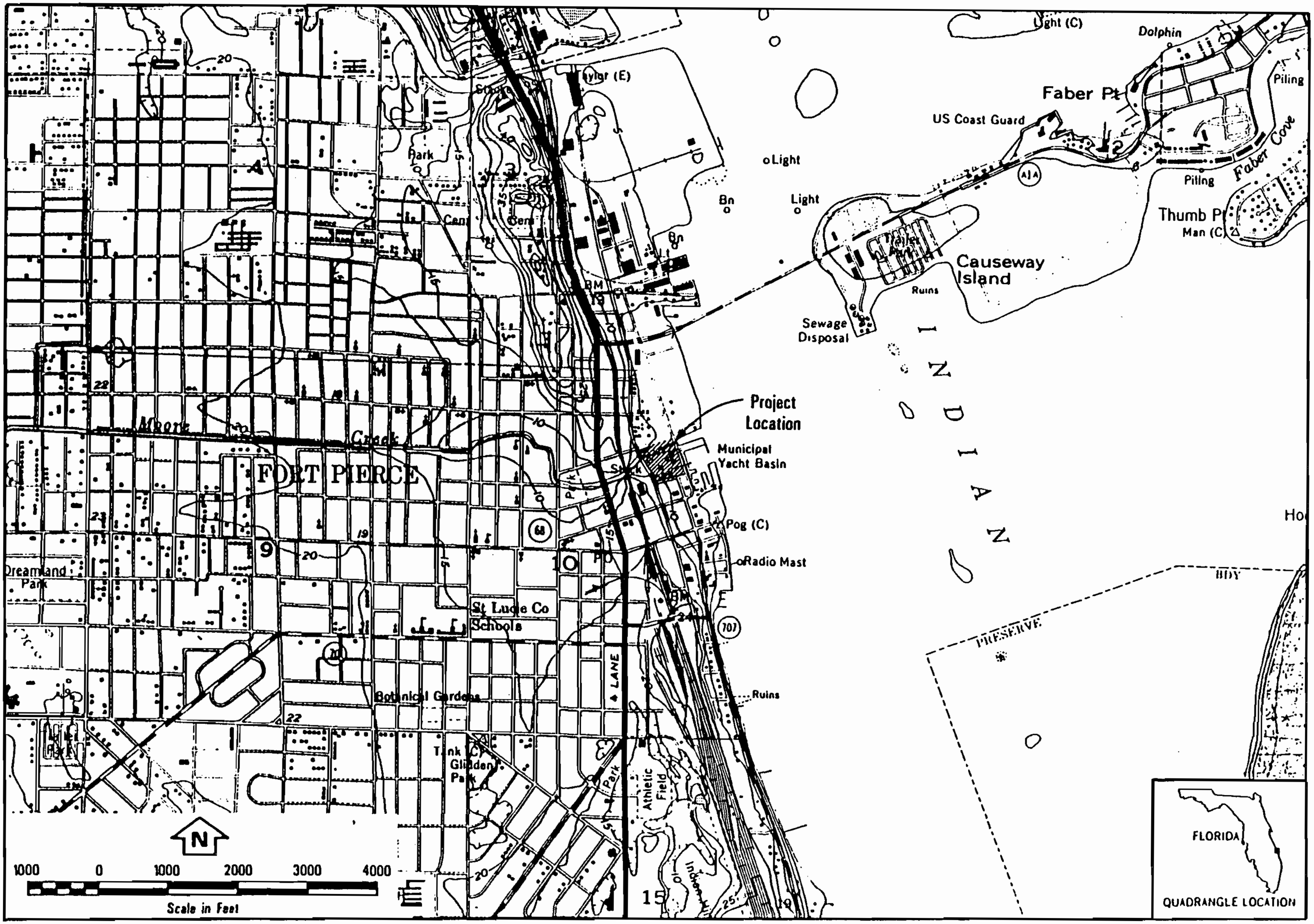
This report describes the PSD applicability and modeling methodology for air quality permitting of the Unit 9 combined cycle system. The permit methodology assumes that Units 6, 7, and 8 can operate at the levels described in their respective permits (AO-56-113534, AO-56-112679, and AO-56-112678). The purpose of this analysis is to demonstrate that the combustion turbine will not cause or contribute to an exceedance of any national or state ambient air quality standards and will not consume more than the applicable amount of Prevention of Significant Deterioration (PSD) air quality increment. A Workplan which described the proposed methodology to be followed in this analysis was discussed with the appropriate FDER staff on July 24, 1990.

2.0 PROJECT DESCRIPTION

The FPUA Project is located in St. Lucie County, Florida, on land currently owned by the FPUA. The land is zoned M-1 and is adjacent to the Indian River. A project site location map is shown in Figure 2-1. The approximate Universal Transverse Mercator (UTM) coordinates of the facility are: 566.8 kilometers (East) and 3,036.3 kilometers (North). The project site arrangement is shown in Figure 2-2.

The combined cycle system includes a 23.4 MW combustion turbine (CT), a steam generator, and an 8.2 MW condensing steam turbine. The CT will burn natural gas as the primary fuel. No. 2 fuel oil (distillate) will only be used as emergency backup fuel. Emergency fuel is defined in Subpart GG, Standard of Performance for Stationary Gas Turbines, 40 CFR 60.331.

less than 15 days



Base Map Source: USGS,
Fort Pierce, FL Quadrangle, 1983

PROJECT SITE LOCATION

Figure 2-1

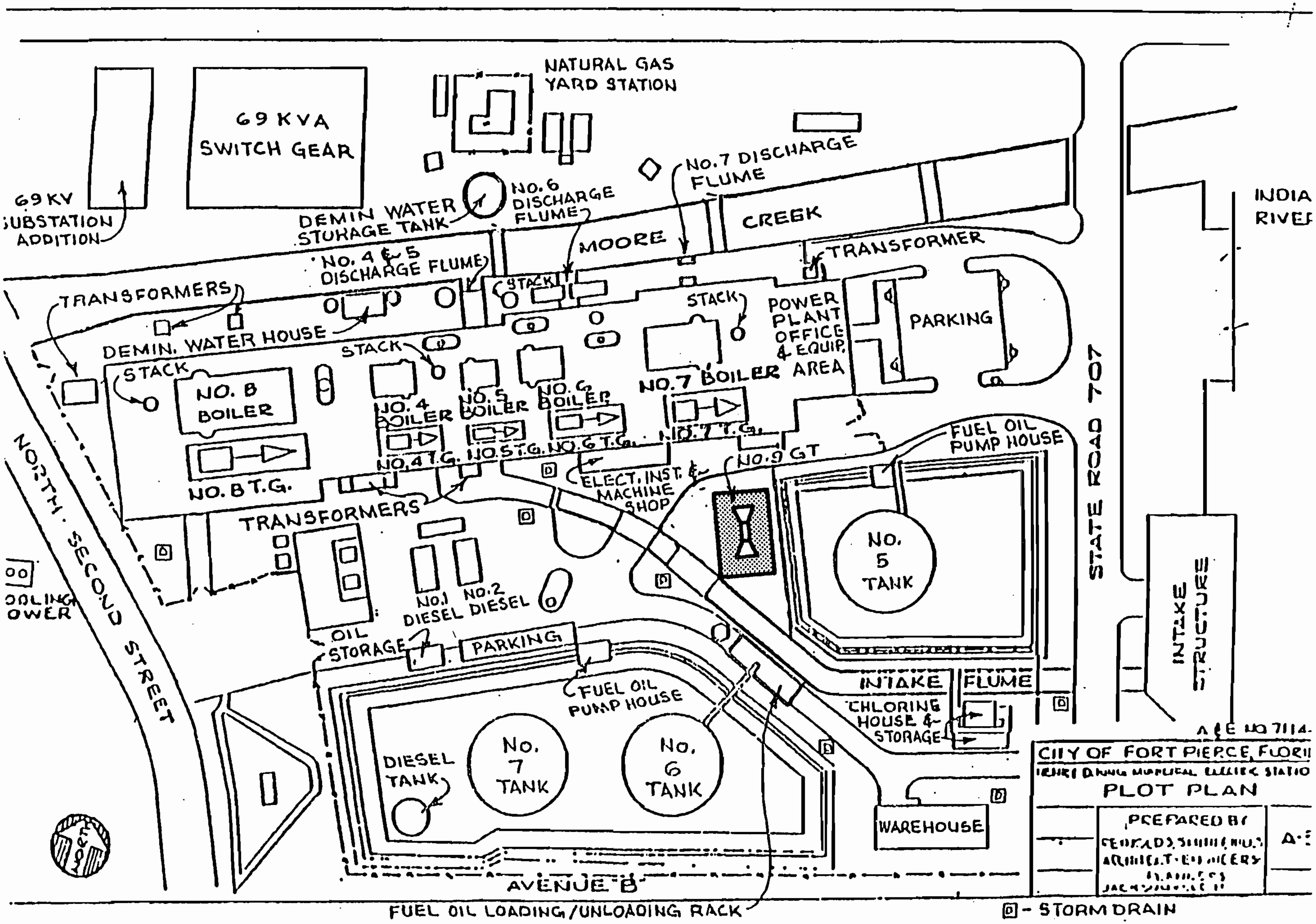


FIGURE 2-2. SITE ARRANGEMENT

3.0 APPLICABILITY ANALYSIS

For PSD regulations to be applicable, a source must be considered a new major stationary source or a major modification to an existing facility. In addition, the source must be located in an area which is designated as "attainment" or "unclassifiable" for at least one pollutant emitted by the source and regulated under the Clean Air Act. If a source is determined to be subject to PSD regulations, then each regulated pollutant that is emitted in excess of designated "significant emission rates" is subject to additional PSD review. Additional review includes a Best Available Control Technology (BACT) analysis, an Ambient Air Quality Impact Analysis (AAQIA), and additional impacts analysis, as appropriate.

3.1 CURRENT AIR QUALITY STATUS

The project site is located in St. Lucie County. This area is currently designated as attainment or unclassifiable with regard to carbon monoxide (CO), particulate matter (PM_{10}), nitrogen oxides (NO_x), ozone (VOCs) and sulfur dioxide (SO_2).

An area is designated as "attainment" for a pollutant if ambient air quality standards for that pollutant are being met and "nonattainment" if they are not. An area is designated as "unclassifiable" for a pollutant if the attainment status cannot be determined. Unclassifiable areas will be considered in attainment for this PSD analysis.

The nearest nonattainment area is Palm Beach County, which is designated nonattainment for ozone. This area, located over 50 km from the H. D. King site, is not anticipated to be significantly impacted by the proposed project.

3.2 SOURCE APPLICABILITY

A major stationary source is defined as any one of 28 source categories listed in 40 CFR 52.21 which emits, or has the potential to emit, 100 tons per year or more of any regulated pollutant. In addition, any stationary source not listed in 40 CFR 52.21 which emits 250 tons per year (tpy) or more of any regulated pollutant is also considered a major stationary source. The existing Unit 6, 7, and 8 boilers can be categorized in one of the 28 listed source categories. These boilers emit at least 100 tpy of a criteria pollutant and are thus considered to be a major existing source.

A major modification is defined as any physical or operational change in a major stationary source that would result in a significant net emissions increase of any regulated pollutant. The previous permit for Unit 9 restricted the operational hours of Units 6, 7, and 8 such that the net emission increases were below PSD significant levels. The emission calculations were based on net emission increases from Unit 9 minus the net emission decreases resulting from the operational limitations of Units 6, 7, and 8.

Due to increased energy demands, it is necessary to remove operational restrictions on Units 6, 7, and 8. Therefore, the emission credit can no longer be taken for the contemporaneous decreases in emissions for these units. Thus, the net increases from Unit 9 alone must be compared to the PSD significant emission rates.

The significant emission rates and Unit 9 emissions are given in Table 3-1. The annual emissions are based on Unit 9 operating at maximum load for 8,760 hours per year. The NO_x emissions are based on 42 parts per million on a dry volume basis (ppmvd), referenced to 15 percent oxygen. As shown in the table, Unit 9 emissions of NO_x exceed the PSD significant emission rate. Therefore, the project is considered to be a major modification to an existing major source and is subject to PSD regulations.

3.3 POLLUTANT APPLICABILITY

Once a source is determined to be subject to PSD regulations, each regulated pollutant must be assessed for PSD program applicability. The significant emission rate criteria used to determine source applicability are also used to establish pollutant applicability. Table 3-1 shows that only NO_x has the potential to be emitted at levels above the PSD significant emission rates. Thus, NO_x is subject to further PSD review, including a BACT assessment and an AAQIA.

TABLE 3-1. SIGNIFICANT AND UNIT 9 ANNUAL EMISSION RATES

Pollutant	Significant Emission Rates tpy	Unit 9 Estimated Annual Emissions[a] tpy	Applicable Pollutant Yes/No
Carbon Monoxide (CO)	100	41.6	No
Nitrogen Oxide (NO_x)	40	288.4	Yes
Sulfur Dioxide (SO_2)	40	0.9	No
Particulate (TSP)	25	11.0	No
Particulate (PM_{10})	15	11.0[b]	No
Ozone (VOC)	40	17.5	No
Lead	0.6	<<0.6	No
Asbestos	0.007	<<0.007	No
Beryllium	0.0004	<<0.0004	No
Mercury	0.1	<<0.1	No
Fluorides	3	<<3	No
Sulfuric Acid Mist	7	0.027	No
Vinyl Chloride	1.0	<<1.0	No
Total Reduced Sulfur (TRS)	10	<< 10	No
Reduced Sulfur	10	<< 10	No
Hydrogen Sulfide	10	<< 10	No

[a] Emissions are based on 8,760 hours per year of natural gas firing at full load.

[b] Assumes all particulate less than 10 microns.

4.0 BEST AVAILABLE CONTROL TECHNOLOGY ANALYSIS

4.1 INTRODUCTION

The existing Fort Pierce Utilities Authority H. D. King Electric Generating Plant Unit 9 consists of one 23.4 MW General Electric Frame 5 combustion turbine. The combustion turbine is followed by a heat recovery steam generator (HRSG) manufactured by the Henry Vogt Machine Company. Steam from the HRSG is directed to the 8.2 MW Unit 5 steam turbine for repowering.

The primary fuel for the Unit 9 combustion turbine is natural gas. However, distillate fuel oil may be burned as an emergency back-up fuel. Since distillate fuel oil will only be burned during emergencies this Best Available Control Technology analysis will only consider the combustion of natural gas. Section 3.0 concluded that when natural gas is burned for the maximum project operation (8,760 hours per year), the project's nitrogen oxide emissions are subject to the provisions of the PSD program.

The existing operating permit for Unit 9 limits NO_x emissions to New Source Performance Standards for combustion turbines (40 CFR 60 Subpart GG) of 75 parts per million dry volume (ppmdv) at 15 percent oxygen, corrected for fuel nitrogen content and turbine heat rate, or 84 ppmdv at 15 percent oxygen, whichever is more stringent. Nitrogen oxide emissions from the existing combustion turbine are controlled by steam injection.

Under the federal Clean Air Act, BACT represents the maximum degree of pollutant reduction determined on a case-by-case basis considering technical, economic, energy, and environmental considerations. However, BACT cannot be less stringent than the emission limits established by any applicable New Source Performance Standards (NSPS).

This BACT analysis follows the general requirements of EPA's draft "top down" BACT guidance document. This approach requires that the BACT analysis start by assuming the use of the Lowest Achievable Emission Rate (LAER) control alternative. Other, less efficient emission control technologies are similarly evaluated when LAER is determined to be unreasonable considering the above factors.

4.2 NITROGEN OXIDES EMISSIONS CONTROL

During combustion, two types of NO_x are formed; fuel NO_x and thermal NO_x. Fuel NO_x emissions are formed through the oxidation of a portion of the nitrogen contained in the fuel. Thermal NO_x emissions are generated through the oxidation of a portion of the nitrogen contained in the combustion air. Nitrogen oxides formation can be limited by lowering combustion temperatures, and staging combustion (a reducing atmosphere followed by an oxidizing atmosphere).

4.2.1 Alternative NOx Emission Reduction Systems

A review of the Environmental Protection Agency's BACT/LAER Clearinghouse - A Compilation of Control Technology Determinations (1985 edition and subsequent supplements) indicates that the lowest NO_x emission limit established to date for a combustion turbine is 4.5 ppmdv (at 15 percent oxygen) for a combustion turbine with a heat recovery steam generator located in California. That permit value was based on the use of water injection into the combustion turbine and a selective catalytic reduction (SCR) system contained within the heat recovery steam generator (combined cycle operation). Therefore, the LAER NO_x emission control alternative for use with combustion turbines is established as water or steam injection followed by an SCR system.

Injection of steam into the Unit 9 turbine combustion chamber is capable of limiting NO_x emissions to 42 ppmdv (at 15 percent oxygen) when burning natural gas. Addition of an SCR system downstream of the Unit 9 combustion turbine has the potential to limit NO_x emissions to 9 ppmdv (at 15 percent oxygen).

In addition to combustion controls and addition of an SCR system, NO_x emissions from other types of combustion sources have also been controlled through installation of selective non-catalytic reduction (SNCR) systems such as Thermal $DeNO_x$. However, a SNCR system requires gas temperatures of at least 1,500 F for NO_x reduction. The temperature at the outlet of a combustion turbine is too low (950 F to 1,100 F) for such systems. Since raising the flue gas exit temperature to 1,500 F would require supplemental heating of the flue gas, thereby increasing total emissions from increased fuel usage, this alternative is judged technically unacceptable for application on a combustion turbine.

4.2.1.1 Selective Catalytic Reduction. SCR is a post-combustion method for control of NO_x emissions. The SCR process combines vaporized ammonia with NO_x in the presence of a catalyst to form nitrogen and water. The vaporized ammonia is injected into the exhaust gases prior to passage through the catalyst bed. The SCR process can achieve up to 90 percent reduction of NO_x with a new catalyst. However, an aged catalyst will provide a maximum of between 80 and 85 percent percent NO_x reduction.

The optimum flue gas temperature range for SCR operation is approximately 650 to 750 F. Flue gas from the combustion turbines will typically be 950 F to 1100 F. Therefore, an SCR would be installed in an intermediate point of the existing heat recovery steam generator boiler where a temperature of approximately 700 F occurs. The existing Unit 9 HRSG does not include adequate space to incorporate an SCR system. For an SCR system to be installed downstream of the Unit 9 combustion turbine it will be necessary to split and expand the existing HRSG.

4.2.1.2 Steam Injection. Use of steam injection in the combustion zones of a combustion turbine can limit the amount of NO_x formed. Existing operation of the Unit 9 combustion turbines uses steam injection. Thermal NO_x formation is avoided due to lower combustion temperatures resulting from the steam injection. The degree of reduction in NO_x formation is somewhat proportional to the amount of steam injected into the turbine.

Since the combustion turbine NSPS was last revised in 1982, combustion turbines have improved their tolerance to the water or steam necessary to control NO_x emissions below the current NSPS level. However, there is still a point at which the amount of water or steam injected into the turbine seriously degrades the turbine's reliability and operational life. With the existing turbine design for Unit 9 this generally occurs below a NO_x emission level of about 42 ppmdv (at 15 percent oxygen) when firing natural gas and 65 ppmdv when firing distillate oil. These NO_x emission levels can be achieved with little additional cost and without significant impact on reliability or power output over those costs required to comply with the current NSPS.

4.2.2 Capital and Operating Costs of Alternatives

Table 4-1 presents the capital and levelized annual cost of installing an SCR system within the existing HRSG. Annual operating costs and NO_x emissions are based on natural gas firing for a maximum of 8,760 hours per year in the turbines.

The differential capital costs for the SCR system include the costs of the ammonia storage/injection system, the catalytic reactors, HRSG modifications and balance of plant equipment. In addition to the 1991 equipment costs of the two alternatives, the total capital costs include a contingency charge, escalation, indirect costs, and interest during construction.

Levelized annual costs include operating personnel, maintenance costs (primarily catalyst replacement), ammonia additive, energy, lost generating capacity and fixed charges on capital investment. The differential energy cost and lost generating capacity for the SCR alternative is the result of the reduced net output of the turbine and the energy requirements of associated equipment. Levelized annual costs are based on the following parameters.

- Remaining plant life of 25 years.
- Operator cost of $45,000 per man-year.
- Catalyst life of three years.
- Ammonia cost of $250 per ton.
- Energy cost of 70 mills/kwh.
- Demand cost of $800 per kw.
- Escalation rate of 6 percent.
- Present worth discount rate of 8.0 percent.
- Levelization factor of 1.75.

The 1993 total capital cost for addition of an SCR system to Unit 9 is $3.2 million. The levelized annual cost for addition of SCR is $0.98 million per year. This levelized annual cost results in a removal cost of approximately $4,500 per ton of NO_x reduction (218 tons per year).

TABLE 4-1. NITROGEN OXIDE EMISSIONS REDUCTION SYSTEM CAPITAL AND LEVELIZED ANNUAL COSTS

	SCR SYSTEM $1,000
Capital Costs:	
SCR System	930
HRSG Modifications	590
System Erection	520
Differential Balance of Plant	70
1991 Capital Cost	2,110
Contingency (15 percent)	320
Direct Capital Cost	2,430
Escalation (6 percent)	150
Indirects (16 percent)	410
Interest During Construction (8 percent)	240
1993 Total Capital Cost	3,230
Levelized Annual Costs*:	
Operating Personnel	60
Maintenance	420
Ammonia	70
Energy	40
Lost Generation	40
1993 Annual Operating Cost	630
Fixed Charges on Capital (13.6 percent)	350
1993 Total Annual Cost	980
Nitrogen Oxides Emission Rate, ppmdv	9
Annual NO_x Emission Reduction, tpy	218
NO_x Emission Reduction Cost, $/ton	4,500

*Annual costs are based on a 100 percent capacity factor.

4.2.3 Other Considerations

Compared to the existing combustion turbine with steam injection, the energy requirements of the SCR system would reduce the output of the combustion turbines by approximately one percent.

The use of an SCR system could result in a negative environmental impact due to the release of quantities of unreacted ammonia to the atmosphere. Ammonia and a number of amine compounds are recognized hazardous air pollutants. This represents a potential adverse human health effect, since prolonged exposure to these compounds can increase chances of contracting a number of debilitating diseases. Although ammonia emissions are not regulated nationally, a number of sources are limited to ammonia emissions as low as 10 ppm. Unreacted ammonia emissions from an SCR system could average 7 to 10 ppm, and could create objectionable odor and health hazards.

Ammonia is also a hazardous material. Accordingly, this material must be handled and stored with extreme care. Additionally, some catalytic elements are toxic, and because they have to be replaced periodically, hazardous waste disposal procedures may be necessary.

4.2.4 Conclusions

Installation of an SCR system on Unit 9 designed to meet a NO_x emission limitation of 9 ppmdv would cost Fort Pierce Utilities Authority approximately $3.3 million. Addition of an SCR system increases total levelized annual costs for the project by $1.01 million resulting in a removal cost of $4,640 per ton of NO_x removed while burning natural gas (8760 hrs/yr). The use of SCR would reduce the effective output of the turbine generator by approximately one percent. In addition, the use of an SCR system could result in adverse environmental effects due to unreacted ammonia being released to the atmosphere causing a potential human health hazard. Project emissions of 42 ppmdv do not result in any violation of ambient air quality standards. Therefore, based on economic, energy, and environmental considerations, NO_x BACT proposed for this combustion turbine facility is the use of steam injection to achieve NO_x emissions of 42 ppmdv (at 15 percent oxygen) when burning natural gas. Additionally, it is recommended that during emergency situations where distillate oil must be used NO_x emissions be limited to 65 ppmdv (at 15 percent oxygen) through the use of steam injection.

5.0 MODELING METHODOLOGY

This section describes the modeling methodology for determining the ambient air quality impacts for Unit 9. The methodology is based on FDER and EPA guidelines and used EPA approved dispersion models. The dispersion models have been revised to include the most recent changes associated with EPA dispersion modeling guidelines. The modeling methodology includes a discussion of the GEP stack height, source data, appropriate dispersion models, receptor locations, meteorological data, and the definition of modeling assumptions used in the preliminary modeling analysis.

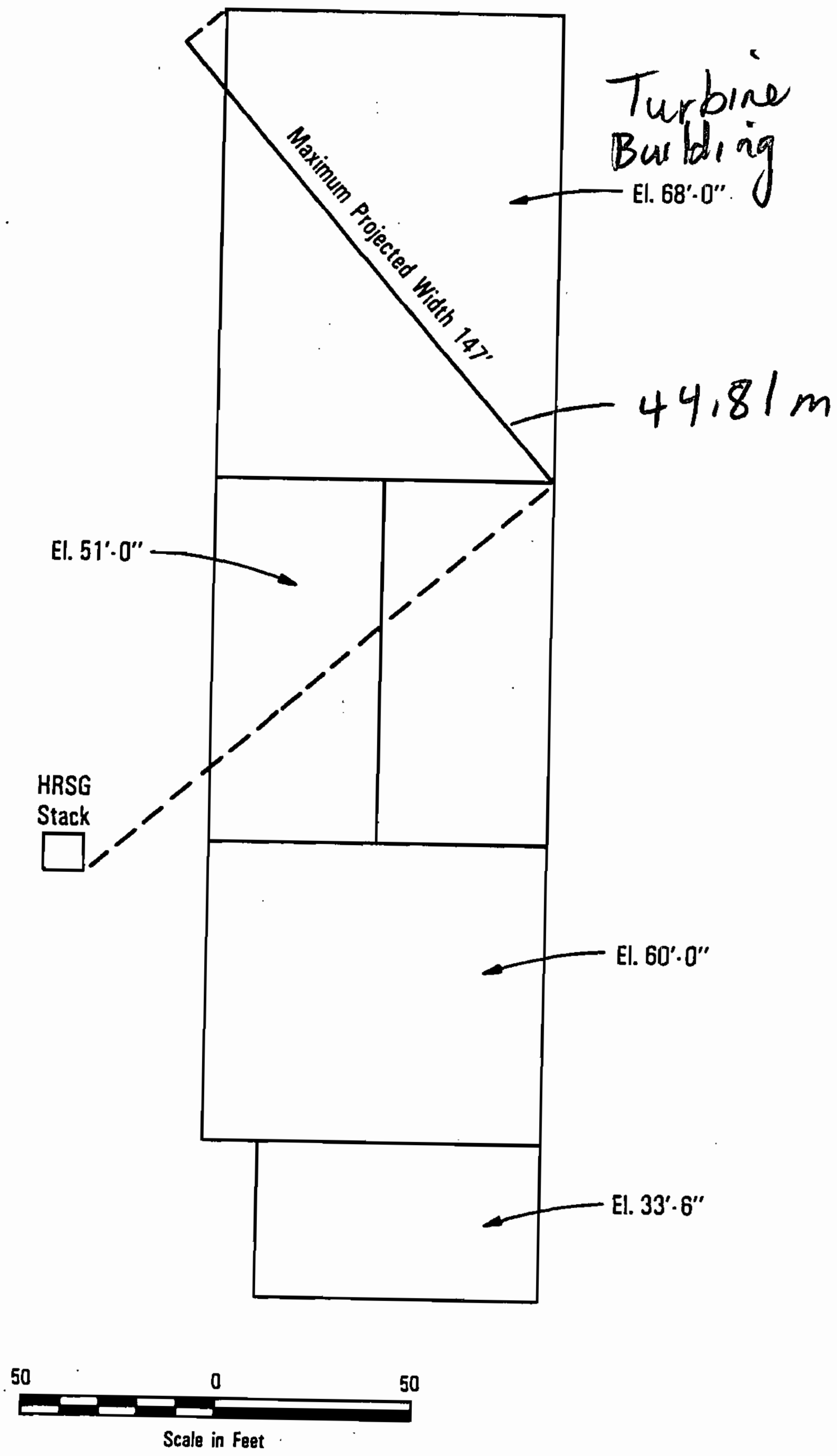
The air quality modeling output files supporting the PSD Permit Application will be submitted to the FDER on diskette and as hardcopy.

5.1 GEP STACK HEIGHT DETERMINATION

A Good Engineering Practice (GEP) stack height is defined as the height at which emissions are not significantly influenced by building downwash. The GEP stack height is calculated as the height of a nearby building plus 1.5 times the lesser of the building height or maximum projected width. A nearby building is defined as one which is located within five times the lesser of its height or maximum projected width from the stack. The resultant GEP stack height is the highest calculated stack height based on all influencing building dimensions.

Emissions from the Unit 9 stack will be influenced by the structures associated with the existing H. D. King facility. The building dimensions and GEP determination are shown in Figure 5-1. The GEP stack height of 170 feet is based on the steam turbine building height of 68 feet, and a maximum projected width that exceeds the height. The bypass and HRSG stacks for Unit 9 are constructed at 60 feet. Because the stack height is less than the calculated GEP height, the effect of building downwash on pollutant dispersion will be incorporated in the modeling analysis. In fact, since the stack height is less than the dominant building height, direction-specific building heights and widths must be used in the refined modeling analysis. Appendix A shows the output of Trinity Consultant's "BRZWAKE" program, which was used to determine direction-specific building dimensions.

68x2.5=
170



GEP STACK HEIGHT DETERMINATION

Figure 5-1

5.2 PROPOSED SOURCE DATA

Unit 9 will fire natural gas as the primary fuel with distillate used as emergency ~~backup~~ fuel. No Modeling was based on natural gas firing assuming 8,760 hours of operation per year at maximum design capacity. Unlike steam generating plants, gas turbines typically operate at maximum (100 percent) load and generally do not operate at reduced load conditions.

The bypass stack will operate only when the HRSG is being serviced. The flue gas exiting the bypass stack is hotter than the HRSG flue gas. Increased thermal buoyancy associated with the bypass stack will enhance plume rise and subsequent dispersion. Thus, impacts from the bypass stack are expected to be less than those from HRSG operation. Therefore, only impacts from HRSG operation were modeled in this analysis.

Modeling parameters for Unit 9 operating in combined cycle and firing natural gas are given in Table 5-1.

5.3 MODEL SELECTION AND DESCRIPTION

For most air quality modeling assessments, it is desirable to use both screening-level and refined dispersion modeling techniques. In this analysis, screening-level modeling was used to determine impacts in the building cavity region. Refined dispersion modeling was used to identify the maximum ambient pollutant impacts, the location of those impacts, and the area which will be significantly impacted by the source.

5.3.1 Screening Modeling

The EPA approved "Screen" model was used to determine the impacts in the building cavity region. This model assumes worst case meteorological conditions to predict maximum 1-hour pollutant impacts. If the cavity region is on FPUA property, then the cavity impacts need not be considered. However, if the cavity region extends beyond the property boundary, then the impacts must be considered in the AAQIA.

5.3.2 Refined Modeling

In order to assess the Unit 9 impacts, the modeling analyses incorporated simple terrain, rural land use, calculation of short-term and annual impacts, and building downwash effects. EPA guideline documents

TABLE 5-1. SOURCE DATA FOR THE UNIT 9 COMBUSTION TURBINE FIRING NATURAL GAS

Model Parameters	Unit 9	
Stack Height, feet	60	18.29 m
Stack Exit Diameter, feet	11.2	3.41 m
Stack Flow Volume, acfm	418,540	
Stack Exit Velocity, fpm	4,271	21.7 ms^{-1}
Stack Exit Temperature, F	491	528°K
Ambient Temperature, F	20	266.33°K
Emissions*		
SO_2 emissions, lb/h	0.2**	
NO_x emissions, lb/h	65.9***	8.3 g s^{-1}
CO emissions, lb/h	9.5	1.2 g s^{-1}
TSP/PM_{10} emissions, lb/h	2.5	0.32 g s^{-1}
VOC emissions, lb/h	4	0.5 g s^{-1}
Model Coordinates, km		
(East - x)	0	
(North - y)	0	
Source Coordinates, km		
(East - x)	566.8	
(North - y)	3036.3	

*Emissions based on manufacturer's performance estimates with natural gas firing.

**The SO_2 emission rate is based on a sulfur content of 2,000 grains of sulfur per million cubic feet of natural gas (AP-42), a heat content of 929.6 Btu/ft^3, and a heat input of 340 MBtu/h.

***The NO_x emission rate is based on 42 ppmvd referenced to 15 percent oxygen.

recommend that the Industrial Source Complex Short-Term (ISCST) dispersion model be used for these modeling situations. EPA has issued guidelines to assist in determining what model options should be used. The following assumptions were made for the modeling analyses:

- The site was considered rural based on actual land use within 3 km. OK
- Standard EPA default modeling options were applied. OK
- Terrain elevations were not used. OK
- Schulman-Scire building downwash with direction-specific building heights and widths were considered. OK
- The highest modeled concentrations were used to represent the annual impacts. OK

Preliminary modeling (see Section 6.0) for determining the Unit 9 significant impact areas and maximum impacts was based on a nominal emissions rate (1 g/s) and a ratio of actual pollutant emissions. That is, individual pollutant impacts were determined by multiplying the nominal impacts by the actual pollutant emission rates (g/s).

5.4 RECEPTOR LOCATIONS

Initial modeling for the Unit 9 stack was performed with receptors placed along the 36 standard radial directions surrounding the Unit 9 stack at the following downwind distances: 100 meter intervals from 100 to 1,000 OK meters, 250 meter intervals from 1,250 OK to 3,000 meters, and 1,000 meter intervals from 4,000 to 10,000 OK meters. Furthermore, discrete receptors were placed at the boundaries that restrict public access along the 36 OK radial directions.

5.5 METEOROLOGICAL DATA

Five consecutive years of meteorological data from a nearby National Weather Service station can be considered to be representative of the dispersion patterns at the site. Specifically, West Palm Beach surface and upper air data for the period 1982 through 1986 were obtained from the FDER and were used for the analysis.

6.0 AIR QUALITY IMPACT ANALYSES

6.1 CAVITY ANALYSIS

The "Screen" model cavity analysis showed that the cavity region extends 33 meters downwind from the source. Since this distance is well within the facility property boundary, cavity impacts were not considered in the ambient impact analysis.

6.2 PRELIMINARY MODELING

Unit 9 was modeled with ISCST and the five years of meteorological data. The modeling was based on the stack parameters and modeling assumptions given in Section 5.0. The results of the modeling were used to determine if a pollutant's impact exceeds PSD significant impact levels, determine whether preconstruction monitoring is required, and establish pollutant significant impact areas.

The results of the preliminary modeling are given in Table 6-1. As demonstrated in Section 3-2, it was only necessary to model NO_x. As shown, the annual NO_x impact (9.6 ug/m3) is predicted to exceed the PSD significant impact level (1 ug/m3) but not the monitoring threshold (14 ug/m3). The maximum impact for each year occurred along the plant boundary. Since the annual NO_x impact exceeds the significance level, interacting source modeling must be performed. b/l

For each applicable pollutant, the extent of the significant impact area must be defined. The radii of significant impact is determined by extending the receptor array outward until the predicted pollutant concentration at a receptor distance is less than the appropriate significance level. The highest modeled annual concentrations were used to determine the significant impact area.

The significant impact area for NO_x was found to extend only 300 meters from the HRSG stack. This radius is small because of the extreme downwash associated with the nearby H. D. King structures.

TABLE 6-1. RESULTS OF THE PRELIMINARY MODELING ANALYSIS

	Unit 9 NO_x Annual Impact
Significant Impact Criteria	1 ug/m3
Monitoring Criteria	14 ug/m3
Maximum Impact*	9.6 ug/m3
Location	
Distance	0.88 km
Direction	260 deg
Year	1984

* Maximum nominal impacts for 1 g/s are 1.15697 ug/m^3 (annual).

6.3 POTENTIAL INTERACTING SOURCES

Since the annual NO_x impact is greater than the PSD significant impact criteria, potential interacting sources must be assessed. The FDER provided copies of the Air Pollution Information System Master Detail Report ("the inventory") for St. Lucie, Indian River, and Martin counties. All sources in these counties that satisfied one of the following conditions were considered potential interacting sources.

- All sources within the Unit 9 NO_x significant impact area (300 meters).
- All sources within 50 kilometers of Unit 9 which have annual NO_x emissions greater than 100 tons per year and show a significant impact in the Unit 9 significant impact area.
- All sources within 10 kilometers of Unit 9 which have annual NO_x emissions greater than 1 ton per year and show a significant impact in the Unit 9 significant impact area.

From the inventory, it is apparent that the only NO_x sources within the 300 meter significant impact area are associated with the FPUA H.D. King power plant. Consequently, the H.D. King Unit 6, 7, and 8 boilers were used in the National Ambient Air Quality Standards (NAAQS) interacting source modeling. However, since the inventory does not indicate that these sources are subject to PSD regulations, they were not used in the PSD increment modeling. The source parameters for these boilers were extracted from the inventory and are listed in Table 6-2.

All 100 ton per year sources within 50 kilometers and 1 ton per year sources within 10 kilometers were extracted from the inventory and are listed below by facility.

- City of Vero Beach Steam Power Plant 1,2,3,4
- Tropicana Products
- Fort Pierce Lawnwood Regional Medical Center
- Minton Sun Citrus Processing Plant
- Fort Pierce Contracting Corporation Asphalt Plant

These facilities were modeled using ISCST and the source parameters listed in the inventory to determine if the significant impact level was exceeded at the FPUA facility. Where possible, the maximum allowable

TABLE 6-2. NAAQS INTERACTING SOURCES

Parameter[a]	FPUA Unit 6	FPUA Unit 7	FPUA Unit 8
East Coordinate[b] (m):	-18.6	6.7	-68.0
North Coordinate[b] (m):	36.3	33.8	18.3
Volumetric Flow (acfm)	42,735	83,333	125,847
Stack Exit Diameter (ft)	5 1.52m	7.1 2.16m	8.0 2.44m
Stack Exit Velocity (fps)	36.3 11.06m	35.1 10.7m	41.7 12.7m
Stack Height (ft)	148 45.11m	128 39.01m	150 45.72m
Exit Temperature (F)	325 436° K	253 396°K	275 408°K
NO_x Emission Rate[c] (lb/h)	1.3 .16 g s	104.4 13.15 g s^{-1}	173.2 21.82 g s^{-1}

[a] Source parameters extracted from FDER source inventory. ✓

[b] Stack coordinates relative to FPUA Unit 9 stack. ✓

[c] Hourly emission rates as stated in FPUA Unit 9 permit. ✓

pounds per hour NO_x emission rate was used in the modeling. However, since the allowable emission rate was not listed in the inventory, the actual NO_x emission rate was used for the Tropicana and Fort Pierce Contracting Corporation sources. The modeling showed that the highest annual NO_x impact from these facilities was ~~0.08~~ .15 ug/m3. Since this impact is well below the PSD significance level of 1.0 ug/m3, these sources were not included in the NAAQS or PSD increment modeling.

6.4 PSD INCREMENT ANALYSIS

PSD regulations were promulgated as a result of the 1977 Clean Air Act Amendments to ensure that air quality in defined areas does not significantly deteriorate or exceed NAAQS while providing a margin for future growth. Currently SO_2, NO_x, and TSP are regulated by the PSD program. The EPA is currently proposing PSD regulations for PM_{10}.

The proposed site is located in a PSD Class II area. Since Unit 9 has significant ambient impacts for NO_x, compliance with the NO_x Class II PSD increment (25 ug/m3) must be demonstrated. As stated in Section 6.3, only the FPUA sources have the potential to significantly interact with Unit 9 impacts. These sources are not considered PSD increment consuming sources. Thus, only the Unit 9 impact was compared to the PSD Class II NO_x increment. As shown in Table 6-1, the Unit 9 annual NO_x impact is 9.6 ug/m3, which is 38.4 percent of the available PSD Class II increment. Consequently, the addition of Unit 9 does not cause an exceedance of PSD Class II increments.

OK

The nearest mandatory PSD Class I area is the Everglades National Park, located approximately 150 kilometers south-southwest of the site. A Class I analysis was not necessary because this area is more than 100 km from the site.

6.5 NAAQS ANALYSIS

To predict the total impact on ambient air quality, a refined air quality assessment must be performed for applicable pollutants. This analysis must show compliance with the applicable NAAQS.

The NAAQS concentration was determined by adding the Unit 9 and additional source impacts to a representative background level. To show compliance with NAAQS, the combined NO_x annual impacts must be less than 100 ug/m3. Identification of interacting NO_x sources for use in demonstrating NAAQS compliance was performed as described in Section 6.3. A representative NO_x background concentration of 24 ug/m3 was obtained from the FDER. This value represents the annual arithmetic mean measured at the West Palm Beach monitor in 1989. Data from the West Palm Beach monitor are considered conservatively high since West Palm Beach is significantly more urbanized than Fort Pierce.

NAAQS modeling was performed following the modeling methodology described in Section 5.0. FPUA Units 6, 7, and 8 were included as the only significant interacting sources. Table 6-3 shows the results of the NAAQS modeling. The maximum combined source impact was 11.3 ug/m3, which occurred along the property boundary. This value was added to the 24 ug/m3 background value to get a total concentration of 35.3 ug/m3. This value is only 35.3 percent of the annual NO_x standard. Consequently, the Unit 9 annual NO_x impacts do not exceed the NAAQS.

TABLE 6-3. NAAQS MODELING RESULTS

Includes All Sources

	NAAQS Modeling Summary
Maximum Impact Location	
Distance	0.88 km
Direction	260 deg
Meteorological Year	1984
Combined Source Maximum Impact	11.3 ug/m3
Background Concentration	24 ug/m3
Total Concentration (Combined Maximum Impact plus Background)	35.3 ug/m3
NAAQS Primary NO_x Standard	100 ug/m3
Percent of Standard	35.3 percent

7.0 ADDITIONAL IMPACT ANALYSIS

7.1 VISIBILITY

The nearest PSD Class I area is the Everglades National Park. The Everglades National Park is located approximately 150 kilometers south-southwest of the project site. Since this area is not within 100 kilometers of the plant site, no visibility assessment is considered necessary.

7.2 SOILS AND VEGETATION

Ambient air quality standards have been established to protect public health and welfare from any adverse effect of air pollutants. It is not expected that the estimated effects of the proposed project will significantly add to the background pollutant concentrations. Therefore, no adverse effects on soils and terrestrial vegetation is expected.

7.3 GROWTH

The operation of the Unit 9 combustion turbine at the H. D. King Power Plant is not expected to induce any secondary growth in the surrounding area.

APPENDIX A

DIRECTION-SPECIFIC BUILDING ANALYSIS

```
RBRZWAKE
IBM-PC VERSION (2.0 )
(C) COPYRIGHT 1989, TRINITY CONSULTANTS, INC.
SERIAL NUMBER 6440 SOLD TO BLACK & VEATCH CONSULTING ENG
RUN NAME: FPHD
RUN BEGAN ON 08-09-90 AT 16:53:32
```

```
NUMBER OF SOURCES =   4


THE FOLLOWING OPTIONS HAVE BEEN CHOSEN:

CALCULATIONS ARE MADE FOR THE ISCST MODEL.

ALL STACKS MUST BE WITHIN 5L TO BE CONSIDERED FOR DIRECTION SPECIFIC DOWNWASH.

DOWNWASH IS CALCULATED IN 36 RADIAL DIRECTIONS.

BUILDINGS ARE COMBINED REPEATEDLY.


                        ALGORITHMS:

               ---------------------------
               0 = NO DOWNWASH
               1 = HUBER-SNYDER DOWNWASH
               2 = SCHULMAN-SCIRE DOWNWASH

               ---------------------------
```

```
                 INPUT BUILDINGS

DESCRIPTION       BLDG #   BLDG HT(M)  # OF CORNERS    X(M)       Y(M)

-------------------------------------------------------------------------------
F.O. TANK 5          1       13.23        10
                                                         39.12        1.51
                                                         42.72       -3.44
                                                         42.72       -9.56
                                                         39.12      -14.51
                                                         33.30      -16.40
                                                         27.48      -14.51
                                                         23.88       -9.56
                                                         23.88       -3.44
                                                         27.48        1.51
                                                         33.30        3.40
F.O. TANK 6          2       12.93        10
                                                          9.72      -47.69
                                                         13.32      -52.64
                                                         13.32      -58.76
                                                          9.72      -63.71
                                                          3.90      -65.60
                                                         -1.92      -63.71
                                                         -5.52      -58.76
                                                         -5.52      -52.64
                                                         -1.92      -47.69
                                                          3.90      -45.80
F.O. TANK 7          3       13.92        10
                                                        -18.91      -46.94
                                                        -15.02      -52.29
                                                        -15.02      -58.91
                                                        -18.91      -64.26
                                                        -25.20      -66.30
                                                        -31.49      -64.26
                                                        -35.38      -58.91
                                                        -35.38      -52.29
                                                        -31.49      -46.94
                                                        -25.20      -44.90
GEN BUILD 68 FT      4       20.73         4
                                                        -33.53        4.88
                                                        -38.71       30.48
                                                        -74.68       22.86
                                                        -69.49       -2.74
GEN BUILD 60 FT      5       18.29         4
                                                         17.37       15.54
                                                         12.19       41.15
                                                        -10.67       36.58
                                                         -5.79       10.67
GEN BUILD 51 FT      6       15.54         4
                                                         -5.79       10.67
                                                        -10.67       36.58
                                                        -38.71       30.48
                                                        -33.53        4.88
GEN BUILD 33.5 FT    7       10.21         4
                                                         28.65       22.86
                                                         24.38       43.89
                                                         12.19       41.15
                                                         16.76       19.81

-------------------------------------------------------------------------------
```

```
                    COMBINED BUILDINGS

STRUCTURE  1 HAS A HEIGHT 20.73 METERS AND CONTAINS THE FOLLOWING BUILDINGS:
             BUILDING # 4:  GEN BUILD 68 FT
STRUCTURE  2 HAS A HEIGHT 18.29 METERS AND CONTAINS THE FOLLOWING BUILDINGS:
             BUILDING # 5:  GEN BUILD 60 FT
STRUCTURE  3 HAS A HEIGHT 15.54 METERS AND CONTAINS THE FOLLOWING BUILDINGS:
             BUILDING # 4:  GEN BUILD 68 FT
             BUILDING # 5:  GEN BUILD 60 FT
             BUILDING # 6:  GEN BUILD 51 FT
STRUCTURE  4 HAS A HEIGHT 13.92 METERS AND CONTAINS THE FOLLOWING BUILDINGS:
             BUILDING # 3:  F.O. TANK 7
STRUCTURE  5 HAS A HEIGHT 13.23 METERS AND CONTAINS THE FOLLOWING BUILDINGS:
             BUILDING # 1:  F.O. TANK 5
             BUILDING # 4:  GEN BUILD 68 FT
             BUILDING # 5:  GEN BUILD 60 FT
             BUILDING # 6:  GEN BUILD 51 FT
STRUCTURE  6 HAS A HEIGHT 12.93 METERS AND CONTAINS THE FOLLOWING BUILDINGS:
             BUILDING # 2:  F.O. TANK 6
             BUILDING # 3:  F.O. TANK 7
STRUCTURE  7 HAS A HEIGHT 10.21 METERS AND CONTAINS THE FOLLOWING BUILDINGS:
             BUILDING # 1:  F.O. TANK 5
             BUILDING # 4:  GEN BUILD 68 FT
             BUILDING # 5:  GEN BUILD 60 FT
             BUILDING # 6:  GEN BUILD 51 FT
             BUILDING # 7:  GEN BUILD 33.5 FT
```

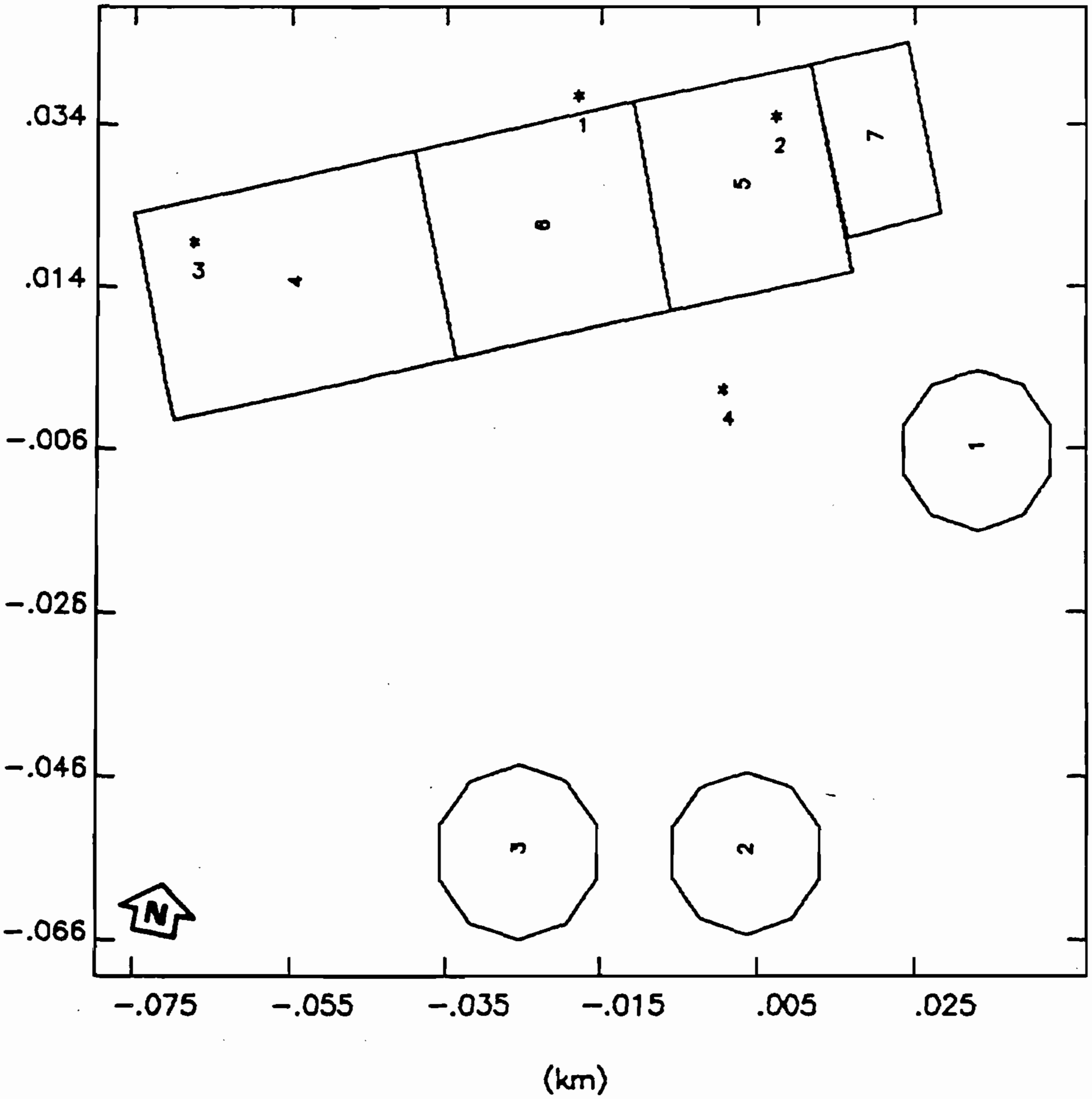
```
                          INPUT STACKS

STACK ID #     STACK #            STACK HT(M)            X(M)        Y(M)

-----------------------------------------------------------------------------
     1             1                 45.11              -18.60        36.30
     2             2                 39.01                6.70        33.80
     3             3                 45.72              -68.00        18.30
     4             4                 18.29                 .00          .00

----------------------------------------------------------------------------
```

FORT PIERCE PLANT SITE



```
      STACK ID #  1,   STACK #  1

        THE DOMINANT STRUCTURE WITHIN 5L IS
  STRUC=   1   H=  20.73   W=  45.29   GEP= 51.81

          DIRECTION SPECIFIC BUILDING DOWNWASH
  DEGREE   STRUCTURE #  HEIGHT      WIDTH       GEP    ALGORITHM

-------------------------------------------------------------------
    10          1        20.73      43.65      51.81       1
    20          1        20.73      44.82      51.81       1
    30          1        20.73      44.63      51.81       1
    40          1        20.73      43.08      51.81       1
    50          1        20.73      40.22      51.81       1
    60          1        20.73      36.15      51.81       1
    70          1        20.73      30.97      51.81       1
    80          1        20.73      27.37      51.81       1
    90          1        20.73      33.22      51.81       1
   100          1        20.73      38.06      51.81       1
   110          2        18.29      34.79      45.72       1
   120          2        18.29      35.39      45.72       1
   130          2        18.29      34.91      45.72       1
   140          2        18.29      33.37      45.72       1
   150          2        18.29      30.81      45.72       1
   160          2        18.29      27.32      45.72       1
   170          2        18.29      23.96      45.72       1
   180          2        18.29      28.04      45.72       1
   190          1        20.73      43.65      51.81       1
   200          1        20.73      44.82      51.81       1
   210          1        20.73      44.63      51.81       1
   220          1        20.73      43.08      51.81       1
   230          1        20.73      40.22      51.81       1
   240          1        20.73      36.15      51.81       1
   250          1        20.73      30.97      51.81       1
   260          1        20.73      27.37      51.81       1
   270          1        20.73      33.22      51.81       1
   280          1        20.73      38.06      51.81       1
   290          2        18.29      34.79      45.72       1
   300          2        18.29      35.39      45.72       1
   310          2        18.29      34.91      45.72       1
   320          2        18.29      33.37      45.72       1
   330          2        18.29      30.81      45.72       1
   340          2        18.29      27.32      45.72       1
   350          2        18.29      23.96      45.72       1
   360          2        18.29      28.04      45.72       1

-------------------------------------------------------------------
```

```
        STACK ID #  2,   STACK #  2

         THE DOMINANT STRUCTURE WITHIN 5L IS
    STRUC=   1   H=  20.73   W=  45.29   GEP= 51.81

             DIRECTION SPECIFIC BUILDING DOWNWASH
    DEGREE   STRUCTURE #  HEIGHT      WIDTH       GEP    ALGORITHM

-------------------------------------------------------------------
     10          2         18.29      31.27      45.72       1
     20          2         18.29      33.55      45.72       1
     30          2         18.29      34.80      45.72       1
     40          2         18.29      35.00      45.72       1
     50          1         20.73      40.22      51.81       1
     60          1         20.73      36.15      51.81       1
     70          1         20.73      30.97      51.81       1
     80          1         20.73      27.37      51.81       1
     90          1         20.73      33.22      51.81       1
    100          2         18.29      33.14      45.72       1
    110          2         18.29      34.79      45.72       1
    120          2         18.29      35.39      45.72       1
    130          2         18.29      34.91      45.72       1
    140          2         18.29      33.37      45.72       1
    150          2         18.29      30.81      45.72       1
    160          2         18.29      27.32      45.72       1
    170          2         18.29      23.96      45.72       1
    180          2         18.29      28.04      45.72       1
    190          2         18.29      31.27      45.72       1
    200          2         18.29      33.55      45.72       1
    210          2         18.29      34.80      45.72       1
    220          2         18.29      35.00      45.72       1
    230          1         20.73      40.22      51.81       1
    240          1         20.73      36.15      51.81       1
    250          2         18.29      29.36      45.72       1
    260          2         18.29      26.89      45.72       1
    270          1         20.73      33.22      51.81       1
    280          2         18.29      33.14      45.72       1
    290          2         18.29      34.79      45.72       1
    300          2         18.29      35.39      45.72       1
    310          2         18.29      34.91      45.72       1
    320          2         18.29      33.37      45.72       1
    330          2         18.29      30.81      45.72       1
    340          2         18.29      27.32      45.72       1
    350          2         18.29      23.96      45.72       1
    360          2         18.29      28.04      45.72       1

-------------------------------------------------------------------
```

```
        STACK ID #  3,    STACK #  3

         THE DOMINANT STRUCTURE WITHIN 5L IS
    STRUC=   1   H=  20.73   W=  45.29   GEP= 51.81

              DIRECTION SPECIFIC BUILDING DOWNWASH
    DEGREE   STRUCTURE #  HEIGHT     WIDTH       GEP     ALGORITHM

----------------------------------------------------------------
      10          1          20.73      43.65      51.81       1
      20          1          20.73      44.82      51.81       1
      30          1          20.73      44.63      51.81       1
      40          1          20.73      43.08      51.81       1
      50          1          20.73      40.22      51.81       1
      60          1          20.73      36.15      51.81       1
      70          1          20.73      30.97      51.81       1
      80          1          20.73      27.37      51.81       1
      90          1          20.73      33.22      51.81       1
     100          1          20.73      38.06      51.81       1
     110          1          20.73      41.74      51.81       1
     120          1          20.73      44.16      51.81       1
     130          1          20.73      45.23      51.81       1
     140          1          20.73      44.93      51.81       1
     150          1          20.73      43.27      51.81       1
     160          1          20.73      40.29      51.81       1
     170          1          20.73      37.40      51.81       1
     180          1          20.73      41.15      51.81       1
     190          1          20.73      43.65      51.81       1
     200          1          20.73      44.82      51.81       1
     210          1          20.73      44.63      51.81       1
     220          1          20.73      43.08      51.81       1
     230          1          20.73      40.22      51.81       1
     240          1          20.73      36.15      51.81       1
     250          1          20.73      30.97      51.81       1
     260          1          20.73      27.37      51.81       1
     270          1          20.73      33.22      51.81       1
     280          1          20.73      38.06      51.81       1
     290          1          20.73      41.74      51.81       1
     300          1          20.73      44.16      51.81       1
     310          1          20.73      45.23      51.81       1
     320          1          20.73      44.93      51.81       1
     330          1          20.73      43.27      51.81       1
     340          1          20.73      40.29      51.81       1
     350          1          20.73      37.40      51.81       1
     360          1          20.73      41.15      51.81       1

----------------------------------------------------------------
```

```
        STACK ID #  4,   STACK #  4

         THE DOMINANT STRUCTURE WITHIN 5L IS
    STRUC=   1   H=  20.73   W=  45.29   GEP= 51.81

            DIRECTION SPECIFIC BUILDING DOWNWASH
    DEGREE   STRUCTURE #  HEIGHT     WIDTH      GEP    ALGORITHM

  ---------------------------------------------------------------
      10          2        18.29     31.27     45.72       2
      20          2        18.29     33.55     45.72       2
      30          2        18.29     34.80     45.72       2
      40          2        18.29     35.00     45.72       2
      50          2        18.29     34.14     45.72       2
      60          2        18.29     32.24     45.72       2
      70          2        18.29     29.36     45.72       2
      80          1        20.73     27.37     51.81       2
      90          1        20.73     33.22     51.81       2
     100          1        20.73     38.06     51.81       2
     110          1        20.73     41.74     51.81       2
     120          1        20.73     44.16     51.81       2
     130          1        20.73     45.23     51.81       2
     140          1        20.73     44.93     51.81       2
     150          2        18.29     30.81     45.72       2
     160          2        18.29     27.32     45.72       2
     170          2        18.29     23.96     45.72       2
     180          2        18.29     28.04     45.72       2
     190          2        18.29     31.27     45.72       2
     200          2        18.29     33.55     45.72       2
     210          2        18.29     34.80     45.72       2
     220          2        18.29     35.00     45.72       2
     230          2        18.29     34.14     45.72       2
     240          2        18.29     32.24     45.72       2
     250          2        18.29     29.36     45.72       2
     260          1        20.73     27.37     51.81       2
     270          1        20.73     33.22     51.81       2
     280          1        20.73     38.06     51.81       2
     290          1        20.73     41.74     51.81       2
     300          1        20.73     44.16     51.81       2
     310          1        20.73     45.23     51.81       2
     320          1        20.73     44.93     51.81       2
     330          2        18.29     30.81     45.72       2
     340          2        18.29     27.32     45.72       2
     350          2        18.29     23.96     45.72       2
     360          2        18.29     28.04     45.72       2

  ---------------------------------------------------------------
```

```
                              STACK #   1
 STACK ID:  1,    BUILDING HEIGHT:  20.73,    BUILDING WIDTH:  45.29
  20.73 20.73 20.73 20.73 20.73 20.73 20.73 20.73 20.73 20.73 18.29 18.29
  18.29 18.29 18.29 18.29 18.29 18.29 20.73 20.73 20.73 20.73 20.73 20.73
  20.73 20.73 20.73 20.73 18.29 18.29 18.29 18.29 18.29 18.29 18.29 18.29
  43.65 44.82 44.63 43.08 40.22 36.15 30.97 27.37 33.22 38.06 34.79 35.39
  34.91 33.37 30.81 27.32 23.96 28.04 43.65 44.82 44.63 43.08 40.22 36.15
  30.97 27.37 33.22 38.06 34.79 35.39 34.91 33.37 30.81 27.32 23.96 28.04
                              STACK #   2
 STACK ID:  2,    BUILDING HEIGHT:  20.73,    BUILDING WIDTH:  45.29
  18.29 18.29 18.29 18.29 20.73 20.73 20.73 20.73 20.73 18.29 18.29 18.29
  18.29 18.29 18.29 18.29 18.29 18.29 18.29 18.29 18.29 18.29 20.73 20.73
  18.29 18.29 20.73 18.29 18.29 18.29 18.29 18.29 18.29 18.29 18.29 18.29
  31.27 33.55 34.80 35.00 40.22 36.15 30.97 27.37 33.22 33.14 34.79 35.39
  34.91 33.37 30.81 27.32 23.96 28.04 31.27 33.55 34.80 35.00 40.22 36.15
  29.36 26.89 33.22 33.14 34.79 35.39 34.91 33.37 30.81 27.32 23.96 28.04
                              STACK #   3
 STACK ID:  3,    BUILDING HEIGHT:  20.73,    BUILDING WIDTH:  45.29
  20.73 20.73 20.73 20.73 20.73 20.73 20.73 20.73 20.73 20.73 20.73 20.73
  20.73 20.73 20.73 20.73 20.73 20.73 20.73 20.73 20.73 20.73 20.73 20.73
  20.73 20.73 20.73 20.73 20.73 20.73 20.73 20.73 20.73 20.73 20.73 20.73
  43.65 44.82 44.63 43.08 40.22 36.15 30.97 27.37 33.22 38.06 41.74 44.16
  45.23 44.93 43.27 40.29 37.40 41.15 43.65 44.82 44.63 43.08 40.22 36.15
  30.97 27.37 33.22 38.06 41.74 44.16 45.23 44.93 43.27 40.29 37.40 41.15
                              STACK #   4
 STACK ID:  4,    BUILDING HEIGHT:  20.73,    BUILDING WIDTH:  45.29
  18.29 18.29 18.29 18.29 18.29 18.29 18.29 20.73 20.73 20.73 20.73 20.73
  20.73 20.73 18.29 18.29 18.29 18.29 18.29 18.29 18.29 18.29 18.29 18.29
  18.29 20.73 20.73 20.73 20.73 20.73 20.73 20.73 18.29 18.29 18.29 18.29
  31.27 33.55 34.80 35.00 34.14 32.24 29.36 27.37 33.22 38.06 41.74 44.16
  45.23 44.93 30.81 27.32 23.96 28.04 31.27 33.55 34.80 35.00 34.14 32.24
  29.36 27.37 33.22 38.06 41.74 44.16 45.23 44.93 30.81 27.32 23.96 28.04
```