INTEROFFICE MEMORANDUM

Sensitivity: COMPANY CONFIDENTIAL

Date: 24-Aug-1999 04:18pm
From: Jeff Koerner TAL
KOERNER_J
Dept: Air Resources Management
Tel No: 850/414-7268 GIC 069

To: Kristine Roselius TAL (ROSELIUS_K @ EPIC5A1 @ DER)
To: Howard Rhodes TAL (RHODES_H)
To: Clair Fancy TAL (FANCY_C)
To: Alvaro Linero TAL (LINERO_A)

Subject: Phone Call From Gainesville Sun Reporter

Here's the Media Contact Sheet for a phone call I received at about 3:30 pm this afternoon.

DEP MEDIA HOT SHEET

EMAIL TO:

TO: Kristine Roselius, Office of Communications
Howard L. Rhodes, Director, DARM
Clair Fancy, Chief, BAR

FAX: 850/921-6227 or SC 291-6227 (Communication Office)

TOPIC: Routine Checking of Owner's Compliance History for All Air Permit Projects

DATE: August 24, 1999 REPORTERS NAME: Ron Maidus(sp?)

FROM: Gainesville Sun TELEPHONE: Unknown
(Newspaper, TV Station, Radio, etc.)

PERSON INTERVIEWED: Jeff Koerner TELEPHONE: 850/414-7268

DIVISION/BUREAU/OFFICE: DARM/BAR, New Source Review Section

DATE OF INTERVIEW: August 24, 1999 (3:30 pm) ACTION TIME NEEDED: None

FOLLOW-UP NEEDED? No

DEADLINE: None

SUMMARY OF CONVERSATION (Use additional pages if necessary)

The reporter asked specifically about a current air permitting project for Florida Power Corporation (FPC) in Intercession City (PSD-FL-268). He was aware of a project to add several new combustion turbine peaking units to the existing facility. We discussed the existing plant capacities and the proposed additional capacities in terms of electrical power production. I briefly described the process of requesting and receiving additional information for this project and that the application appeared to be complete. He asked me when I expected to make a preliminary determination and I replied probably within the next three weeks.

Next, he asked how I intended to determine the compliance history for this particular corporation. I responded that DEP's District office was responsible for determining compliance for the existing facility. In addition, copies of the permit application are available to each District office. No negative comments regarding the compliance history had been received from the District office.

He revised his question to include not just the compliance history for the existing facility, but for FPC in general, the owner of several power plants in Florida. I responded that I was unaware of any ongoing enforcement actions against FPC. He followed this up by asking me to define the normal steps the Department uses to determine whether or not a permit applicant's violation of Department rules is great enough to warrant a denial. He specifically mentioned the Suwanee American cement plant denial. I mentioned that, for some projects, I have used our state database (ARMS) to view the history of enforcement actions for a given applicant. Again, I stated that I was not aware of any ongoing enforcement actions against FPC, but could ask our Compliance/Enforcement staff if he had specific information. He responded that no, that really wasn't what he wanted. He was just trying to better understand the steps that the Department normally takes to ensure a "satisfactory" compliance history before issuing a permit.

We briefly discussed general permits, minor source permits, and major source permits. He asked for the correct spelling of my name, thanked me for my time and hung up.

INTEROFFICE MEMORANDUM

Date: 12-Aug-1999 07:49pm
From: Dee_Morse
Dee_Morse@nps.gov
Dept:
Tel No:

To: Jeff Koerner TAL 850/414-7268 GIC 0 (Jeff.Koerner@dep.state.fl.us)

Subject: Re[2]: US Sugar PSD Application

Further update on Intercession City. Ellen Porter is the lead for sources locating near US Fish and Wildlife Service Class I areas. I found out that Intercession City is a source close to Chassahowitzka NWR, Ellen informed Florida DEP that given the long distance from Intercession City to Chassahowitzka NWR and low emissions, the FWS did not think there would be any significant impacts on resources at the NWR from this source, therefore they informed Florida DEP on 6/9/1999 that they had no comments on this application.

____________________Reply Separator__________________
Subject: Re: US Sugar PSD Application
Author: Jeff Koerner TAL 850/414-7268 GIC 069 <Jeff.Koerner@dep.state.fl.us>
Date: 08/12/1999 1:55 PM

Dee,

Thanks for sending Don's comments early on the US Sugar project. I'll look for modeling comments next week.

I have another project, Florida Power Corp. - Intercession City, that I haven't seen any comments on BACT or modeling yet. It's listed as PSD-FL-268. Of course, it involves three simple cycle conbustion turbines (GE 7EA's). The application was received on May 25, 1999, I requested additional information on June 22, 1999, and I received their information on August 2, 1999. You should have copies of everything. Please let me know if NPS have any comments on this project (or no comments).

Thanks!

Jeff

Received: from epic5.dep.state.fl.us (199.73.143.30) by ccmail.itd.nps.gov with SMTP
(IMA Internet Exchange 2.12 Enterprise) id 00330D0C; Thu, 12 Aug 99 16:12:00 -0400
Received: from epic1.dep.state.fl.us ([199.73.238.11])
by mail.epic5.dep.state.fl.us (PMDF V5.2-32 #31508)
with ESMTP id <01JEOKW8Y37C0020PO@mail.epic5.dep.state.fl.us> for
Dee_Morse@nps.gov; Thu, 12 Aug 1999 14:01:26 EDT
Received: from a1.epic1.dep.state.fl.us by mail.epic1.dep.state.fl.us
(PMDF V5.2-32 #37976) id <01JEOKOKFLBE0000FE@mail.epic1.dep.state.fl.us> for
Dee_Morse@nps.gov; Thu, 12 Aug 1999 13:55:15 -0400 (EDT)
Alternate-recipient: prohibited
Date: Thu, 12 Aug 1999 13:55:11 -0400 (EDT)
From: Jeff Koerner TAL 850/414-7268 GIC 069 <Jeff.Koerner@dep.state.fl.us>

INTEROFFICE MEMORANDUM

Date: 12-Aug-1999 07:19pm
From: Dee_Morse
Dee_Morse@nps.gov
Dept:
Tel No:

To: Jeff Koerner TAL 850/414-7268 GIC 0 (Jeff.Koerner@dep.state.fl.us)

Subject: Re[2]: US Sugar PSD Application

I have not seen the Intercession City PSD application. Where is it locate with regard to Everglades NP?

____________________Reply Separator____________________
Subject: Re: US Sugar PSD Application
Author: Jeff Koerner TAL 850/414-7268 GIC 069 <Jeff.Koerner@dep.state.fl.us>
Date: 08/12/1999 1:55 PM

Dee,

Thanks for sending Don's comments early on the US Sugar project. I'll look for modeling comments next week.

I have another project, Florida Power Corp. - Intercession City, that I haven't seen any comments on BACT or modeling yet. It's listed as PSD-FL-268. Of course, it involves three simple cycle conbustion turbines (GE 7EA's). The application was received on May 25, 1999, I requested additional information on June 22, 1999, and I received their information on August 2, 1999. You should have copies of everything. Please let me know if NPS have any comments on this project (or no comments).

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Jeff

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by mail.epic5.dep.state.fl.us (PMDF V5.2-32 #31508)
with ESMTP id <01JEOKW8Y37C0020PO@mail.epic5.dep.state.fl.us> for
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Received: from a1.epic1.dep.state.fl.us by mail.epic1.dep.state.fl.us
(PMDF V5.2-32 #37976) id <01JEOKOKFLBE0000FE@mail.epic1.dep.state.fl.us> for
Dee_Morse@nps.gov; Thu, 12 Aug 1999 13:55:15 -0400 (EDT)
Alternate-recipient: prohibited
Date: Thu, 12 Aug 1999 13:55:11 -0400 (EDT)
From: Jeff Koerner TAL 850/414-7268 GIC 069 <Jeff.Koerner@dep.state.fl.us>
Subject: Re: US Sugar PSD Application
To: Dee_Morse <Dee_Morse@nps.gov>
Message-id: <C2135IBA2ZY5E*/R=A1/R=EPIC1/U=KOERNER_J/@MHS>
MIME-version: 1.0
Content-type: TEXT/PLAIN; CHARSET=US-ASCII

Florida Power
CORPORATION

RECEIVED

AUG 02 1999

BUREAU OF AIR REGULATION

July 30, 1999

Mr. Al Linero, P.E.
Administrator, New Source Review Section
Florida Department of Environmental Protection
2600 Blair Stone Road
Tallahassee, FL 32399-2400

Dear Mr. Linero:

Re: Florida Power Corporation's Intercession City Facility
Addition of Three New Combustion Turbine Peaking Units
Draft Permit No. 097-0014-003-AC (PSD-FL-268)

Florida Power Corporation (FPC) is in receipt of the Department's letter, dated June 22, 1999, indicating that the application for the above-referenced project has been received and reviewed. The Department has determined that additional information is necessary to continue with the processing of the application. This letter serves to provide responses to the Department's requests in the order they were listed.

Summary of Project- The Department's summary of the proposed project is correct. The only aspect that is not an accurate statement relates to the start-up of the combustion turbines (CTs). FPC had supplied information in the application indicating that the CTs "light off" on oil. This was accurate for the last phase of CTs that were installed at the site and was inadvertently left in the application for the three proposed units. However, with natural gas capability at the site and the dual-fuel capability of the proposed CTs, it is not necessary to start-up or light off the CTs on oil prior to firing natural gas.

Further, the Department has requested that FPC provide a description of the proposed inlet air cooling system and equipment. The system is typically referred to as inlet air "fogging". FPC recently added inlet fogging to the existing four GE 7EA units at the Intercession City. This information is attached as Appendix A.

NO_x BACT Determination- Only one dry low NO_x (DLN) combustor system is available for GE 7EA units. GE refers to the 7EA system as its DLN 1.0. This particular combustor has a proven design that inhibits the formation of NO_x. As requested, FPC is enclosing the manufacturer's description of the combustor design that includes its effects on NO_x formation (Appendix B). The Department also requested documentation concerning the vendor's guarantee to meet the proposed NO_x emission limits of 9 and 42 ppmvd at 15 percent O_2 while firing gas and oil, respectively. FPC has attached the vendor specification sheet for each fuel (Appendix C) containing emissions data with the appropriate guarantees noted.

CO BACT Determination- The Department notes that FPC's application proposes CO emission limits of 25 and 20 ppmvd at 15 percent O_2 for gas and oil firing, respectively. The Department asks FPC to verify that this is the case when, in general, available information for a variety of manufacturers and models of CTs seems to indicate higher CO emissions when firing oil than when firing gas (the opposite of the proposed limits). In response to the Department's comment, FPC again approached the vendor to confirm the CO emissions data. Upon further review, GE has confirmed that the information supplied in FPC's original application is indeed correct, only ***not*** corrected to 15 percent O_2.

Air Quality Impact Analysis- As noted in the Department's letter, the emission rates used in the SCREEN modeling were for a single unit. This was to assess the worst-case conditions for each unit, and one unit was representative since the three units are identical to each other. For purposes of the refined ISCST3 modeling, the simultaneous operation of all three proposed turbines was used as input.

As reflected in the Department's letter, the ISCST3 analysis predicted one exceedance of the 24-hour PSD Class I significance level for SO_2. Following discussions with Mr. Cleve Holladay, it was determined that an additional analysis of the Class I receptor impact would be performed using the CALPUFF model. Golder Associates performed this analysis, and the results show that expected maximum SO_2 impacts from the proposed sources will be well below the Class I significance levels. An analysis report is attached as Appendix D.

Maximum SO2 Emissions Rate- The maximum SO_2 emission rate of 55 lb/hour used in the ISCST3 analysis was provided by the combustion turbine manufacturer (GE). The slightly higher rate of 56.4 lb/hour was inadvertently not included in the subsequent CALPUFF analysis. This small difference will not have a substantive effect on the predicted ambient concentrations. All impacts will remain less than significance levels.

Additional Impacts Analysis- Through discussions with Mr. Cleve Holladay, it was determined that neither the DEP nor the National Parks Service will require a regional haze or visibility analysis for this proposed installation.

NPS Comments- To date, the NPS has not provided any additional comments or questions regarding this application.

Please contact Mike Kennedy at (727) 826-4334 or me at (727) 826-4258 if you have any questions regarding this submittal.

Sincerely,

Scott H. Osbourn
Senior Environmental Engineer

cc: EPA
NPS

Enclosures

cc: Jeffery F. Koerner, P.E., DEP Tallahassee
Chris Carlson, DEP Tallahassee
Len Kozlov, DEP Central District
Robert C. McCann, Jr., Golder Associates

APPENDIX A

INLET FOGGING

POWERFog™

Performance Engineered Combustion Turbine Inlet Air Cooling

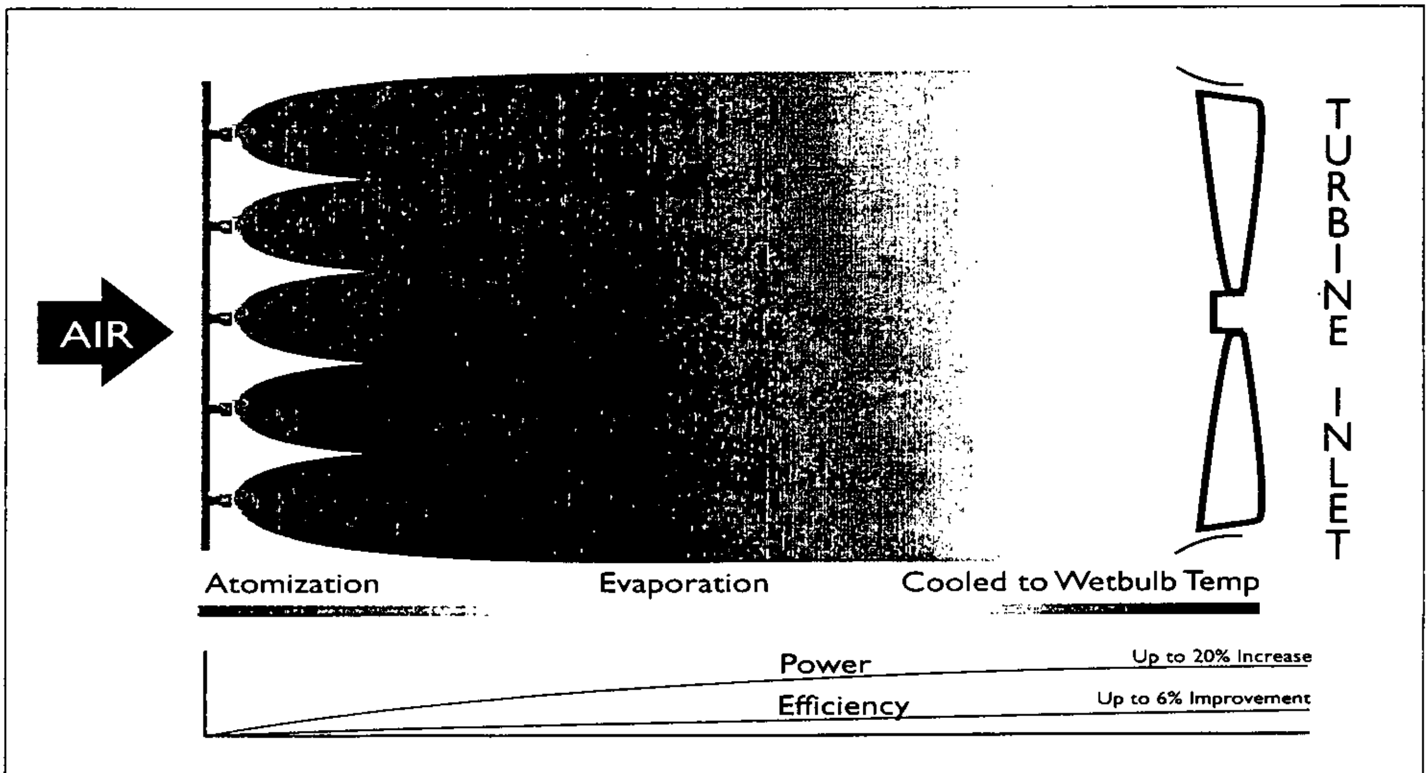

Figure 1

One of the most cost-effective ways to increase combustion turbine power output in high temperature ambient conditions is to reduce the air temperature by evaporating water into the turbine's inlet air. This denser air increases the mass flow to the turbine and since combustion turbines rely on this mass flow for power, output of the combustion turbine is significantly increased. On a 90° F day, with 20% relative humidity, inlet air temperature can be reduced to 63° F simply by evaporating water into the turbine's air stream. For the majority of combustion turbine types, this means a 9% increase in power output. The illustration above shows how a **POWERFog**™ system can improve your Combustion Turbine(s) performance.

Traditional methods of evaporating water into the inlet air use media blocks and de-misters that increase the pressure drop, and therefore reduce the power output capability of combustion turbines. These systems also require a significant amount of annual maintenance.

A more efficient way to evaporate water into the inlet air stream is to use a device that creates a "fog" of micron sized droplets of water. These droplets can be made so small that they can achieve more evaporative efficiency than traditional evaporative coolers. Inlet pressure drop across the system typically cannot even be measured by plant instrumentation. Caldwell Energy will engineer and guarantee the superior performance of a **POWERFog**™ system over media type evaporative coolers.

Caldwell Energy engineered the POWERFog **HP** system specifically for combustion turbine applications. This Combustion Turbine Inlet Air Cooling (CTIAC) system uses Caldwell Energy's proprietary high pressure nozzle design which maximizes evaporative efficiency and hence the power output of the combustion turbine. Custom engineered advanced control system logic, combined with multiple nozzle arrays, are all designed to optimize the system's performance. Special features provide for safe system operation.

The POWERFog **HP** nozzle creates a fog by spraying a high pressure water jet at an impaction pin directly in front of the ejected water stream. Water pressure can vary, typically between 1,000 and 3,500 pounds per square inch depending on the required droplet size. A drawing of the POWERFog **HP** nozzle is illustrated in Figure 2.

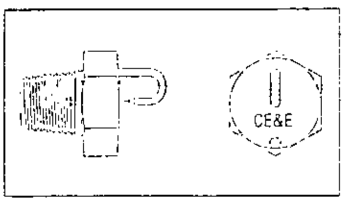

Figure 2

Increased pressure reduces the size of the droplets. The key to determining the system design is the residence time of the water droplets in the inlet air, prior to the cooled air entering the compressor of the combustion turbine. This defines the required droplet size.

Fogging systems cool inlet air down to the wet bulb temperature of the ambient. This makes it highly effective in dry climates but also effective in more humid ones. Fogging systems in humid climates are still economical since the hottest periods of a day coincide with the periods of lowest relative humidity. Figure 3 illustrates the temperature and humidity distribution for a hot, sunny, and humid day. Note that the wet bulb temperature remains relatively constant.

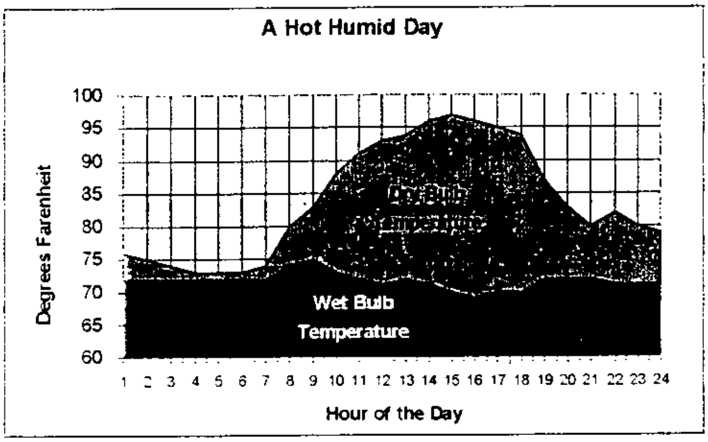

Figure 3

In the case where the residence time of the fog prior to entry into compressor section of the combustion turbine is short, high pressure systems may not ensure complete evaporation. To address this condition, Caldwell Energy developed the POWERFog **US** system. This system produces smaller droplets, a fraction of the diameter of high pressure systems. These smaller droplets allow for faster evaporation.

Internally mounted POWERFog systems can be installed during a 2-4 day outage while you are doing your turbine inspection. Externally mounted POWERFog systems can normally be installed while the combustion turbine is running.

Caldwell Energy engineers, designs, manufactures, and installs all types of combustion turbine Inlet Air Cooling (CTIAC) systems, including fogging, chilling, refrigeration, and thermal energy storage systems. Let us give you the complete cooling picture today.

Contact:

Caldwell Energy & Environmental, Inc.
4020 Tower Road, Louisville, KY 40219
Phone(502)964-6450 Fax(502)964-7444
Email: mail@caldwellenergy.com
Or visit our Website at www.caldwellenergy.com

APPENDIX B

VENDOR DESIGN INFORMATION

DRY LOW NO_x COMBUSTION SYSTEMS FOR GE HEAVY-DUTY GAS TURBINES

L.B. Davis
GE Power Systems
Schenectady, NY

ABSTRACT

State-of-the-art emissions control technology for heavy-duty gas turbines is reviewed with emphasis on the operating characteristics and field experience of Dry Low NO_x(DLN) combustors for E- and F- technology machines. The lean premixed DLN systems for gas fuel have demonstrated their ability to meet the ever-lower emission levels required today. Lean premixed technology has also been demonstrated on oil fuel and is also discussed.

INTRODUCTION

The regulatory requirements for low emissions from gas turbine power plants have increased during the past 10 years. Environmental agencies throughout the world are now requiring even lower rates of emissions of NO_x and other pullutants from both new and existing gas turbines. Traditional methods of reducing NO_x emissions from combustion turbines (water and steam injection)are limited in their ability to reach the extremely low levels required in many localities. GE's involvement in the development of both the traditional methods (References 1 through6) and the newer Dry Low NO_x(DLN) technology (References 7 and 8) has been well-documented. This paper focuses on DLN.

Since the commercial introduction of GE's DLN combustion systems for natural-gas-fired heavy-duty gas turbines in 1991, systems have been installed in more than 145 machines, from the most modern F technology (firing temperature class of 2400 F/1316 C) to field retrofits of older machines. As of August 1996, these machines have operated more than one million hours with DLN; more than 290,000 hours have been in the F technology. To meet marketplace demands, GE has developed DLN products broadly classified as either DLN-1, which was developed for E-technology (2000 F/1093C firing temperature class) machines, or DLN-2, which was developed specifically for the F technology machines and is also being applied to the EC, G and H machines.

Development of these products has required an intensive engineering effort involving both GE Power Systems and GE Corporate Research and Development. This collaboration will continue as DLN is applied to the G and H machines and combustor development for Dry Low NO_x on oil ("dry oil") continues.

This paper presents the current status of DLN-1 technology and experience, including dry oil, and of DLN-2 technology and experience. Background information about gas turbine emissions and emissions control is contained in the Appendix.

DRY LOW NO_X SYSTEMS

Dry Low NO_X Product Plan

Figure 1 shows GE's Dry Low NO_x product offerings for its new and existing machines in three major groupings. The first group includes the MS3000, MS5000 and MS6001B products. The 6B DLN-1 is the technology flagship product for this group and, as can be noted, is available to meet 9 ppm NO_x requirements. Such low NO_x emissions are generally not attainable on lower firing temperature machines such as the MS3000s and MS5000s because carbon monoxide (CO) would be excessive.

The second major group includes the MS7000B/E, MS7001EA and MS9001E machines with the 9 ppm 7EA DLN-1 as the flagship product. The dry oil program focuses initially on this group.

The third group combines all of the DLN-2 products and includes the FA, EC, G and H machines, with the 7FA product as the flagship.

As shown in Figures 2 and 3, most of these products are capable of power augmentation and of peak firing with increased NO_x emissions. With gas fuel, power augmentation with steam is in the premixed mode for both DLN-1 and DLN-2 systems. Power augmentation with water is in the lean-lean mode for DLN-1 and in the premixed mode for DLN-2.

The GE DLN systems integrate a staged premixed combustor, the gas turbine's SPEEDTRONICTM controls and the fuel and associated systems. There

Turbine Model	Gas			Distillate		
	NO_x (ppmvd)	CO (ppmvd)	Diluent	NO_x (ppmvd)	CO (ppmvd)	Diluent
MS3002 (J) - RC	33	25	Dry	Not Available		
MS3002 (J) - SC	42	50	Dry			
MS5001P	42	50	Dry	65	20	Water
MS5001R	42	50	Dry	65	20	Water
MS5002C	42	50	Dry	65	20	Water
MS6001B	25	15	Dry	42	20	Water
	9	25	Dry	42	30	Water/Steam
MS7001B/E Conv.	25	25	Dry	42	30	Water
MS7001EA	25	15	Dry	42	20	Water
	15	25	Dry	42	30	Water/Steam
	9	25	Dry	42	30	Water/Steam
MS9001E	35	15	Dry	42	20	Water
	25	25	Dry	42	20	Water
	25	25	Dry	90	20	Dry
MS6001FA	25	15	Dry	42/65	20	Water/Steam
MS7001FA	25	15	Dry	42/65	20	Water/Steam
	9	9	Dry	42/65	30	Water/Steam
MS7001H	25	15	Dry	42/65	20	Water/Steam
	9	9	Dry	42/65	30	Water/Steam
MS9001EC	25	15	Dry	42/65	20	Water/Steam
MS9001FA	25	15	Dry	42/65	20	Water/Steam
MS9001H	25	15	Dry	42/65	20	Water/Steam

Notes: 1. No_x levels are at 15% oxygen. Ambient range 30 F/-1 C to 100 F/30 C

GT24717E

Figure 1. Dry Low No_x product plan

are two principal measures of performance. The first is meeting the emission levels required at base load on both gas and oil fuel and controlling the variation of these levels across the load range of the gas turbine.

The second measure is system operability, with

Turbine Model	NO_x @15% O_2 (ppmvd)	Operating Mode	Diluent	Maximum Diluent/Fuel	NO_x at Max D/F (ppmvd)	CO Max D/F (ppmvd)
MS6001(B)	9	Premix	Steam	2.5/1	9	25
		Lean-Lean	Steam	2.5/1	25	15
	25	Premix	Steam	2.5/1	25	15
		Lean-Lean	Water	1.5/1	25	15
		Lean-Lean	Steam	2.5/1	25	15
MS7001(EA)	9	Premix	Steam	2.5/1	9	25
		Lean-Lean	Water	1.5/1	25	15
		Lean-Lean	Steam	2.5/1	25	15
	25	Premix	Steam	2.5/1	25	15
		Lean-Lean	Water	1.5/1	25	15
		Lean-Lean	Steam	2.5/1	25	15
MS7001(FA)	25	Premix	Steam	2.1/1	25	15

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Figure 2. DLN power augmentation summary - gas fuel

	NO_x-Base (ppmvd)	NO_x-Peak (ppmvd)	CO-Base (ppmvd)	CO-Peak (ppmvd)
MS6001(B)	9 25	18 50	25 15	6 4
MS7001(EA)	9 25	18 50	25 15	6 4
MS7001(FA)	25	35	15	6
MS9001(E)	25	40	15	6

GT24557A .ppt

Figure 3. DLN peak firing summary - gas fuel

emphasis placed on the smoothness and reliability of combustor mode changes, ability to load and unload the machine without restriction, capability to switch from one fuel to another and back again, and system response to rapid transients (e.g., generator breaker open events or rapid swings in load). GE's design goal is to make the DLN system operate so the gas turbine operator does not know whether a DLN or conventional combustion system is installed (i.e., its operation is "transparent to the user"). As of August 1996, a significant portion of the DLN design and development effort has focused on system operability.

Design of a successful DLN combustor for a heavy-duty gas turbine also requires the designer to develop hardware features and operational methods that simultaneously allow the equivalence ratio and residence time in the flame zone to be low enough to achieve low NO_x, but with acceptable levels of combustion noise (dynamics), stability at part load operation and sufficient residence time for CO burn-out, hence the designation of DLN combustion design as "four-sided box" (Figure 4).

A scientific and engineering development program by GE's Corporate Research and Development Center, Power Systems business and Aircraft Engine business has focused on understanding and controlling dynamics in lean premixed flows. The objectives have been to:

- Gather and analyze machine and laboratory data to create a comprehensive dynamics data base
- Create analytical models of gas turbine combustion systems that can be used to understand dynamics behavior
- Use the analytical models and experimental methods to develop methods to control dynamics

As of August 1996, these efforts have resulted in a large number of hardware and control features that limit dynamics, plus analytical tools that are used to predict system behavior. The latter are particularly useful in correlating laboratory test data from full scale combustors with actual gas turbine data.

DLN-1 System

DLN-1 development began in the 1970s with the goal of producing a dry oil system to meet the United States Environmental Protection Agency's New Source Performance Standards of 75 ppmvd NO_x at 15% O_2. As noted in Reference 7, this system was tested on both oil and gas fuel at Houston Lighting & Power in 1980 and met its emission goals. Subsequent to this, DLN program goals changed in response to stricter environmental regulations and the pace of the program accelerated in the late 1980s.

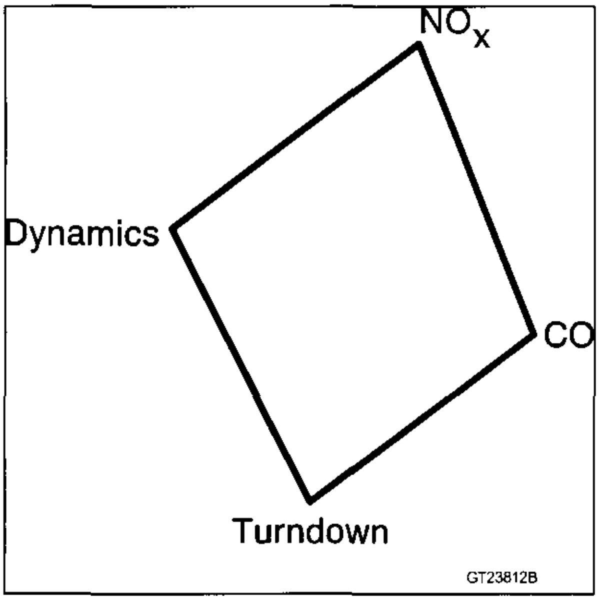

Figure 4. DLN technology - a four-sided box

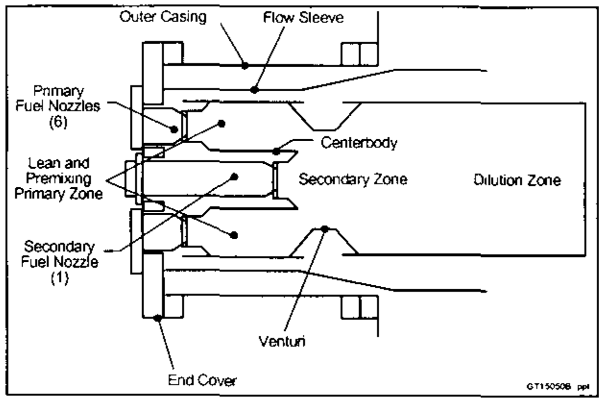

Figure 5. DLN-1 combustor schematic

DLN-1 Combustor

The GE DLN-1 combustor (shown in cross section in Figure 5 and described in Reference 8) is a two-stage premixed combustor designed for use with natural gas fuel and capable of operation on liquid fuel. As shown, the combustion system includes four major components: fuel injection system, liner, venturi and cap/centerbody assembly.

These components form two stages in the combustor. In the premixed mode, the first stage thoroughly mixes the fuel and air and delivers a uniform, lean, unburned fuel-air mixture to the second stage.

The GE DLN-1 combustion system operates in four distinct modes, illustrated in Figure 6, during pre-mixed natural gas or oil fuel operation:

<u>Mode</u>	<u>Operating Range</u>
Primary	Fuel only to the primary nozzles. Flame is in the primary stage only. This mode of operation is used to ignite, accelerate and operate the machine over low- to mid-loads, up to a preselected combustion reference temperature.
Lean-Lean	Fuel to both the primary and secondary nozzles. Flame is in both the primary and secondary stages. This mode of operation is used for intermediate loads between two preselected combustion reference temperatures.
Secondary	Fuel to the secondary nozzle only. Flame is in the secondary zone only. This mode is a transition state between lean-lean and premix modes. This mode is necessary to extinguish the flame in the primary zone, before fuel is reintroduced into what becomes the primary premixing zone.
Premix	Fuel to both primary and secondary nozzles. Flame is in the secondary stage only. This mode of operation is achieved at and near the combustion reference temperature design point. Optimum emissions are generated in premix mode.

The load range associated with these modes varies with the degree of inlet guide vane modulation and, to a smaller extent, with the ambient temperature. At ISO ambient, the premix operating range is 50% to 100% load with IGV modulation down to 42 Degrees, and 75% to 100% load with IGV modulation down to 57 Degrees. The 42 Degrees IGV minimum requires an inlet bleed heat system.

If required, both the primary and secondary fuel nozzles can be dual-fuel nozzles, thus allowing automatic transfer from gas to oil throughout the load range. When burning either natural gas or distillate oil, the system can operate to full load in the lean-lean mode (Figure 6) and in the pre-mixed. Power augmentation with water is the most common reason.

The spark plug and flame detector arrangements in a DLN-1 combustor are different from those used in a conventional combustor. Since the first stage must be re-ignited at high load in order to transfer from the

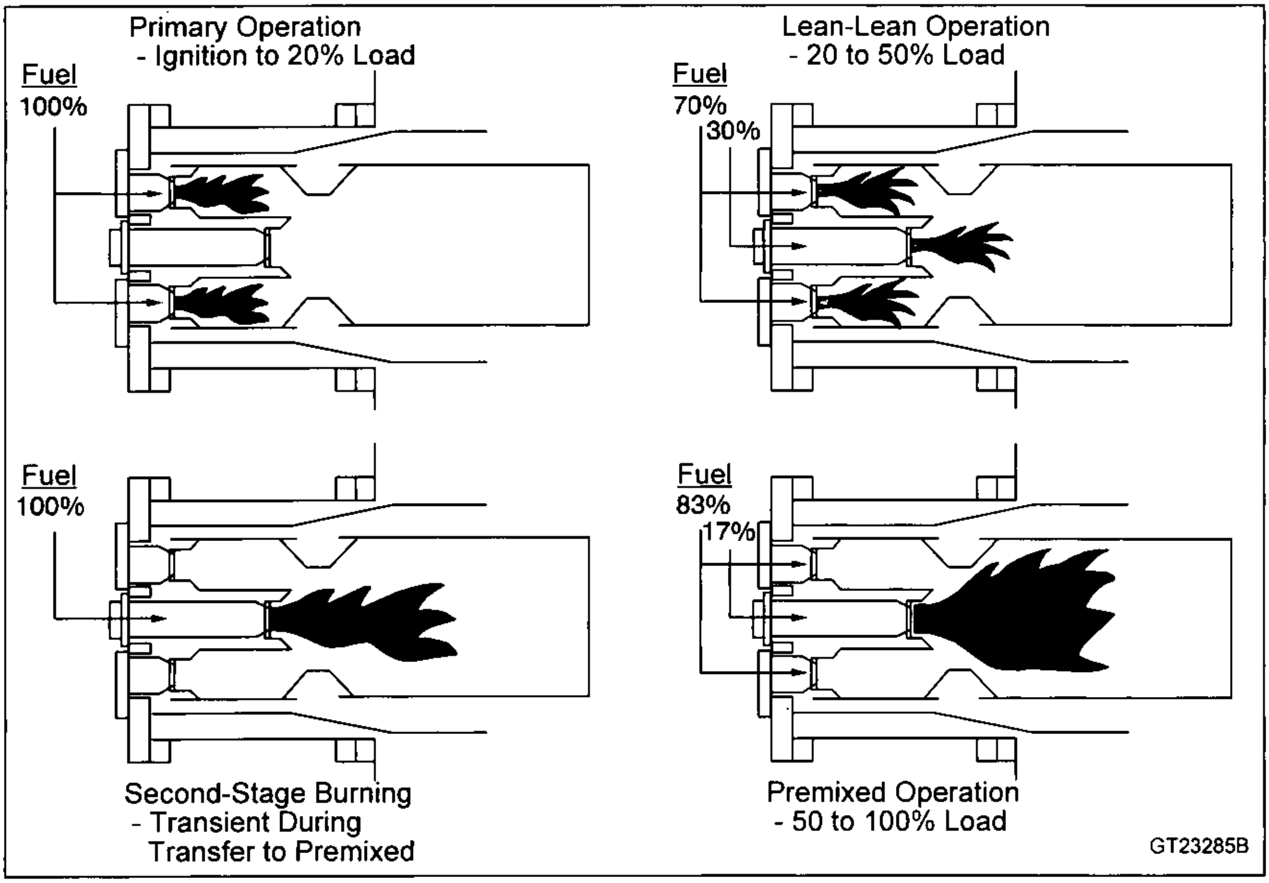

Figure 6. Fuel-staged Dry Low NOx operating modes

premixed mode back to lean-lean operation, the spark plugs do not retract. One plug is mounted in a primary zone cup in each of two combustors. The system uses flame detectors to view the primary stage of selected chambers (similar to conventional systems), and secondary flame detectors that look through the centerbody and into the second stage.

The primary fuel injection system is used during ignition and part load operation. The system also injects most of the fuel during premixed operation and must be capable of stabilizing the flame. For this reason, the DLN-1 primary fuel nozzle is similar to GE's MS7001EA multi-nozzle combustor with multiple swirl-stabilized fuel injectors. The GE DLN-1 system uses five primary fuel nozzles for the MS6001B and smaller machines and six primary fuel nozzles for the larger machines. This design is capable of providing a well-stabilized diffusion flame that burns efficiently at ignition and during part load operation.

In addition, the multi-nozzle fuel injection system provides a satisfactory spatial distribution of fuel flow entering the first-stage mixer. The primary fuel-air mixing section is bound by the combustor first-stage wall, the cap/centerbody and the forward cone of the venturi. This volume serves as a combustion zone when the combustor operates in the primary and lean-lean modes. Since ignition occurs in this stage, crossfire tubes are installed to propagate flame and to balance pressures between adjacent chambers. Film slots on the liner walls provide cooling, as they do in a standard combustor.

In order to achieve good emissions performance in premixed operation, the fuel-air equivalence ratio of the mixture exiting the first-stage mixer must be very lean. Efficient and stable burning in the second stage, is achieved by providing continuous ignition sources at both the inner and outer surfaces of this flow. The three elements of this stage comprise a piloting flame, an associated aerodynamic device to force interaction between the pilot flame and the inner surface of the main stage flow, and an aerodynamic device to create a stable flame zone on the outer surface of the main stage flow exiting the first stage.

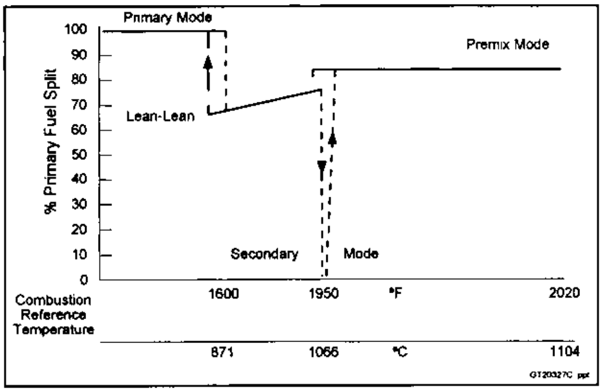

Figure 7. Typical Dry Low Nox fuel gas split schedule

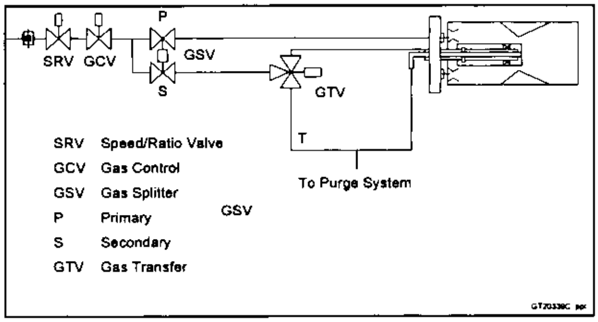

Figure 8. DLN-1 gas fuel system

The piloting flame is generated by the secondary fuel nozzle, which premixes a portion of the natural gas fuel and air (nominally, 17% at full-load operation) and injects the mixture through a swirler into a cup where it is burned. This flame is stabilized by burning an even smaller amount of fuel (less than 2% of the total fuel flow) as a diffusion flame in the cup. The secondary nozzle, which is mounted in the cap centerbody, is simple and highly effective for creating a stable flame.

A swirler mounted on the downstream end of the cap/centerbody surrounds the secondary nozzle. This creates a swirling flow that stirs the interface region between the piloting flame and the main-stage flow and ensures that the flame is continuously propagated from the pilot to the inner surface of the fuel-air mixture exiting the first stage. Operation on oil fuel is similar except that all of the secondary oil is burned in a diffusion flame in the current dry oil design.

The sudden expansion at the throat of the venturi creates a toroidal recirculation zone over the downstream conical surface of the venturi. This zone, which entrains a portion of the venturi cooling air, is a stable burning zone that acts as an ignition source for the main stage fuel-air mixture. The cone angle

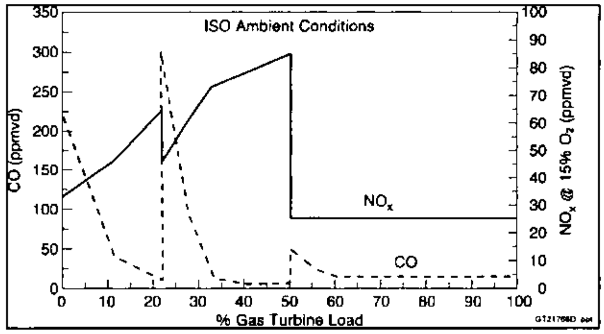

Figure 9. MS7001EA/MS9001E DLN-1 combustion system performance on natural gas fuel

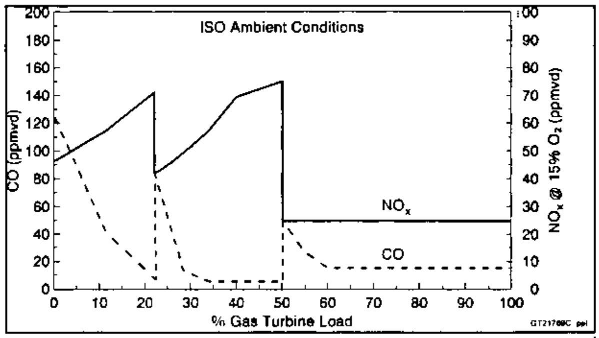

Figure 10. MS6001B DLN-1 emissions performance on natural gas fuel

and axial location of the venturi cooling air dump have significant effects on the efficacy of this ignition source. Finally, the dilution zone (the region of the combustor immediately downstream from the flame zone in the secondary) provides a region for CO burnout and for shaping the gas temperature profile exiting the combustion system.

DLN-1 Controls and Accessories

The gas turbine accessories and control systems are configured so that operation on a DLN-equipped turbine is essentially identical to that of a turbine equipped with a conventional combustor. This is accomplished by controlling the turbines in identical fashions, with the exhaust temperature, speed and compressor discharge pressure establishing the fuel flow and compressor inlet guide vane position.

A turbine with a conventional diffusion combustor that uses diluent injection for NO_x control will use an underlying algorithm to control steam or water injection. This algorithm will use top level control variables (exhaust temperature, speed, etc.) to establish a steam-to-fuel or water-to-fuel ratio to control NO_x.

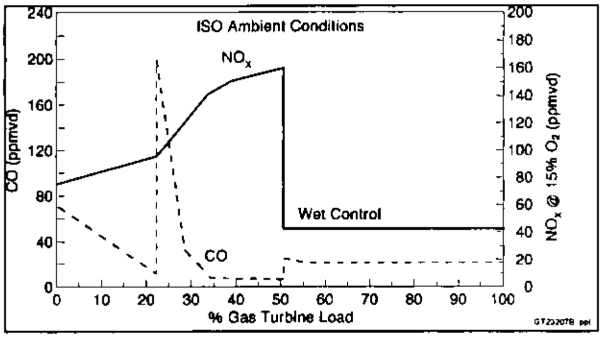

Figure 11. MS7001EA/MS9001E DLN-1 combustion system performance on distillate oil

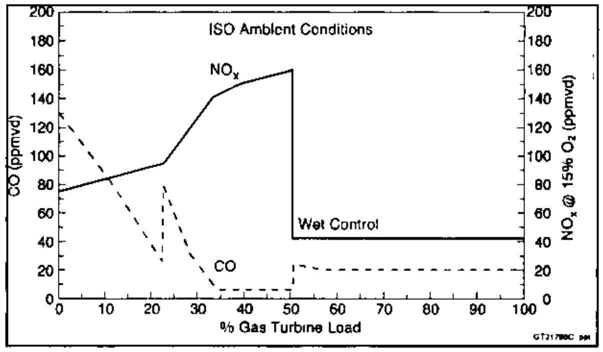

Figure 12. MS6001B DLN-1 emissions performance on distillate oil fuel

In a similar fashion, the same variables are used to divide the total turbine fuel flow between the primary and secondary stages of a DLN combustor. The fuel division is accomplished by commanding a calibrated splitter valve to move to a set position based on the calculated combustion reference temperature (Figure 7). Figure 8 shows aschematic of the gas fuel system for a DLN-equipped turbine.

The only special control sequences required are concerned protection of the turbine during a generator breaker-open trip, or flashback, from the second stage to the first stage during premixed operation. When either the breaker opens at load or flashback is sensed by ultraviolet flame detectors looking into the first stage, the splitter valve is commanded to move to a pre-determined position. In the case of a flashback, the control system can execute an automatic sequence to return to premixed, full-load operation.

DLN-1 Emissions

The emissions performance of the GE DLN system can be illustrated as a function of load for a given ambient temperature and turbine configuration. Figures 9 and 10 show the NO_x and CO emissions from typical MS7001EA and MS6001B DLN systems designed for 9 ppmvd NO_x and 25 ppm CO when operated on natural gas fuel. Note that in premixed operation, NO_x is generally highest at higher loads and CO only approaches 25 ppm at lower premixed loads.

Figures 11 and 12 show NO_x and CO emissions for the same systems operated on oil fuel with water injection for NO_x control, rather than premixed oil. These figures are for units equipped with inlet bleed heat and extended IGV modulation. NO_x and CO emissions from the DLN combustor at loads less than 20% of base load are similar to those from standard combustion systems. This result is expected because both systems are operating as diffusion flame combustors in this range. Between 20% and 50% load, the DLN system is operated in the lean-lean mode, and the flow split between the primary fuel nozzles and secondary nozzle is varied to give the decreasing NO_x characteristic shown.

From 50%to 100%load, the DLNsystem operates as a lean premixed combustor. As shown in Figures 9 through 12, NO_x emissions are significantly reduced, while CO emissions are comparable to those from the standard system.

DLN-1 Experience

GE's first DLN-1 system was tested at Houston Lighting & Power in 1980 (Reference 7). A prototype DLN system using the combustor design discussed above was tested on an MS9001E at the Electricity Supply Board's (ESB) Northwall Station in Dublin, Ireland, between October 1989 and July 1990. A comprehensive engineering test of the prototype DLN combustor, controls and associated systems was conducted with NO_x levels of 32 ppmvd (at 15% O_2) obtained at base load. The results were incorporated into the design of prototype systems for the MS7001E and MS6001B.

The 7E DLN-1 prototype was tested at Anchorage Municipal Light and Power (AMLP) in early 1991 and entered commercial service shortly afterward. Since then, development of advanced combustor configurations have been carried out at AMLP. These results have been incorporated into production hardware.

The MS6001B prototype system was first operated at Jersey Central Power & Light's Forked River Station in early 1991. A series of additional tests culminated in the demonstration of a 9 ppm combustor at Jersey Central in November 1993.

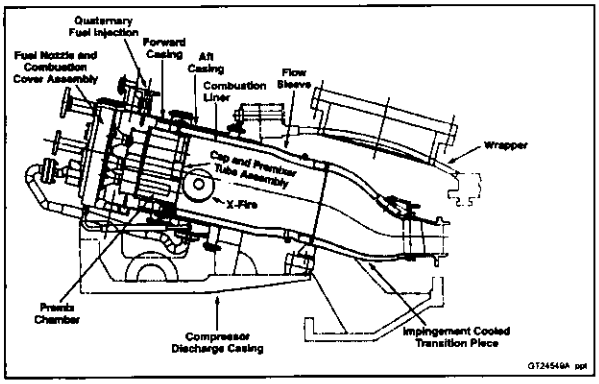

Figure 13. DLN-2 combustion system

As of August 1996, 28 MS6001B machines are equipped with DLN-1 systems. In total, they have accumulated more than 370,000 hours of operation. There are, in addition, four MS7001E, eight MS7001B-E, 26 MS7001EA, 18 MS9001E, one MS5001P and three MS3002J DLN-1 machines that have collectively operated for more than 350,000 hours. Excellent emission results have been obtained in all cases, with single-digit NO_x and COachieved on several MS7001EAs. Several MS7001E/EA machines have the capability to power augment with either massive water or steam injection.

Starting in early 1992, eight MS7001F machines equipped with GE DLN systems were placed in service at Korea Electric Power Company's Seoinchon site. These F technology machines have achieved better than 55% (gross) efficiency in combined-cycle operation, and the DLN systems are currently operating between 30 and 40 ppmvd NO_x on gas fuel (the guarantee level is 50 ppmvd). These units have operated for more than 150,000 hours. Four additional F technology DLN-1 systems have been commissioned at Scottish Hydro's Keadby site and at National Power's Little Barford site. These 9F machines have operated more than 20,000 hours at less than 60 ppm NO_x.

The combustion laboratory testing and field operation have shown that the DLN-1 system can achieve single digit NO_x and CO levels on E technology machines operating on gas fuel. Current DLN-1 development activity focuses on four goals:

- Application of single-digit technology to the MS6001B, MS7001EA and MS9001E
- Application of DLN-1 technology for retrofitting existing field machines (including MS3002s and MS5000s, some of which will require upgrade before DLN retrofit)

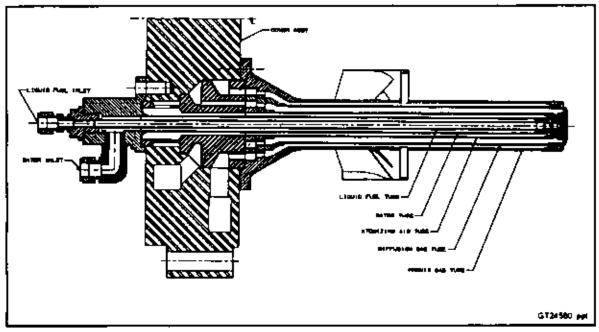

Figure 14. Cross-section of a DLN-2 fuel nozzle

- Completing the development of steam and water power augmentation as needed by the market
- Completing the development of dry oil DLN-1 products.

DLN-2 SYSTEM

As F-technology gas turbines became available in the late 1980s, studies were conducted to establish what type of DLN combustor would be needed for these new higher firing temperature machines. Studies concluded that that air usage in the combustor (e.g., for cooling) other than for mixing with fuel would have to be strictly limited. A team of engineers from GE Power Generation, GE Corporate Research and Development and GE Aircraft Engine proposed a design that repackaged DLN-1 premixing technology but eliminated the venturi and centerbody assemblies that require cooling air.

The resulting combustor is called DLN-2, which is the standard system for the 6FA, 7FA, 9FA, 9EC, 7G, 7H, 9G and 9H machines. Fourteen combustors are installed in the 7FA and 9EC, 18 in the 9FA, and six in the 6FA. These combustors, for all but the 7FA, are not scaled, but are full-size 9FA combustors; the 7FA is slightly smaller.

DLN-2 Combustion System

The DLN-2 combustion system shown in Figure 13 is a single-stage dual-mode combustor that can operate on both gaseous and liquid fuel. On gas, the combustor operates in a diffusion mode at low loads (< 50% load), and a premixed mode at high loads (> 50% load). While the combustor can operate in the diffusion mode across the load range, diluent injection would be required for NO_x abatement. Oil operation on this combustor is in the diffusion mode

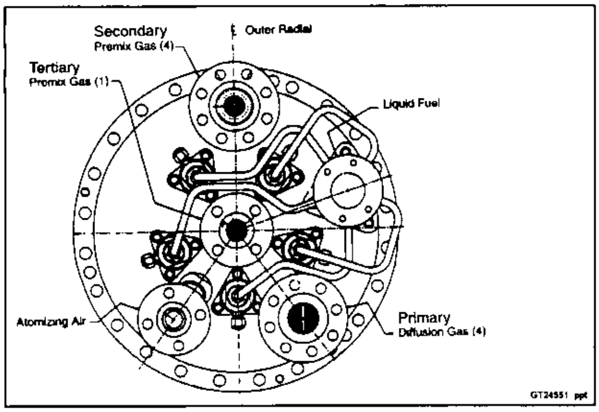

Figure 15. External view of DLN-2 fuel nozzles mounted

across the entire load range, with diluent injection used for NO_X control.

Each DLN-2 combustor system has a single burning zone formed by the combustor liner and the face of the cap. In low emissions operation, 90% of the gas fuel is injected through radial gas injection spokes in the premixer, and combustion air is mixed with the fuel in tubes surrounding each of the five fuel nozzles. The premixer tubes are part of the cap assembly. The fuel and air are thoroughly mixed, flow out of the five tubes at high velocity and enter the burning zone where lean, low- NO_x combustion occurs. The vortex breakdown from the swirling flow exiting the premixers, along with the sudden expansion in the liner, are mechanisms for flame stabilization. The DLN-2 fuel nozzle/premixer tube arrangement is similar in design and technology to the secondary nozzle/centerbody of a DLN-1. Five nozzle/premixer tube assemblies are located on the head end of the combustor. A quaternary fuel manifold is

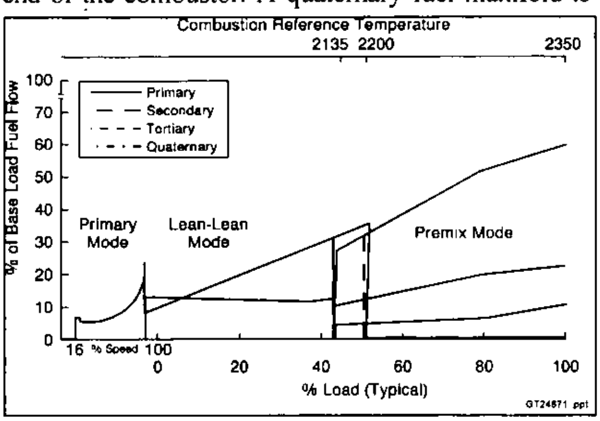

Figure 16. Fuel flow scheduling associated with DLN-2 operation

located on the circumference of the combustion casing to bring the remaining fuel flow to casing injection pegs located radially around the casing.

Figure 14 shows a cross-section of a DLN-2 fuel nozzle. As noted, the nozzle has passages for diffusion gas, premixed gas, oil and water. When mounted on the end cover, as shown in Figure 15, the diffusion passages of four of the fuel nozzles is fed from a common manifold, called the primary, that is built into the end cover. The premixed passage of the same four nozzles are fed from another internal manifold called the secondary. The premixed passages of the remaining nozzle are supplied by the tertiary fuel system; the diffusion passage of that nozzle is always purged with compressor discharge air and passes no fuel.

Figure 15 shows the fuel nozzles installed on the combustion chamber end cover and the connections for the primary, secondary and tertiary fuel systems. DLN-2 fuel streams are:

- Primary fuel – fuel gas entering through the diffusion gas holes in the swirler assembly of each of the outboard four fuel nozzles
- Secondary fuel – premix fuel gas entering through the gas metering holes in the fuel gas injector spokes of each of the outboard four fuel nozzles
- Tertiary fuel – premix fuel gas delivered by the metering holes in the fuel gas injector spokes of the inboard fuel nozzle
- The quaternary system – injects a small amount of fuel into the airstream just upstream from the fuel nozzle swirlers

The DLN-2 combustion system can operate in several different modes.

Primary

Fuel only to the primary side of the four fuel nozzles; diffusion flame. Primary mode is used from ignition to 81% corrected speed.

Lean-Lean

Fuel to the primary (diffusion) fuel nozzles and single tertiary (premixing) fuel nozzle. This mode is used from 81% corrected speed to a preselected combustion reference temperature. The percentage of primary fuel flow is modulated throughout the range of operation as a function of combustion reference temperature. If necessary, lean-lean mode can be operated throughout the entire load range of the turbine. Selecting "lean-lean base on" locks out premix operation and enables the machine to be taken to base load in lean-lean.

Premix Transfer

Transition state between lean-lean and premix modes. Throughout this mode, the primary and secondary gas control valves modulate to their final position for the next mode. The premix splitter valve is also modulated to hold a constant tertiary flow split.

Piloted Premix

Fuel is directed to the primary, secondary and tertiary fuel nozzles. This mode exists while operating with temperature control off as an intermediate mode between lean-lean and premix mode. This mode also exists as a default mode out of premix mode and, in the event that premix operating is not desired, piloted premix can be selected and operated to base load. Primary, secondary and tertiary fuel split are constant during this mode of operation.

Premix

Fuel is directed to the secondary, tertiary and quaternary fuel passages and premixed flame exists in the combustor. The minimum load for premixed operation is set by the combustion reference temperature and IGV position. It typically ranges from 50% with inlet bleed heat on to 65% with inlet bleed heat off. Mode transition from premix to piloted premix or piloted premix to premix, can occur whenever the combustion reference temperature is greater than 2200 F/1204 C. Optimum emissions are generated in premix mode.

Tertiary Full Speed No Load (FSNL)

Initiated upon a breaker open event from any load greater than 12.5%. Fuel is directed to the tertiary nozzle only and the unit operates in secondary FSNL mode for a minimum of 20 seconds, then transfers to lean-lean mode.

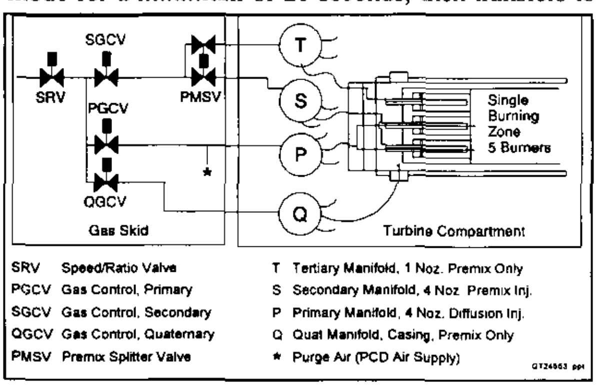

Figure 17. DLN-2 gas fuel system

Figure 16 illustrates the fuel flow scheduling associated with DLN-2 operation. Fuel staging depends on combustion reference temperature and IGV temperature control operation mode.

DLN-2 Controls and Accessories

The DLN-2 control system regulates the fuel distribution to the primary, secondary, tertiary and quaternary fuel system. The fuel flow distribution to each combustion fuel system is a function of combustion reference temperature and IGV temperature control mode. Diffusion, piloted premix and premix flame are established by changing the distribution of fuel flow in the combustor. The gas fuel system (Figure 17) consists of the gas fuel stop/ratio valve, primary gas control valve, secondary gas control valve premix splitter valve and quaternary gas control valve. The stop/ratio valve is designed to maintain a predetermined pressure at the control valve inlet.

The primary, secondary and quaternary gas control valves regulate the desired gas fuel flow delivered to the turbine in response to the fuel command from the SPEEDTRONICTM controls.

The premix splitter valve controls the fuel flow split between the secondary and tertiary fuel system.

DLN-2 Emissions Performance

Figures 18 and 19 show the emissions performance for a DLN-2 equipped 7FA/9FA for gas fuel and for oil fuel with water injection.

DLN-2 Experience

The first DLN-2 systems were placed in service at Florida Power and Light's Martin Station with com-

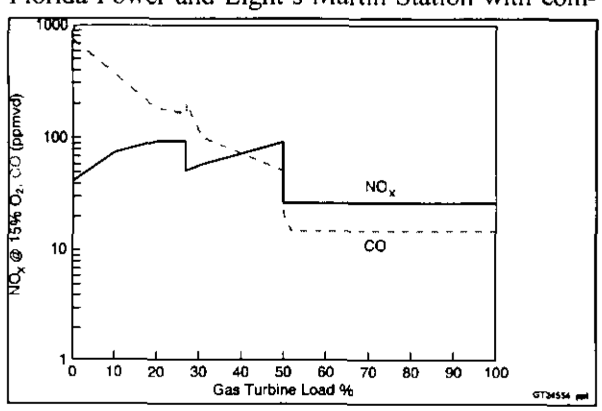

Figure 18. Emissions performance for DLN-2-equipped 7FA/9FA for gas fuel

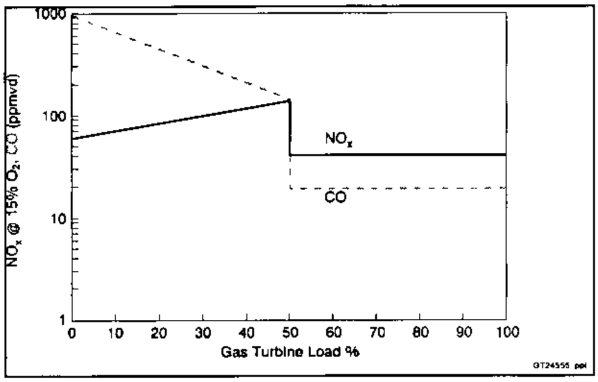

Figure 19. Emissions performance for DLN-2-equipped 7FA/9FA for oil fuel with water injection

missioning beginning in September 1993, and the first two (of four) 7FA units entering commercial service in February 1994. During commissioning, quaternary fuel was added and other combustor modifications were made to control dynamic pressure oscillations in the combustor.

As of August 1996, 23 DLN-2 7FA and 17 9FA units are in commercial service. They have accumulated more than 150,000 hours of operation. Of these units, 11 are dual-fuel units, and the remainder are gas-only.

CONCLUSION

GE's Dry Low NO_x Program continues to focus on the development of systems capable of the extremely low NO_x levels required to meet today's regulations and to prepare for more stringent requirements in the future. New unit production needs and the requirements of existing machines, are being addressed. GE DLN systems are operating on more than 145 machines and have accumulated more than one million service hours. More than 200 DLN systems have been either put into service, shipped or placed on order. GE is the only manufacturer with F technology machines operating below 25 ppmvd.

APPENDIX

Gas Turbine Combustion Systems

A gas turbine combustor mixes large quantities of fuel and air and burns the resulting mixture. In concept the combustor is comprised of a fuel injector and a wall to contain the flame. There are three fundamental factors and practical concerns that complicate the design of the combustor: equivalence ratio, flame stability, and ability to operate from ignition through full load.

Equivalence ratio

A flame burns best when there is just enough fuel to react with the available oxygen. With this stoichiometric mixture (equivalence ratio of 1.0) the flame temperature is the highest and the chemical reactions are the fastest, compared to cases where there is either more oxygen ("fuel lean," < 1.0) or less oxygen ("fuel rich," > 1.0) for the amount of fuel present.

In a gas turbine, the maximum temperature of the hot gases exiting the combustor is limited by the tolerance of the turbine nozzles and buckets. This temperature corresponds to an equivalence ratio of 0.4 to 0.5 (40 to 50% of the stoichiometric fuel flow). In the combustors used on modern gas turbines, this fuel-air mixture would be too lean for stable and efficient burning. Therefore, only a portion of the compressor discharge air is introduced directly into the combustor reaction zone (flame zone) to be mixed with the fuel and burned. The balance of the airflow either quenches the flame prior to the combustor discharge entering the turbine or to cool the wall of the combustor.

Flame Stability

Even with only part of the air being introduced into the reaction zone, flow velocities in the zone are higher than the turbulent flame speed at which a flame propagates through the fuel-air mixture. Special mechanical or aerodynamic devices must be used to stabilize the flame by providing a low velocity region. Modern combustors employ a combination of swirlers and jets to achieve a good mix and to stabilize the flame.

Operational Stability

The combustor must be able to ignite and to support acceleration and operation of the gas turbine over the entire load range of the machine. For a single-shaft generator-drive machine, speed is constant under load and, therefore, so is the airflow for a fixed ambient temperature. There will be a five- or six-to-one turndown in fuel flow over the load range, and a combustor whose reaction zone equivalence ratio is optimized for full load operation will be very lean at the lower loads. Nevertheless, the flame must be sta-

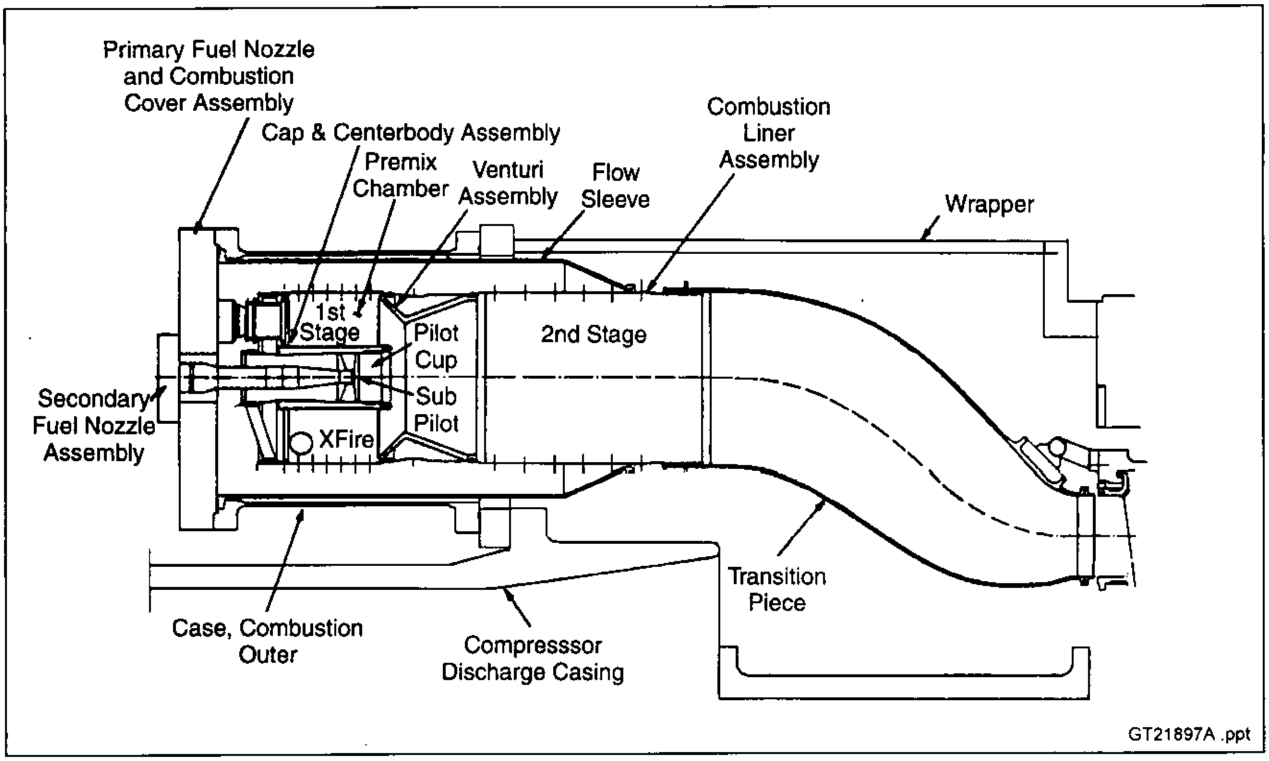

Figure A1. MS7001EA Dry Low Nox combustion chamber

ble and the combustion process must be efficient at all loads.

GE uses multiple-combustion chamber assemblies in its heavy-duty gas turbines to achieve reliable and efficient turbine operation. As shown in Figure A-1, each combustion chamber assembly comprises a cylindrical combustor, a fuel injection system and a transition piece that guides the flow of the hot gas from the combustor to the inlet of the turbine. Figure A-2 illustrates the multiple-combustor concept.

There are several reasons for using the multiple-chamber arrangement instead of large silo-type combustors:

- The configuration permits the entire turbine to be factory assembled, tested and shipped without interim disassembly
- The turbine inlet temperature can be better controlled, thus providing for longer turbine life with reduced turbine cooling air requirements
- Smaller parts can be handled more easily during routine maintenance
- Smaller transition pieces are less susceptible to damage from dynamic forces generated in the combustor; furthermore, the shorter combustion system length ensures that acoustic natural frequencies are higher and less likely to couple with the pressure oscillations in the flame
- Smaller combustors generate less NO_x because of much better mixing and shorter residence time
- As turbine inlet temperatures have increased to improve efficiency, the size of the combustors has decreased to minimize cooling requirements, as in aircraft gas turbine combustors
- Small can-type combustors can be completely developed in the laboratory through a combination of both atmospheric and full-pressure, full-flow tests. Therefore, there is a higher degree of confidence that a combustor will perform as designed across all load ranges before it is installed and tested in a machine.

Gas Turbine Emissions

The significant products of combustion in gas turbine emissions are:

- Oxides of nitrogen (NO and NO_2, collectively called NO_x)
- Carbon monoxide (CO)
- Unburned hydrocarbons or UHCs (usually expressed as equivalent methane (CH_4) particles and arise from incomplete combustion)

• Oxides of sulfur (SO_2 and SO_3) particulates.

Unburned hydrocarbons include both volatile organic compounds (VOCs), which contribute to the formation of atmospheric ozone, and compounds, such as methane, that do not.

There are two sources of NO_x emissions in the exhaust of a gas turbine. Most of the NO_x is generated by the fixation of atmospheric nitrogen in the flame, which is called thermal NO_x. Nitrogen oxides are also generated by the conversion of a fraction of any nitrogen chemically bound in the fuel (called fuel-bound nitrogen or FBN). Lower-quality distillates and low-Btu coal gases from gasifiers with hot gas cleanup carry various amounts of fuel-bound nitrogen that must be taken into account when emissions calculations are made. The methods described below to control thermal NO_x emissions are ineffective in controlling the conversion of FBN to NO_x.

Thermal NO_x is generated by a chemical reaction sequence called the Zeldovich Mechanism (Reference 6). This set of well-verified chemical reactions postulates that the rate of generation of thermal NO_x is an exponential function of the temperature of the flame. The amount of NO_x generated is a function of the flame temperature and of the time the hot gas mixture is at flame temperature. This turns out to be a linear function of time. Thus, temperature and residence time determine thermal NO_x emissions levels and are the principal variables that a gas turbine designer can adjust to control emission levels.

For a given fuel, since the flame temperature is a unique function of the equivalence ratio, the rate of NO_x generation can be cast as a function of the equivalence ratio. Figure A-3, shows that the highest rate of NO_x production occurs at an equivalence ratio of 1.0, when the temperature is equal to the stoichiometric, adiabatic flame temperature.

To the left of the maximum temperature point (Figure A-3), more oxygen is available (the equivalence ratio is less than 1.0) and the resulting flame temperature is lower. This is a fuel-lean operation. Since the rate of NO_x formation is a function of temperature and time, it follows that some difference in NO_x emissions can be expected when different fuels are burned in a given combustion system. Since distillate oil and natural gas have approximately a 100F/38 C flame temperature difference, a significant difference in NO_x emissions can be expected if reaction zone equivalence ratio, water injection rate, etc. are equal.

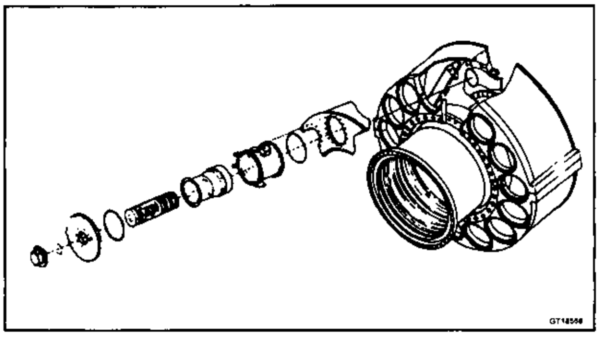

Figure A2. Exploded view of combustion chamber

As shown in Figure A-3, the rate of NO_x production dramatically decreases as flame temperature decreases (i.e., the flame becomes fuel lean). This is because of the exponential effect of temperature in the Zeldovich Mechanism and is the reason why diluent injection (usually water or steam) into a gas turbine combustor flame zone reduces NO_x emissions. For the same reason, very lean dry combustors can be used to control emissions. This is desirable for reaching the lower NO_x levels now required in many applications.

There are two design challenges associated with very lean combustors. First, care must be taken to ensure that the flame is stable at the design operating point. Secondly, a turndown capability is necessary since a gas turbine must ignite, accelerate, and operate over the load range. At lower loads, as fuel flow to the combustors decreases, the flame will be very lean and will not burn well, or it can become unstable and blow out.

In response to these challenges, combustion system designers use staged combustors so a portion of the flame zone air can mix with the fuel at lower loads or during startup. The two types of staged combustors are fuel-staged and air-staged (Figure A-4). In its simplest and most common configuration, a fuel-staged combustor has two flame zones; each receives a constant fraction of the combustor airflow. Fuel flow is divided between the two zones so that at each machine operating condition, the amount of fuel fed to a stage matches the amount of air available.

An air-staged combustor uses a mechanism for diverting a fraction of the airflow from the flame zone to the dilution zone at low load to increase turndown. These methods can be combined.

Emissions Control Methods

There are three principal methods for controlling gas turbine emissions:

- Injection of a diluent such as water or steam into the burning zone of a conventional (diffusion flame) combustor
- Catalytic clean-up of NO_x and CO from the gas turbine exhaust (usually used in conjunction with the other two methods)
- Design of the combustor to limit the formation of pollutants in the burning zone by utilizing "lean-premixed" combustion technology.

The last method includes both DLN combustors and catalytic combustors. GE has considerable experience with each of these three methods.

Since September 1979, when regulations required that NO_x emissions be limited to 75 ppmvd (parts per million by volume, dry), more than 300 GE heavy-duty gas turbines have accumulated more than 2.5 million operating hours using either steam or water-injection to meet or exceed these required NO_x emissions levels. The amount of water required to accomplish this is approximately one-half of the fuel flow. However, there is a 1.8% heat-rate penalty associated with using water to control NO_x emissions for oil-fired simple-cycle gas turbines. Output, increases by approximately 3%, making water (or steam) injection for power augmentation economically attractive in some circumstances (such as peaking applications).

Single-nozzle combustors that use water or steam injection are limited in their ability to reduce NO_x levels below 42 ppmvd on gas fuel and 65 ppmvd on oil fuel. GE developed multi-nozzle quiet combustors (MNQC) for the MS7001EA and MS7001FA capable of achieving 25 ppmvd on gas fuel and 42 ppmvd on oil, using either water or steam injection. Since October 1987, more than 26 MNQC-equipped MS7001s that use water or steam injection have been placed in service. One unit that uses steam injection has operated nearly 50,000 hours at 25 ppmvd NO_x(at 15% O_2).

Frequent combustion inspections and decreased hardware life are undesirable side effects that can result from the use of diluent injection to reduce NO_x emissions from combustion turbines. For applications that require NO_x emissions below 42 ppmvd (or 25 ppmvd in the case of the MS7001EA or MS7001FA MNQC), or to avoid the significant cycle efficiency penalties incurred when water or steam injection is used for NO_x control, one of the other two principal

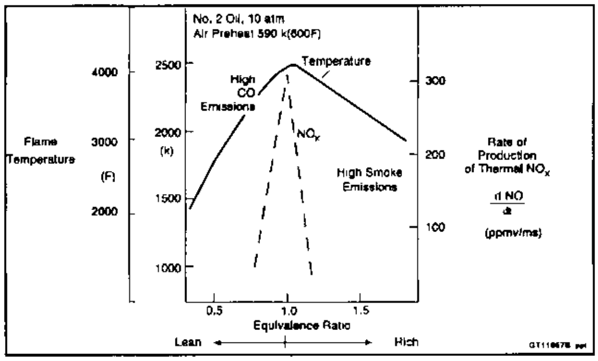

Figure A3. Rate of thermal Nox production

methods of NO_x control mentioned above must be used.

Selective catalytic reduction (SCR) converts NO and NO_2 in the gas turbine exhaust stream to molecular nitrogen and oxygen by reacting the NO_x with ammonia in the presence of a catalyst. Conventional SCR technology requires that the temperature of the exhaust stream remain in a narrow range (550 F to 750 F or 288 C to 399 C) and is restricted to applications with a heat recovery system installed in the exhaust. The SCR is installed at a location in the boiler where the exhaust gas temperature has decreased to the above temperature range. New high-temperature SCR technology is being developed that may allow SCRs to be used for applications without heat recovery boilers.

For an MS7001EA gas turbine, an SCR designed to remove 90% of the NO_x from the gas turbine exhaust stream has a volume of approximately 175 cubic meters and weighs 111 tons. It is comprised of

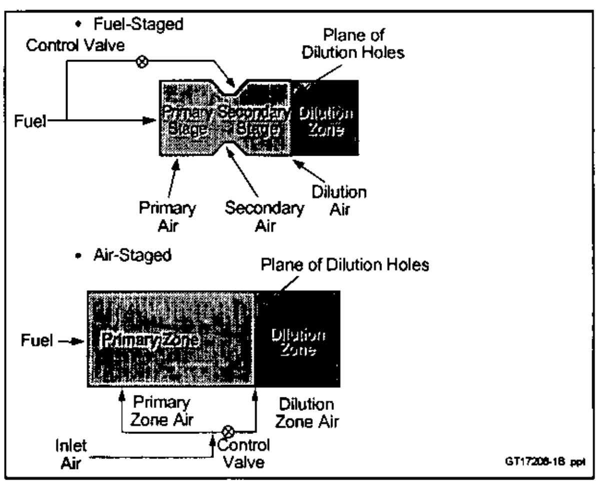

Figure A4. Staged combustors

segments stacked in the exhaust duct. Each segment has a honeycomb pattern with passages that are aligned in the direction of the exhaust gas flow. A catalyst, such as vanadium pentoxide, is deposited on the surface of the honeycomb.

SCR systems are sensitive to fuels containing more than 1,000 ppm of sulfur (light distillate oils may have up to 0.8% sulfur). There are two reasons for this sensitivity: first, sulfur poisons the catalyst being used in SCRs.

Secondly, the ammonia will react with sulfur in the presence of the catalyst to form ammonium bisulfate, which is extremely corrosive, particularly near the discharge of a heat recovery boiler. Special catalyst materials that are less sensitive to sulfur have been identified, and there are some theories as to how to inhibit the formation of ammonium bisulfate. This, however, remains an open issue with SCRs.

More than 100 GE units have accumulated more than 100,000 operating hours with SCRs installed. Twenty of the units are in Japan; others are located in California, New Jersey, New York and several other eastern U.S. states. Units operating with SCRs include MS9000s, MS7000s, MS6000s, LM2500s and LM5000s.

Lean premixed combustion is the basis for achieving low emissions from Dry Low NO_x and catalytic combustors. GE has participated in the development of catalytic combustors for many years. These systems use a catalytic reactor bed mounted within the combustor to burn a very lean fuel-air mixture. They have the potential to achieve extremely low emissions levels without resorting to exhaust gas cleanup. Technical challenges in the combustor and in the catalyst and reactor bed materials must be overcome in order to develop an operational catalytic combustor. GE has development programs in place with both ceramic and catalyst manufacturers to address these challenges. GE does not believe commercial systems employing this technology will be available in the near term.

REFERENCES

1. Washam, R. M., "Dry Low NO_x Combustion System for Utility Gas Turbine," ASME Paper 83-JPGC-GT-13, Sept. 1983.
2. Davis, L. B. and Washam, R. M., "Development of a Dry Low NO_x Combustor," ASME Paper No. 89-GT-255, June 1989.
3. Dibelius, N.R., Hilt, M.B., and Johnson, R.H., "Reduction of Nitrogen Oxides from Gas Turbines by Steam Injection," ASME Paper No. 71-GT-58, Dec. 1970
4. Miller, H. E., "Development of the Quiet Combustor and Other Design Changes to Benefit Air Quality," American Cogeneration Association, San Francisco, March 1988.
5. Cutrone, M. B., Hilt, M. B., Goyal, A., Ekstedt, E. E., and Notardonato, J., "Evaluation of Advanced Combustor for Dry NO_x Suppression with Nitrogen Bearing Fuels in Utility and Industrial Gas Turbines," ASME Paper 81-GT-125, March 1981.
6. Zeldovich, J., "The Oxidation of Nitrogen in Combustion and Explosions," Acta Physicochimica USSR, Vol. 21, No. 4, 1946, pp 577-628.
7. Washam, R. M., "Dry Low NO_x Combustion System for Utility Gas Turbine," ASME Paper 83-JPGC-GT-13, Sept. 1983.
8. Davis, L. B., and Washam, R. M., "Development of a Dry Low NO_x Combustor," ASME Paper No. 89-GT-255, June 1989.

LIST OF FIGURES

APPENDIX C

VENDOR SPEC SHEET

Florida Power Corp - Intercession City
ESTIMATED PERFORMANCE PG7121(EA)

Load Condition		BASE	
Ambient Temp.	Deg F.	59.	
Output	kW	84,090.	*
Heat Rate (LHV)	Btu/kWh	10,490.	*
Heat Cons. (LHV) X 10^6	Btu/h	882.1	
Exhaust Flow X 10^3	lb/h	2356.	
Exhaust Temp.	Deg F.	998. +/- 10 F	*
Exhaust Heat (LHV) X 10^6	Btu/h	561.6	

EMISSIONS

NOx	ppmvd @ 15% O2	9.	*
NOx AS NO2	lb/h	32.	
CO	ppmvd	25.	*
CO	lb/h	54.	
UHC	ppmvw	7.	
UHC	lb/h	9.	
Particulates (TSP)	lb/h	5.0	
Opacity		10%	*

EXHAUST ANALYSIS % VOL.

Argon	0.90
Nitrogen	74.92
Oxygen	13.86
Carbon Dioxide	3.22
Water	7.10

SITE CONDITIONS

Elevation	ft.	74.0
Site Pressure	psia	14.66
Inlet Loss	in Water	3.5
Exhaust Loss	in Water	5.5
Relative Humidity	%	60
Fuel Type		Cust Gas
Fuel LHV	Btu/lb	20831 @ 60 °F
Application		7A6 Air-Cooled Generator
Combustion System		9/42 DLN Combustor

Emission information based on GE recommended measurement methods. NOx emissions are corrected to 15% O2 without heat rate correction and are not corrected to ISO reference condition per 40CFR 60.335(c)(1). NOx levels shown will be controlled by algorithms within the SPEEDTRONIC control system.

* Guarantee Parameter

IPS- 80883 version code- 1 . 5 . 1 Opt: N 71210696
ALMSTEJO 6/16/99 13:08 Base Guar 59F Gas IBH.dat

Florida Power Corp - Intercession City
ESTIMATED PERFORMANCE PG7121(EA)

Load Condition		BASE	
Ambient Temp.	Deg F.	59.	
Output	kW	86,980.	*
Heat Rate (LHV)	Btu/kWh	10,940.	*
Heat Cons. (LHV) X 10^6	Btu/h	951.6	
Exhaust Flow X 10^3	lb/h	2407.	
Exhaust Temp.	Deg F.	993. +/- 10 F	*
Exhaust Heat (LHV) X 10^6	Btu/h	574.7	
Water Flow	lb/h	(* Guarantee not to exceed 51,500 lb/hr at this operating condition & fuel definition)	

EMISSIONS

NOx	ppmvd @ 15% O2	42.	*
NOx AS NO2	lb/h	167.	
CO	ppmvd	20.	*
CO	lb/h	43.	
UHC	ppmvw	7.	
UHC	lb/h	9.	
Particulates (TSP)	lb/h	10.0	
Opacity		10%	*

EXHAUST ANALYSIS % VOL.

Argon	0.88
Nitrogen	73.53
Oxygen	13.21
Carbon Dioxide	4.52
Water	7.86

SITE CONDITIONS

Elevation	ft.	74.0
Site Pressure	psia	14.66
Inlet Loss	in Water	3.5
Exhaust Loss	in Water	5.5
Relative Humidity	%	60
Fuel Type		Distillate, H/C Ratio of 1.8
Fuel LHV	Btu/lb	18300 @ 60 °F
Application		7A6 Air-Cooled Generator
Combustion System		9/42 DLN Combustor

Emission information based on GE recommended measurement methods. NOx emissions are corrected to 15% O2 without heat rate correction and are not corrected to ISO reference condition per 40CFR 60.335(c)(1). NOx levels shown will be controlled by algorithms within the SPEEDTRONIC control system.

Distillate Fuel is Assumed to have 0.015% Fuel-Bound Nitrogen, or less.
FBN Amounts Greater Than 0.015% Will Add to the Reported NOx Value.

* Guarantee Parameter
IPS- 80883 version code- 1 . 5 . 1 Opt: N 71210696
ALMSTEJO 6/16/99 13:02 Base Guar 59F Dist IBH.dat

APPENDIX D

CALPUFF ANALYSIS

CALPUFF CLASS I AREA ANALYSIS

INTRODUCTION

Florida Power Corporation (FPC) is proposing to construct three nominal 100-Mw combustion turbines (CT) at the existing Intercession City power plant located in Osceola County. The CTs will be fired with natural gas and distillate fuel oil with a maximum sulfur content of 0.05 percent. Based on the proposed maximum pollutant emission levels, the project is subject to the requirements under the Prevention of Significant Deterioration (PSD) regulations as part of new source review. The preliminary air modeling analysis performed by FPC using the Industrial Source Complex Short-Term (ISCST3) model (Version 98356) has indicated that the proposed project's maximum 24-hour average sulfur dioxide (SO_2) concentration was predicted to be slightly greater than the corresponding PSD Class I significant impact level (SIL), proposed by the Environmental Protection Agency's (EPA), at the Chassahowitzka National Wildlife Refuge (CNWR), a PSD Class I area. However, this value was predicted to occur only at one receptor for one 24-hour averaging period during the five years considered in the modeling analysis. Thus, the probability that the maximum project's concentrations would be greater than the significant impact levels is very low:

- one occurrence from a potential 1,826 24-hour average concentrations predicted at that receptor and
- one occurrence in about 23,700 24-hour average concentrations predicted for the entire receptor grid at the Chassahowitzka NWR;

For all other receptors for that year and at all receptors for other years, the maximum 24-hour SO_2 concentrations were predicted to be 15 percent or more lower than the significant impact level of 0.2 ug/m^3.

The CNWR is located approximately 113 kilometers (km) to the west, northwest of the project site. At distances beyond 50 km, the ISCST3 model is considered to overpredict air quality impacts because it is a steady-state model. To provide a more realistic assessment of the project's air quality impacts at the CNWR, Golder Associates Inc. (Golder) was contracted to perform a significant impact analysis at the PSD Class I area using the long-range transport model, California Puff model (CALPUFF, Version 5.0).

Currently, CALPUFF is not a recommended model in EPA's Guideline on Air Quality Models (40 CFR Part 51, Appendix W). As such, the model must be approved by EPA on a case-by-case basis. EPA is planning to formally propose incorporating CALPUFF into Appendix W at the 7th Conference on Air Quality Modeling currently planned for the fall of 1999. However, in the interim, the Federal Land Managers (FLM) and the Interagency Workgroup on Air Quality Modeling (IWAQM) are recommending the use of CALPUFF for all long-range transport assessments at PSD Class I areas.

A discussion of the CALPUFF model and modeling methodology used for this analysis and the air modeling results is presented in the following sections.

MODEL SELECTION

CALPUFF is a non-steady-state Lagrangian, Gaussian puff model appropriate for simulating air quality impacts over large distances. The model features include algorithms for simulating plume behavior over complex (i.e., terrain above stack plume height) terrain, plume transport over water bodies, coastal (i.e., land-sea air) interaction, chemical transformation, and wet and dry deposition and removal. CALPUFF can also incorporate the same building downwash effects currently used within the ISCST3 model. The model can be used in a screening mode by processing an "enhanced" ISCST3 meteorological data set, or in a refined mode by inputting a three-dimensional meteorological parameter data set generated by the meteorological preprocessor program CALMET. The "enhanced" meteorological data refers to the additional parameters used by the model. These parameters include relative humidity, precipitation, and solar radiation. CALMET produces this data set by inputting various surface, upper air, precipitation, land use, and terrain data over a region and processes this data for a predetermined modeling domain. A postprocessor program called CALPOST processes the CALPUFF-generated concentration or deposition data and produces output of pollutant species concentrations and depositions for various averaging times.

For this analysis, CALPUFF was used in a screening analysis mode, as recommended by the IWAQM Phase 2 Summary Report (12/98). The CALPUFF screening analysis is also referred to as the IWAQM Level II screening analysis or a CALPUFF "light" analysis. The following modeling procedures were used for the Phase II screening analysis.

- Five years of ISCST preprocessed meteorological data. The data set includes the standard ISCST model parameters of wind direction, wind speed, temperature, mixing height and atmospheric stability class, and additional parameters used for dry and wet deposition. These additional parameters include relative humidity, precipitation, and solar radiation.
- Location of receptors in a circle at radials separated by 2-degree intervals. The receptors are located on each radial at a distance that passes through the PSD Class I area. For this analysis, a radius of 113 km was used, which is the closest distance from the FPC project site to the CNWR.
- For SO2, use two pollutant species of SO_2 and SO_4.
- MESOPUFF II scheme for chemical transformation with CALPUFF default background concentrations of 80 and 10 ppb for ozone and ammonia, respectively
- Both dry and wet deposition and plume depletion
- Modeling domain extends 80 km beyond receptor grid.
- Agricultural, unirrigated land use; minimum mixing height of 50 m
- Transitional plume rise, stack-tip downwash, and partial plume penetration
- Puff plume element dispersion (Pasquill-Gifford), rural mode, and ISC building downwash scheme
- Partial plume path adjustment terrain effects
- Highest concentrations predicted in 5 years compared to allowable PSD increments.

BUILDING WAKE EFFECTS

The air modeling analysis included the proposed project's building dimensions to account for the effects of building-induced downwash on the emission sources. The building's dimensions were processed using the Building Profile Input Program (BPIP), Version 95086 and were included in the preliminary ISCST3 modeling analysis.

RECEPTOR LOCATIONS

Receptors were located along a circle that was centered over the FPC project site with a radius equal to the minimum distance to the CNWR (i.e., 113.2 km). The circle contained 180 receptors, equally spaced at 2-degree intervals. A second modeling analysis was performed with 13 receptors located only at the CNWR. Results for both sets of receptors are presented.

METEOROLOGICAL DATA

A 5-year data record was used that consisted of hourly surface observations taken from the National Weather Service (NWS) station at the Orlando International Airport (OIA), coupled with twice-daily mixing height data from the NWS station in Ruskin. The data record was for the years 1987 to 1991. Because certain required parameters of the enhanced data set were not available from the NWS at the OIA for the entire period of record (see discussion below), data from the NWS station at Tampa International Airport (TPA) was used as a substitute for those parameters during those years.

The surface and upper data were preprocessed into an ASCII modeling format by EPA's PCRAMMET meteorological preprocessing program. An anemometer height of 33 ft was used for the modeling analysis.

Additional meteorological parameters were added to the meteorological data records for use with the CALPUFF model. The addition parameters include:

1. Friction velocity,
2. Monin-Obukhov length,
3. Surface roughness used for calculating dry deposition,

4. Precipitation type code and precipitation rate used for calculating wet deposition,
5. Short-wave solar radiation, and
6. Relative humidity used for calculating chemical transformation rates.

The dry deposition parameters were added to the meteorological data records using the PCRAMMET model in dry deposition mode. Using the guidance provided in Section 3.1 of the PCRAMMET User's Manual (8/98), the following input values were selected:

1. Surface roughness at both application and measurement sites: 0.15 m,
2. Noontime Albedo: 0.2,
3. Bowen Ratio: 1.0,
4. Anthropogenic Heat flux: 0,
5. Minimum Monin-Obukhov Length: 2 m, and
6. Fraction of Net Radiation Absorbed by Ground: 0.15.

Hourly precipitation data were obtained from the NWS stations at OIA (1990 to 1991) and TPA (1987 to 1989). A precipitation code value was determined for each hour, based on the precipitation classification scheme provided in Table 2-11 of the CALPUFF Users' Manual (7/95). An hour during which no precipitation occurred received a precipitation code value of zero. Hours with precipitation amounts of 0.01 to 0.1, inches, greater than 0.1 to 0.3 inches and greater than 0.3 inches, received precipitation codes of 1, 2, or 3, respectively. These codes are indicative of slight, moderate and heavy rain, respectively. Hourly relative humidity and short-wave radiation data were added to the meteorological data record for each of the 5 years. The relative humidity data were obtained from the NWS station at OIA (1990 to 1991) and from the NWS station at TPA (1987 to 1989), while the radiation data were obtained from the NWS station at TPA for all years. The addition parameters were obtained from the National Climatic Data Center's Solar and Meteorological Surface Observation Network (SAMSON) and Hourly United States Weather Observations (HUSWO) CDs.

EMISSION INVENTORY

Source parameter and emission rate data used for the CALPUFF modeling analysis are identical to that used by FPC for their ISCST3 air modeling analysis.

RESULTS

CIRCLE OF 180 RECEPTORS

The results of the Level II screening analysis are summarized in Table 1. The highest and second-highest 24-hour predicted concentrations are 0.13 and 0.11 ug/m^3. These concentrations are below the proposed EPA Class I significant impact level of 0.2 ug/m^3.

RECEPTORS AT CHASSAHOWITZKA NWA

The results of the Level II screening analysis are summarized in Table 1. The highest and second-highest 24-hour predicted concentrations are 0.094 and 0.072 ug/m^3. These concentrations are well below the proposed EPA Class I significant impact level of 0.2 ug/m^3.

Department of Environmental Protection

Jeb Bush
Governor

Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

David B. Struhs
Secretary

June 22, 1999

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

Mr. W. Jeffrey Pardue, C.E.P
Director, Environmental Services
Florida Power Corporation
P.O. Box 14042, MAC BB1A
St. Petersburg, FL 33733

Re: DRAFT Permit No. 097-0014-003-AC (PSD-FL-268)
FPC Intercession City Plant
Propose Peaking Gas Turbines

Dear Mr. Pardue:

On May 25, 1999, the Department received your application to install three new GE Frame 7EA combustion turbines to provide additional peaking power at FPC's Intercession City plant. After review of the application, the Department has determined that the additional information listed below is necessary to process this request.

1. Summary of Project: The project consists of three identical Model PG 7121EA combustion turbines manufactured by General Electric, each capable of generating 87.3 MW of electrical power. The primary fuel will be pipeline natural gas with low sulfur distillate oil as a backup. NOX will be controlled by DLN combustion technology when firing gas and water injection when firing oil. A cooling system will reduce the temperature of the inlet air to the turbine to a nominal 59°F. The applicant requests the flexibility to be able to operate any combination of the three combustion turbines up to a maximum of 10,170 turbine hours per year of which 3000 turbine hours may be on low sulfur oil. This equates to 3390 hours of operation per year per turbine with maximum oil firing of 1000 hours per year per turbine. Startup of the combustion turbines is on oil. Is this information correct? Please provide a description of the inlet air cooling system and equipment. What is the purpose of "lighting off" the units on oil?

2. NOx BACT Determination: The application references the "quiet" combustor and the "9/42" combustor. Please specify the dry low-NOx combustor to be used (i.e., DLN 1.0, 2.0. 2.6, etc.) and provide the manufacturer's description of how this design inhibits the formation of NOx. Also, please provide the manufacturer's guarantee to meet the proposed NOx emission limits of 9.0/42 ppmvd @ 15% oxygen for gas/oil firing.

3. CO BACT Determination: The application proposes CO emission limits of 25/20 ppmvd @ 15% oxygen for gas/oil firing. In general, available information for a variety of manufacturers and models of combustion turbines seems to indicate higher CO emissions when firing oil than when firing gas (the opposite of the proposed limits). Please verify the CO limits for gas/oil firing and provide the manufacturer's guarantee.

4. Air Quality Impact Analysis: The Department received the ISCST3 model output files on June 17th. Based on review of this new information, we may have additional modeling questions.

   The application indicates that the SCREEN3 model results were used as inputs to the ISCST3 model. The emission rates used in the SCREEN3 modeling were for a single combustion turbine. Did the ISCST3 modeling consider simultaneous operation of all three proposed turbines?

   The modeling analysis summary indicates an exceedance of the 24-hour PSD Class I significance level for SO_2. Please provide a modeling analysis including other major sources from the area using ISCST3.

5. Maximum SO_2 Emissions Rate: What was the basis for the SO_2 emissions rate when burning distillate oil? I calculate 56.43 pounds per hour based on a maximum firing rate of 8038 gallons per hour and oil containing 0.05% sulfur by weight with a density of 7.02 pounds per gallon. Although this is a very small difference, please use the higher emissions rate for any additional SO_2 modeling.

6. Additional Impacts Analysis: Please model regional haze and visibility impacts with CALPUFF for this project.

7. NPS Comments: Conversations with the National Parks Services (NPS) indicate they will have questions and comments regarding this project. When available, the Department will forward these comments for your response.

The Department will resume processing this application after receipt of the requested information. Rule 62-4.050(3), F.A.C. requires that all applications for a Department permit must be certified by a professional engineer registered in the State of Florida. This requirement also applies to Department requests for additional information of an engineering nature. Permit applicants are advised that Rule 62-4.055(1), F.A.C. now requires applicants to respond to requests for additional information within 90 days. If there are any questions, please call me at 850/414-7268. Matters regarding modeling issues should be directed to Chris Carlson (Department meteorologist) at (850) 921-9537.

Sincerely,

Jeffery J. Koerner

Jeffery F. Koerner, P.E.
New Source Review Section

JFK/jfk

cc: Jennifer L. Tillman, P.E., FPC
J. Michael Kennedy, Q.E.P., FPC
Mr. Greg Worley, EPA
Mr. John Bunyak, NPS
Len Kozlov, DEP Central District

Z 333 618 164

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PS Form 3800, April 1995

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- Complete items 3, 4a, and 4b.
- Print your name and address on the reverse of this form so that we can return this card to you.
- Attach this form to the front of the mailpiece, or on the back if space does not permit.
- Write *"Return Receipt Requested"* on the mailpiece below the article number.
- The Return Receipt will show to whom the article was delivered and the date delivered.

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Consult postmaster for fee.

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Jeffrey Pardue, CEP
FPC
PO Box 14042 MACBOIA
St. Pete, Fl
33733

4a. Article Number
Z 333 618 164

4b. Service Type
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☐ Express Mail ☐ Insured
☐ Return Receipt for Merchandise ☐ COD

7. Date of Delivery
JUN 24 1999

5. Received By: *(Print Name)*

8. Addressee's Address *(Only if requested and fee is paid)*

6. Signature: (Addressee or Agent)

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Thank you for using Return Receipt Service.

Florida Power
CORPORATION

RECEIVED

JUN 16 1999

BUREAU OF
AIR REGULATION

June 16, 1999

Mr. Cleve Holladay
New Source Review Section
Bureau of Air Regulation
Florida Department of Environmental Protection
2600 Blair Stone Rd.
Tallahassee, Florida 32399

Dear Mr. Holladay:

Re: Modeling Files for Intercession City

PSD - FL - 268

The purpose of this letter is to transmit the air quality dispersion modeling files for Florida Power Corporation's (FPC) proposed Intercession City Units P12 - P14 permit application. Due to the volume of information contained in these files, they were not included as part of the application document. The ISCST3 input and output files from the refined modeling analysis are contained on the two diskettes included with this letter. In order to identify the files, the following describes the file naming system:

Filename: icxxx.zii

ic - refers to Intercession City
xxx - pollutant designation (SO_2, NO_2, PM, CO)
z - denotes input (I) or output (o) file
ii - denotes year of meteorological data (87 through 91)

Please feel free to review these files in conjunction with the PSD permit application review. Please contact me at (727) 826-4334 if you have any questions.

Sincerely,

J. Michael Kennedy, Q.E.P.
Manager, Air Programs

Florida Power
CORPORATION

RECEIVED

JUN 10 1999

BUREAU OF AIR REGULATION

June 3, 1999

Mr. Jeff Koerner, P.E.
Bureau of Air Regulation
Florida Department of Environmental Protection
2600 Blair Stone Rd.
Tallahassee, Florida 32399-2400

Dear Mr. Koerner:

Re: Intercession City PSD Application Sections 7 and 8

I have enclosed a clean copy of Sections 7 and 8 of the PSD permit application for proposed Units P12 - P14 at Florida Power Corporation's (FPC) Intercession City facility. Several pages were missing from the copies that were distributed.

I apologize for the error and hope that it has not inconvenienced you. Please contact Scott Osbourn at (727) 826-4258 or me at (727) 826-4334 if you have any questions.

Sincerely,

J. Michael Kennedy

J. Michael Kennedy, Q.E.P.
Manager, Air Programs

EPA
NPS
Central District

ONE POWER PLAZA, 263 - 13th Avenue South, BB1A, St. Petersburg, FL 33701-5511 •
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7.0 AIR QUALITY IMPACT ANALYSIS RESULTS

This section summarizes the results of the modelling analyses conducted as described in Section 6.0.

7.1 Intercession City Units P12 - P14

7.1.1 Worst-case Operation Analysis

As indicated in Section 6.4.1, the proposed facility was evaluated for both the primary fuel (natural gas) and the back-up fuel (fuel oil) to determine the worst-case impacts. Since the emissions on fuel oil are higher for the criteria pollutants than for natural gas, the analysis of short-term impacts focused on the fuel oil case. Based on the results of the SCREEN3 analysis, it was determined that 100% load would produce the maximum ground-level impacts for NOx and SO_2. For PM, the worst-case impacts occur at 25% load, and for CO emissions the worst case occurred at 50% load.

For conservatism, all model analyses, including those for annual average concentrations, were run using the worst-case oil-firing emissions described above for year-round operation. In reality, oil-firing will occur a maximum equivalent of 1,000 hours per year per unit.

7.1.2 Significant Impact Analysis

Once the worst-case operating scenario was determined, the next step in the analysis was to determine whether the ambient air quality impact from the proposed units is considered significant under the PSD rules. The worst-case emissions scenario for each pollutant was modeled at the receptor locations described in Section 6.5.1.

The results of the significant impact analysis are presented in Table 7-1. As indicated in Table 7-1, there were no predicted impacts greater than the PSD significance thresholds. Thus, no further analysis is required for purposes of PSD increment consumption and AAQS compliance analysis. A complete set of the ISCST3 model output files have been submitted to the FDEP under separate cover.

7.2 PSD INCREMENT ANALYSIS

7.2.1 Class II Area

Because the maximum predicted ambient air quality impacts are less than the PSD significance levels, no additional PSD Class II increment analysis is required.

7.2.2 Class I Area

Although the proposed project will be located approximately 113 km from the nearest boundary of the nearest Class I PSD area, which is the Chassahowitzka National Wilderness Area (NWA), the impacts of the proposed project were modelled. In its proposed New Source Review reform package, EPA has proposed PSD significance levels for Class I areas. FDEP has approved the use of these proposed values for purposes of assessing significant impacts at Class I areas in. These values are listed in Table 7-2.

A summary of the project's maximum predicted impact on the Class I area is presented in Table 7-2. As indicated, the predicted maximum impacts are below the EPA significance values for particulate matter (PM), SO_2, and NO_2, with the exception of one 24-hour SO_2 average. This single value occurred on February 19, 1991, showing a predicted value of 0.23 ug/m^3. Examination of the meteorological data for this day reveals that 8 calm hours occurred during the day. The model conservatively assumes that, during calm periods, the wind direction remains constant when in fact the wind is not moving in any direction. It is unlikely that the plume from the Intercession City units could travel the 113-km distance to the NWA under such conditions. In addition, the model analysis assumes that all three units operated on oil at maximum load for the entire 24-hour period. Since these are peaking units, this scenario would not actually occur, so the analysis is quite conservative. All other modelled periods resulted in predicted concentrations well below the Class I significance levels. Therefore, the expected impact on the NWA is less than significant.

7.3 Air Toxics Analysis

Concentrations of sulfuric acid mist were modelled with ISCST3 in the same way that SO_2 was modelled. As with SO_2, highest emissions of this pollutant occur while using fuel oil. The predicted maximum 24-hour average concentration of sulfuric acid mist is 0.05 ug/m^3. This is well below the former FDEP ambient reference concentration (ARC) of 2.4 ug/m^3. Therefore, no adverse impacts will occur from emissions of sulfuric acid mist.

TABLE 7-1

SUMMARY OF SIGNIFICANT IMPACT ANALYSIS CONCENTRATIONS

PSD CLASS II AREAS

Pollutant	Averaging Period	Maximum (1) Predicted Concentration (ug/m^3)	Location (2)		Year	Significance Level (ug/m^3)	Distance to Significance (km)	Significant Impact (Yes/No)
			East (km)	North (km)				
Carbon Monoxide	1-Hour	73.6	447.45	3125.0	1988	2,000	None	No
	8-Hour	17.2	433.31	3133.5	1991	500	None	No
Nitrogen Dioxide	Annual	0.13	437.64	3121.0	1990	1	None	No
Sulfur Dioxide	3-Hour	2.44	427.51	3119.2	1988	25	None	No
	24-Hour	0.50	433.31	3133.5	1991	5	None	No
	Annual	0.04	437.64	3121.0	1990	1	None	No
Particulate Matter (PM_{10}) (3)	24-Hour	0.16	433.31	3133.5	1991	5	None	No
	Annual	0.01	446.30	3131.0	1991	1	None	No
Sulfuric Acid Mist	24-Hour	0.05	433.31	3133.5	1991	N/A	N/A	N/A

(1) Short-term values are highest values for this analysis.
(2) With respect to zero point of 446.30 km E; 3,126.0 km N.
(3) As a conservative approach, all project emissions of particulate matter were assumed to be in the form of PM_{10}.

N/A = Not applicable

FPC, 1999

TABLE 7-2

SUMMARY OF MAXIMUM MODELED IMPACTS VS.
PSD CLASS I SIGNIFICANCE VALUES

Pollutant	Averaging Period	Highest Modeled Concentration (ug/m^3)	PSD Class I Signif. Level (ug/m^3)	Significance
Sulfur Dioxide (SO_2)	3-Hour	0.91	1.0	NO
	24-Hour	0.23	0.2	NO*
	Annual	0.01	0.1	NO
Particulate Matter (PM_{10})	24-Hour	0.04	0.3	NO
	Annual	0.002	0.2	NO
Nitrogen Dioxide (NO_2)	Annual	0.03	0.1	NO

* Refer to discussion in Section 7.2.2

8.0 ADDITIONAL IMPACTS

8.1 INTRODUCTION

The PSD guidelines indicate that, in addition to demonstrating that the proposed source will neither cause nor contribute to violations of the applicable PSD increments and AAQS, an additional impacts analysis must be conducted for those pollutants subject to PSD review. As indicated in Table 3-2, those pollutants include CO, NO_X, SO_2, PM, VOC (O_3), and sulfuric acid mist. This additional impacts analysis includes an analysis of air quality impacts due to growth induced by the project, an analysis of air quality impacts on soils and vegetation, and an analysis of project impacts on visibility.

As has been demonstrated in Section 7.0 of this application, the proposed project will have an insignificant impact at the NWA, located from 113 to 128 km from the proposed sources. In spite of this distance, FPC is providing a general assessment of the impact of Units P12 - P14 on air quality-related values (AQRV) as a part of this application.

8.2 IMPACTS DUE TO GROWTH

The growth analysis considers air quality impacts due to emissions resulting from the industrial, commercial, and residential growth associated with the project. Only impacts related to permanent growth are considered; emissions from temporary sources and mobile sources are not addressed in the growth analysis.

Negligible growth is expected to occur as a result of the proposed units. The units are being added to a facility that already contains 11 combustion turbine units. Therefore, existing facility staff will operate the units.

Development of industries supporting the new facility are expected to be negligible. Raw materials consumed by the facility (fuels, supplies, etc.) will be delivered to the site in usable form from outside of the region.

Electricity sales, on the other hand, will be spread out over a large region as part of FPC's generating capacity that will serve to meet increasing residential, commercial, and industrial demand throughout its system, which covers a large portion of the state of Florida.

In summary, there will be little residential growth associated with the FPC project, and there is little potential for new industrial development nearby as a result of the new facility. Impacts resulting from the new development are expected to be small and well-distributed throughout the area.

8.3 VEGETATION, SOILS, AND WILDLIFE ANALYSES

As previously discussed, the expected maximum impacts from Units P12 - P14 on the NWA are less than the PSD Class I and Class II significance levels. Therefore, the project will have a negligible impact on the soils, vegetation, wildlife, and visibility of the area surrounding the plant as well as the more distant Class I area. A general discussion of air quality-related values (AQRVs) of the NWA follows.

The U.S. Department of the Interior (National Park Service) in 1978 administratively defined AQRVs to be: All those values possessed by an area except those that are not affected by changes in air quality and include all those assets of an area whose vitality, significance, or integrity is dependent in some way upon the air environment. These values include visibility and those scenic, cultural, biological, and recreational resources of an area that are affected by air quality. Important attributes of an area are those values or assets that make an area significant as a national monument, preserve, or primitive area. They are assets that are to be preserved if the area is to achieve the purposes for which it was set aside.

In a November 1996 report entitled "Air Quality and Air Quality Related Values in Chassahowitzka National Wildlife Refuge and Wilderness Area," the US Fish and Wildlife Service discussed vegetation, soils, wildlife, visibility, and water quality as potential AQRVs in the NWA. Effects from air pollution on visibility have been evaluated in the NWA, but the other potential AQRVs have not been specifically evaluated by the Fish and Wildlife Service for Chassahowitzka. Since specific AQRVs have not been identified for the Chassahowitzka NWA, this AQRV analysis evaluates the effects of air quality on general vegetation types and wildlife found on the Chassahowitzka NWA. Vegetation type AQRVs and their representative species types have been defined as:

Marshlands - black needlerush, saw grass, salt grass, and salt marsh cordgrass

Marsh Islands - cabbage palm and eastern red cedar

Estuarine Habitat - black needlerush, salt marsh cordgrass, wax myrtle

Hardwood Swamp - red maple, red bay, sweet bay and cabbage palm

Upland Forests - live oak, scrub oak, longleaf pine, slash pine, wax myrtle and saw palmetto

Mangrove Swamp - red, white and black mangrove

Wildlife AQRVs included: endangered species, waterfowl, marsh and waterbirds, shorebirds, reptiles and mammals.

A screening approach was used which compared the maximum predicted ambient concentration of air pollutants of concern in the Chassahowitzka NWR with effect threshold limits for both vegetation and wildlife as reported in the scientific literature. A literature search was conducted which specifically addressed the effects of air contaminants on plant species reported to occur in the NWR. While the literature search focused on such species as cabbage palm, eastern red cedar, lichens and species of the hardwood swamplands and mangrove forest, no specific citations that addressed these species were found. It was recognized that effect threshold information is not available for all species found in the Chassahowitzka NWR, although studies have been performed on a few of the common species and on other similar species which can be used as models. Maximum concentrations and depositions were predicted using the ISCST model and five years of meteorological data as described in Sections 6.0 and 7.0.

8.3.1 Vegetation

The effects of air contaminants on vegetation occur primarily from sulfur dioxide, nitrogen dioxide, ozone, and particulates. Effects from minor air contaminants such as fluoride, chlorine, hydrogen chloride, ethylene, ammonia, hydrogen sulfide, carbon monoxide, and pesticides have been reported in the literature. However, most of these air contaminants have not resulted in major effects (i.e., crop damage). Some air contaminants, such as ethylene, are widely distributed but, due to low concentrations, do not result in injury to plants. Others such as CO do not cause damage at concentrations normally found under ambient concentrations. There are no predicted fluoride emissions from the proposed project.

Injury to vegetation from exposure to various levels of air contaminants can be termed acute, physiological or chronic. Acute injury occurs as a result of a short-term exposure to a high contaminant concentration and is typically manifested by visible injury symptoms ranging from chlorosis (discoloration) to necrosis (dead areas). Physiological or latent injury occurs as the result of a long-term exposure to contaminant concentrations below that which results in acute injury symptoms, while chronic injury results from repeated exposure to low concentrations over extended periods of time, often without any visible symptoms, but with some effect on the overall growth and productivity of the plant.

Since expected maximum pollutant concentrations at the NWA are below significance levels, no adverse effects to vegetation will be caused by the proposed project.

8.3.2 Soils

Air contaminants can affect soils through fumigation by gaseous forms, accumulation of compounds transformed from the gaseous state, or by the direct deposition of particulate matter or particulate matter to which certain contaminants are absorbed. Gaseous fumigation of soils does not directly affect the soil but rather the organisms found in the soil. Concentrations several orders of magnitude higher than the predicted values are required before any adverse effects from fumigation are observed. It is more likely that effects on soils and the organisms (plants and animals) found in the soils could occur from the deposition of trace elements over the life of the project. Thus, this analysis of effects on soils specifically addresses the deposition of trace elements and potential pathways for movements into the vegetation.

8.3.2.1 Lead

Lead (Pb) is found naturally occurring in all plants, although it is nonessential for growth (Chapman, 1966; Valkovic, 1975; Gough and Shacklette, 1976). Plants vary in their sensitivity to lead. Many plants tolerate high concentrations of lead, while others exhibit retarded growth at 10 ppm in solution culture (Valkovic, 1975). Orange seedlings grown on soils with lead concentrations ranging from 150-200 ppm did not exhibit adverse effects (Chapman, 1966). Gough et al. (1979) reported that a lead soil concentration of 30 to 100 g/g generally retarded the growth of plants. The negligible amount of lead emissions from Units P12 - P14 will not contribute to a soil concentration toxic to plants.

8.3.2.2 Mercury

Mercury (Hg) is not an essential element for plant growth. It is typically used as a seed fungicide. In general, Hg is not concentrated in plants grown on soils containing normal levels of Hg. Soil bound Hg is typically not available for plant uptake, although many plants cannot prevent the uptake of gaseous Hg through the roots (Huckabee and Jansen, 1975). Most higher vascular plants are resistant to toxicity from high Hg concentrations even though high concentrations are present in plant tissue. Concentrations of 0.5-50 ppm (HgCl2) were found to inhibit the growth of cauliflower, lettuce, potato, and carrots (Bell and Rickard, 1974). Gough et al. (1979) noted apparently healthy spanish moss plants with a mercury content of 0.5 mg/kg. The extremely small amount of mercury emissions from the proposed units will not contribute to concentrations that are toxic to plants.

8.3.3 Wildlife

Compared with other threats to wildlife, such as pesticides, the toxicological relationships between air pollution and effects on wildlife are not well understood (Newman and Schreiber, 1988). The limited understanding is based primarily on reports of symptoms observed in the field and on information extrapolated from laboratory studies. Information on controlled wildlife studies is limited in the scientific literature. Most studies report symptoms of various air pollutants but do not provide toxicity levels. Those studies that do provide toxicity levels are limited to four air contaminants, SO_2, NO_2, O_3, and particulates.

Since the expected maximum pollutant impacts are less than Class I significance levels, no adverse impacts to wildlife will occur from the proposed facility emissions.

In addition to the impacts on wildlife from the primary pollutants, the Fish and Wildlife Service is concerned about the effects on wildlife resulting from acid deposition (FWS, 1992). Existing acid deposition conditions in Florida were investigated during the five year Florida Acid Deposition Study (ESE, 1986 and 1987) and the two year follow-up program called the Florida Acid Deposition Monitoring Program (ESE, 1988 and 1989). The data collected in these programs indicate that Florida precipitation is only about two-thirds as acidic as precipitation across the southeastern United States and less than half as acidic as precipitation in the midwestern and northeastern United States (ESE, 1988). There is no evidence of a temporal trend in precipitation acidity since the late 1970s (ESE, 1989). The Clean Air Act Amendments of 1990 require significant reductions in SO_2 and NO_2 emissions from existing uncontrolled utility plants nationwide and some of these reductions will occur at plants in the general vicinity of the NWA. These emission reductions will undoubtedly improve on the already good estimated acid deposition conditions in the NWR.

Due to the small emission increases that will be caused by the proposed project and the resulting insignificant concentrations, increase, if any in acid deposition will be negligible.

8.4 VISIBILITY IMPACTS

The maximum predicted SO_2 and NOx impacts from the proposed units have been determined to be less than the Class I significance levels. Therefore, there will be little, if any incremental impact to the area's visibility.

Florida Power CORPORATION

FAXED TO ELLEN PORTER, FWS
ON 6/4 BY J. KOERNER

Date: 6/2/99

To: Jeff Koerner

FAX #: (850) 922-6979

Phone #: ( )

From: Mike Kennedy

FAX #: (727) 826-4216

Phone #: (727) 826-4334

10 Total number of pages including cover page.

Please notify ______________ at (727) 826 - ______________ for any problems concerning the receipt of this FAX.

Comments:

Complete Sections 7 and 8 from the Intercession City PSD application. Sorry about the mistake. I'll send a clean copy through the mail.

7.0 AIR QUALITY IMPACT ANALYSIS RESULTS

This section summarizes the results of the modelling analyses conducted as described in Section 6.0.

7.1 Intercession City Units P12 - P14

7.1.1 Worst-case Operation Analysis

As indicated in Section 6.4.1, the proposed facility was evaluated for both the primary fuel (natural gas) and the back-up fuel (fuel oil) to determine the worst-case impacts. Since the emissions on fuel oil are higher for the criteria pollutants than for natural gas, the analysis of short-term impacts focused on the fuel oil case. Based on the results of the SCREEN3 analysis, it was determined that 100% load would produce the maximum ground-level impacts for NOx and SO_2. For PM, the worst-case impacts occur at 25% load, and for CO emissions the worst case occurred at 50% load.

For conservatism, all model analyses, including those for annual average concentrations, were run using the worst-case oil-firing emissions described above for year-round operation. In reality, oil-firing will occur a maximum equivalent of 1,000 hours per year per unit.

7.1.2 Significant Impact Analysis

Once the worst-case operating scenario was determined, the next step in the analysis was to determine whether the ambient air quality impact from the proposed units is considered significant under the PSD rules. The worst-case emissions scenario for each pollutant was modeled at the receptor locations described in Section 6.5.1.

The results of the significant impact analysis are presented in Table 7-1. As indicated in Table 7-1, there were no predicted impacts greater than the PSD significance thresholds. Thus, no further analysis is required for purposes of PSD increment consumption and AAQS compliance analysis. A complete set of the ISCST3 model output files have been submitted to the FDEP under separate cover.

7.2 PSD INCREMENT ANALYSIS

7.2.1 Class II Area

Because the maximum predicted ambient air quality impacts are less than the PSD significance levels, no additional PSD Class II increment analysis is required.

7.2.2 Class I Area

Although the proposed project will be located approximately 113 km from the nearest boundary of the nearest Class I PSD area, which is the Chassahowitzka National Wilderness Area (NWA), the impacts of the proposed project were modelled. In its proposed New Source Review reform package, EPA has proposed PSD significance levels for Class I areas. FDEP has approved the use of these proposed values for purposes of assessing significant impacts at Class I areas in. These values are listed in Table 7-2.

A summary of the project's maximum predicted impact on the Class I area is presented in Table 7-2. As indicated, the predicted maximum impacts are below the EPA significance values for particulate matter (PM), SO_2, and NO_2, with the exception of one 24-hour SO_2 average. This single value occurred on February 19, 1991, showing a predicted value of 0.23 ug/m^3. Examination of the meteorological data for this day reveals that 8 calm hours occurred during the day. The model conservatively assumes that, during calm periods, the wind direction remains constant when in fact the wind is not moving in any direction. It is unlikely that the plume from the Intercession City units could travel the 113-km distance to the NWA under such conditions. In addition, the model analysis assumes that all three units operated on oil at maximum load for the entire 24-hour period. Since these are peaking units, this scenario would not actually occur, so the analysis is quite conservative. All other modelled periods resulted in predicted concentrations well below the Class I significance levels. Therefore, the expected impact on the NWA is less than significant.

7.3 Air Toxics Analysis

Concentrations of sulfuric acid mist were modelled with ISCST3 in the same way that SO_2 was modelled. As with SO_2, highest emissions of this pollutant occur while using fuel oil. The predicted maximum 24-hour average concentration of sulfuric acid mist is 0.05 ug/m^3. This is well below the former FDEP ambient reference concentration (ARC) of 2.4 ug/m^3. Therefore, no adverse impacts will occur from emissions of sulfuric acid mist.

TABLE 7-1
SUMMARY OF SIGNIFICANT IMPACT ANALYSIS CONCENTRATIONS
PSD CLASS II AREAS

Pollutant	Averaging Period	Maximum [1] Predicted Concentration ($\mu g/m^3$)	Location [2]		Year	Significance Level ($\mu g/m^3$)	Distance to Significance (km)	Significant Impact (Yes/No)
			East (km)	North (km)				
Carbon Monoxide	1-Hour	73.6	447.45	3125.0	1988	2,000	None	No
	8-Hour	17.2	433.31	3133.5	1991	500	None	No
Nitrogen Dioxide	Annual	0.13	437.64	3121.0	1990	1	None	No
Sulfur Dioxide	3-Hour	2.44	427.51	3119.2	1988	25	None	No
	24-Hour	0.50	433.31	3133.5	1991	5	None	No
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Particulate Matter (PM_{10}) [3]	24-Hour	0.16	433.31	3133.5	1991	5	None	No
	Annual	0.01	446.30	3131.0	1991	1	None	No
Sulfuric Acid Mist	24-Hour	0.05	433.31	3133.5	1991	N/A	N/A	N/A

(1) Short-term values are highest values for this analysis.
(2) With respect to zero point of 446.30 km E; 3,126.0 km N.
(3) As a conservative approach, all project emissions of particulate matter were assumed to be in the form of PM_{10}.

N/A = Not applicable

FPC, 1999

TABLE 7-2
SUMMARY OF MAXIMUM MODELED IMPACTS VS. PSD CLASS I SIGNIFICANCE VALUES

Pollutant	Averaging Period	Highest Modeled Concentration (ug/m^3)	PSD Class I Signif. Level (ug/m^3)	Significance
Sulfur Dioxide (SO_2)	3-Hour	0.91	1.0	NO
	24-Hour	0.23	0.2	NO*
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8.0 ADDITIONAL IMPACTS

8.1 INTRODUCTION

The PSD guidelines indicate that, in addition to demonstrating that the proposed source will neither cause nor contribute to violations of the applicable PSD increments and AAQS, an additional impacts analysis must be conducted for those pollutants subject to PSD review. As indicated in Table 3-2, those pollutants include CO, NO_X, SO_2, PM, VOC (O_3), and sulfuric acid mist. This additional impacts analysis includes an analysis of air quality impacts due to growth induced by the project, an analysis of air quality impacts on soils and vegetation, and an analysis of project impacts on visibility.

As has been demonstrated in Section 7.0 of this application, the proposed project will have an insignificant impact at the NWA, located from 113 to 128 km from the proposed sources. In spite of this distance, FPC is providing a general assessment of the impact of Units P12 - P14 on air quality-related values (AQRV) as a part of this application.

8.2 IMPACTS DUE TO GROWTH

The growth analysis considers air quality impacts due to emissions resulting from the industrial, commercial, and residential growth associated with the project. Only impacts related to permanent growth are considered; emissions from temporary sources and mobile sources are not addressed in the growth analysis.

Negligible growth is expected to occur as a result of the proposed units. The units are being added to a facility that already contains 11 combustion turbine units. Therefore, existing facility staff will operate the units.

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Electricity sales, on the other hand, will be spread out over a large region as part of FPC's generating capacity that will serve to meet increasing residential, commercial, and industrial demand throughout its system, which covers a large portion of the state of Florida.

In summary, there will be little residential growth associated with the FPC project, and there is little potential for new industrial development nearby as a result of the new facility. Impacts resulting from the new development are expected to be small and well-distributed throughout the area.

8.3 VEGETATION, SOILS, AND WILDLIFE ANALYSES

As previously discussed, the expected maximum impacts from Units P12 - P14 on the NWA are less than the PSD Class I and Class II significance levels. Therefore, the project will have a negligible impact on the soils, vegetation, wildlife, and visibility of the area surrounding the plant as well as the more distant Class I area. A general discussion of air quality-related values (AQRVs) of the NWA follows.

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8.3.1 Vegetation

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8.3.2 Soils

Air contaminants can affect soils through fumigation by gaseous forms, accumulation of compounds transformed from the gaseous state, or by the direct deposition of particulate matter or particulate matter to which certain contaminants are absorbed. Gaseous fumigation of soils does not directly affect the soil but rather the organisms found in the soil. Concentrations several orders of magnitude higher than the predicted values are required before any adverse effects from fumigation are observed. It is more likely that effects on soils and the organisms (plants and animals) found in the soils could occur from the deposition of trace elements over the life of the project. Thus, this analysis of effects on soils specifically addresses the deposition of trace elements and potential pathways for movements into the vegetation.

8.3.2.1 Lead

Lead (Pb) is found naturally occurring in all plants, although it is nonessential for growth (Chapman, 1966; Valkovic, 1975; Gough and Shacklette, 1976). Plants vary in their sensitivity to lead. Many plants tolerate high concentrations of lead, while others exhibit retarded growth at 10 ppm in solution culture (Valkovic, 1975). Orange seedlings grown on soils with lead concentrations ranging from 150-200 ppm did not exhibit adverse effects (Chapman, 1966). Gough et al. (1979) reported that a lead soil concentration of 30 to 100 g/g generally retarded the growth of plants. The negligible amount of lead emissions from Units P12 - P14 will not contribute to a soil concentration toxic to plants.

8.3.2.2 Mercury

Mercury (Hg) is not an essential element for plant growth. It is typically used as a seed fungicide. In general, Hg is not concentrated in plants grown on soils containing normal levels of Hg. Soil bound Hg is typically not available for plant uptake, although many plants cannot prevent the uptake of gaseous Hg through the roots (Huckabee and Jansen, 1975). Most higher vascular plants are resistant to toxicity from high Hg concentrations even though high concentrations are present in plant tissue. Concentrations of 0.5-50 ppm ($HgCl2$) were found to inhibit the growth of cauliflower, lettuce, potato, and carrots (Bell and Rickard, 1974). Gough et al. (1979) noted apparently healthy spanish moss plants with a mercury content of 0.5 mg/kg. The extremely small amount of mercury emissions from the proposed units will not contribute to concentrations that are toxic to plants.

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Compared with other threats to wildlife, such as pesticides, the toxicological relationships between air pollution and effects on wildlife are not well understood (Newman and Schreiber, 1988). The limited understanding is based primarily on reports of symptoms observed in the field and on information extrapolated from laboratory studies. Information on controlled wildlife studies is limited in the scientific literature. Most studies report symptoms of various air pollutants but do not provide toxicity levels. Those studies that do provide toxicity levels are limited to four air contaminants, SO_2, NO_2, O_3, and particulates.

Since the expected maximum pollutant impacts are less than Class I significance levels, no adverse impacts to wildlife will occur from the proposed facility emissions.

In addition to the impacts on wildlife from the primary pollutants, the Fish and Wildlife Service is concerned about the effects on wildlife resulting from acid deposition (FWS, 1992). Existing acid deposition conditions in Florida were investigated during the five year Florida Acid Deposition Study (ESE, 1986 and 1987) and the two year follow-up program called the Florida Acid Deposition Monitoring Program (ESE, 1988 and 1989). The data collected in these programs indicate that Florida precipitation is only about two-thirds as acidic as precipitation across the southeastern United States and less than half as acidic as precipitation in the midwestern and northeastern United States (ESE, 1988). There is no evidence of a temporal trend in precipitation acidity since the late 1970s (ESE, 1989). The Clean Air Act Amendments of 1990 require significant reductions in SO_2 and NO_2 emissions from existing uncontrolled utility plants nationwide and some of these reductions will occur at plants in the general vicinity of the NWA. These emission reductions will undoubtedly improve on the already good estimated acid deposition conditions in the NWR.

Due to the small emission increases that will be caused by the proposed project and the resulting insignificant concentrations, increase, if any in acid deposition will be negligible.

8.4 VISIBILITY IMPACTS

The maximum predicted SO_2 and NOx impacts from the proposed units have been determined to be less than the Class I significance levels. Therefore, there will be little, if any incremental impact to the area's visibility.

Department of Environmental Protection

Jeb Bush
Governor

Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

David B. Struhs
Secretary

May 26, 1999

Mr. Gregg Worley, Chief
Air, Radiation Technology Branch
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Atlanta, Georgia 30303

Re: Florida Power Corporation – Intercession City Facility
0970014-003-AC, PSD-FL-268

Dear Mr. Worley:

Enclosed for your review and comment is an application for the above mentioned project. It consists of the addition of three nominal 87 MW GE Frame 7EA simple cycle combustion turbines to provide additional peaking power to the existing FPC plant.

The applicant has requested a NOx limit of 9ppm while operating on gas and 42ppm while operating on oil (1000 hours).

Your comments can be forwarded to my attention at the letterhead address or faxed to me at (850)922-6979. If you have any questions, please contact Jeff Koerner at (850)414-7268.

Sincerely,

5/26

A. A. Linero, P.E.
Administrator
New Source Review Section

AAL/kt

Enclosures

cc: Jeff Koerner, BAR

Department of Environmental Protection

Jeb Bush
Governor

Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

David B. Struhs
Secretary

May 26, 1999

Mr. John Bunyak, Chief
Policy, Planning & Permit Review Branch
NPS-Air Quality Division
Post Office Box 25287
Denver, CO 80225

Re: Florida Power Corporation – Intercession City Facility
0970014-003-AC, PSD-FL-268

Dear Mr. Bunyak:

Enclosed for your review and comment is an application for the above mentioned project. It consists of the addition of three GE Frame 7EA combustion turbines to provide additional peaking power to the existing FPC plant.

Your comments can be forwarded to my attention at the letterhead address or faxed to the Bureau at (850)922-6979. If you have any questions, please contact Jeff Koerner at (850)414-7268.

Sincerely,

A. A. Linero 5/26

A. A. Linero, P.E.
Administrator
New Source Review Section

AAL/kt

Enclosures

cc: Jeff Koerner, BAR