ENRON
Gas Pipeline Operating Company

P. O. Box 1188 Houston, Texas 77251-1188 (713) 853-6161

RECEIVED
DER - MAIL ROOM
1990 NOV 20 AM 10: 43

November 17, 1990

Clair Fancy, P.E.
Chief, Bureau of Air Regulation
Florida Department of Environmental Regulation
2600 Blair Stone Road
Tallahassee, FL 32301

Dear Mr. Fancy:

RE: Construction Permit Application - Compressor Station No. 18
Orange County, Florida - Florida Gas Transmission Company

This permit application, sent to you on behalf of Florida Gas Transmission Company (FGT), describes the expansion of FGT's Compressor Station No. 18. With net NO_x emissions exceeding 40 tons per year, this addition, a 2,400 horsepower reciprocating compressor engine, constitutes a major modification. The maximum estimated NO_x concentration from the proposed lean burn engine, however, is less than EPA's significant impact level.

This is the seventh of nine permit applications we plan to submit to FDER as part of FGT's Phase II expansion. We have spent a lot of time and effort to ensure that it is of highest quality. For example, the Best Available Control Technology (BACT) analysis follows EPA's (draft) top-down guideline, and capitalizes on what Enron has learned about guideline interpretation from its Northern Natural Gas Company Waterloo, Iowa station - a recently approved permit application that followed the draft guideline.

Since FGT's Phase II project is designed to bring clean fuel to Floridians by the 1991-92 heating season, and to displace foreign oil imports, we would ask that you review this permit application and issue the construction permit as soon as possible.

If you have any questions concerning this letter, please contact me at (713) 853-7303, or David Buff, KBN Engineering and Applied Sciences, Inc., Gainesville, Florida, at (904) 331-9000.

Sincerely,

W. Alan Bowman

W. Alan Bowman (Room 2570)
Project Environmentalist
Environmental Affairs Department

Enclosures: 8 Copies of Permit Application
Construction Permit Fee

cc: Jerry Murphy, Enron
Kevin McGlynn, Enron
David Buff, KBN

FAN1102wab

CHECK NO.
0822020236

ENRON CORP

ENRON GAS PIPELINE OPERATING COMPANY
P.O. BOX 1188
HOUSTON, TEXAS 77251-1188

DATE OF CHECK
10-19-90

This check is VOID unless printed on BLUE background

AMOUNT OF CHECK

EXACTLY $*******500 DOLLARS 00 CENTS $*******500.00

PAY TO THE ORDER OF
BUREAU OF AIR REGULATION
FLORIDA DEPARTMENT OF
ENVIRONMENTAL REGULATION
2600 BLAIR STONE ROAD
TALLAHASSEE, FL
32399-2400

BY [signature]
AUTHORIZED REPRESENTATIVE

UNITED BANK OF GRAND JUNCTION

⑈0822020236⑈ ⑆102100918⑆ 606 0033370⑈

CHECK NO. 0822020236

REMITTANCE STATEMENT
ENRON GAS PIPELINE OPERATING COMPANY

PAGE 001 OF 001

VOUCHER NO.	INVOICE DATE	INVOICE NUMBER	PURCHASE ORDER	AMOUNT GROSS	DISCOUNT	NET
9010001572	101790	CKR10179005		500.00	0.00	500.00
					TOTAL	500.00

C.S. No. 18 Construction Permit - FGT

50 < Q < 100 tpy

Special Instructions
CALL SUZY AT EXT 7304

P. O. BOX 1188, HOUSTON, TEXAS 77251-1188
DETACH STATEMENT BEFORE DEPOSITING. ENDORSEMENT OF CHECK ATTACHED ACKNOWLEDGES PAYMENT IN FULL OF ALL ITEMS SHOWN ABOVE. IN CASE OF ERROR OR OMISSION RETURN BOTH CHECK AND STATEMENT

PSD PERMIT APPLICATION
FLORIDA GAS TRANSMISSION COMPANY
COMPRESSOR STATION NO. 18

Prepared For:

Florida Gas Transmission Company
1400 Smith Street
Houston, TX 77251-1188

Prepared By:

KBN Engineering and Applied Sciences, Inc.
1034 NW 57th Street
Gainesville, FL 32605

November 1990
90051H1/P

STATE OF FLORIDA

Station No. 18

DEPARTMENT OF ENVIRONMENTAL REGULATION

$500 pd.
11-20-90
Recpt.# 151212

AC48-189456
PSD-FL-163

APPLICATION TO OPERATE/CONSTRUCT AIR POLLUTION SOURCES

SOURCE TYPE: Natural Gas Compressor Engine [X] New[1] [ ] Existing[1]

APPLICATION TYPE: [X] Construction [ ] Operation [ ] Modification

COMPANY NAME: Florida Gas Transmission Company COUNTY: Orange

Identify the specific emission point source(s) addressed in this application (i.e., Lime Kiln No. 4 with Venturi Scrubber; Peaking Unit No. 2, Gas Fired) Station 18, Unit No. 5

SOURCE LOCATION: Street 7990 Steer Lake Road City Orlando

UTM: East 17:451.86 km North 3154.79 km

Latitude 28 ° 31 ' 15 "N Longitude 81 ° 29 ' 31 "W

APPLICANT NAME AND TITLE: W. Alan Bowman, Project Environmentalist

APPLICANT ADDRESS: P.O. Box 1188, Houston, Texas 77251 Phone: (713) 853-7303

SECTION I: STATEMENTS BY APPLICANT AND ENGINEER

A. APPLICANT

I am the undersigned owner or authorized representative* of Florida Gas Transmission Co.

I certify that the statements made in this application for a construction permit are true, correct and complete to the best of my knowledge and belief. Further, I agree to maintain and operate the pollution control source and pollution control facilities in such a manner as to comply with the provision of Chapter 403, Florida Statutes, and all the rules and regulations of the department and revisions thereof. I also understand that a permit, if granted by the department, will be non-transferable and I will promptly notify the department upon sale or legal transfer of the permitted establishment.

*Attach letter of authorization

Signed: [signature]

C.L. Truby, Vice President
Name and Title (Please Type)

Date: 11-12-90 Telephone No. (713) 853-6161

B. PROFESSIONAL ENGINEER REGISTERED IN FLORIDA (where required by Chapter 471, F.S.)

This is to certify that the engineering features of this pollution control project have been designed/examined by me and found to be in conformity with modern engineering principles applicable to the treatment and disposal of pollutants characterized in the permit application. There is reasonable assurance, in my professional judgement, that

[1]See Florida Administration Code Rule 17-2.100(57) and (104)

the pollution control facilities, when properly maintained and operated, will discharge an effluent that complies with all applicable statutes of the State of Florida and the rules and regulations of the department. It is also agreed that the undersigned will furnish, if authorized by the owner, the applicant a set of instructions for the proper maintenance and operation of the pollution control facilities and, if applicable, pollution sources.

Signed _David A. Buff_

David A. Buff, P.E.
Name (Please Type)

KBN Engineering and Applied Sciences, Inc.
Company Name (Please Type)

1034 NW 57th Street, Gainesville, FL 32605
Mailing Address (Please Type)

Florida Registration No. 19011 Date: Nov. 17, 1990 Telephone No. (904) 331-9000

SECTION II: GENERAL PROJECT INFORMATION

A. Describe the nature and extent of the project. Refer to pollution control equipment, and expected improvements in source performance as a result of installation. State whether the project will result in full compliance. Attach additional sheet if necessary.

See PSD report, Section 1.0--Introduction, and
Section 2.0--Project Description

B. Schedule of project covered in this application (Construction Permit Application Only)

Start of Construction March 15, 1991 Completion of Construction 18 months after permit issuance

C. Costs of pollution control system(s): (Note: Show breakdown of estimated costs only for individual components/units of the project serving pollution control purposes. Information on actual costs shall be furnished with the application for operation permit.)

Not applicable

D. Indicate any previous DER permits, orders and notices associated with the emission point, including permit issuance and expiration dates.

Not applicable

E. Requested permitted equipment operating time: hrs/day 24 ; days/wk 7 ; wks/yr 52 ;
If power plant, hrs/yr _____; if seasonal, describe: ________________

F. If this is a new source or major modification, answer the following questions. (Yes or No)

1. Is this source in a non-attainment area for a particular pollutant? No
   a. If yes, has "offset" been applied? ________
   b. If yes, has "Lowest Achievable Emission Rate" been applied? ________
   c. If yes, list non-attainment pollutants. ________
2. Does best available control technology (BACT) apply to this source? If yes, see Section VI. Yes
3. Does the State "Prevention of Significant Deterioration" (PSD) requirement apply to this source? If yes, see Sections VI and VII. Yes
4. Do "Standards of Performance for New Stationary Sources" (NSPS) apply to this source? No
5. Do "National Emission Standards for Hazardous Air Pollutants" (NESHAP) apply to this source? No

H. Do "Reasonably Available Control Technology" (RACT) requirements apply to this source? No
   a. If yes, for what pollutants? ________
   b. If yes, in addition to the information required in this form, any information requested in Rule 17-2.650 must be submitted.

Attach all supportive information related to any answer of "Yes". Attach any justification for any answer of "No" that might be considered questionable.

See PSD Report, Section 3.0--Air Quality Review Requirements and Applicability

SECTION III: AIR POLLUTION SOURCES & CONTROL DEVICES (Other than Incinerators)

A. Raw Materials and Chemicals Used in your Process, if applicable:

Description	Contaminants		Utilization Rate - lbs/hr	Relate to Flow Diagram
	Type	% Wt		
Not applicable				

B. Process Rate, if applicable: (See Section V, Item 1)

1. Total Process Input Rate (lbs/hr): Not applicable

2. Product Weight (lbs/hr): Not applicable

C. Airborne Contaminants Emitted: (Information in this table must be submitted for each emission point, use additional sheets as necessary)

Name of Contaminant	Emission[1]		Allowed[2] Emission Rate per Rule 17-2	Allowable[3] Emission lbs/hr	Potential[4] Emission		Relate to Flow Diagram
	Maximum lbs/hr	Actual T/yr			lbs/hr	T/yr	
NO_x	10.6	46.3	BACT	BACT	10.6	46.3	
CO	11.1	48.7	N/A	N/A	11.1	48.7	
VOCs	2.6	11.6	N/A	N/A	2.6	11.6	
Particulates	0.08	0.36	N/A	N/A	0.08	0.36	
SO_2	0.47	2.04	N/A	N/A	0.47	2.04	

[1]See Section V, Item 2.

[2]Reference applicable emission standards and units (e.g. Rule 17-2.600(5)(b)2. Table II, E. (1) - 0.1 pounds per million BTU heat input)

[3]Calculated from operating rate and applicable standard.

[4]Emission, if source operated with~~out~~ control (See Section V, Item 3).

D. Control Devices: (See Section V, Item 4)

Name and Type (Model & Serial No.)	Contaminant	Efficiency	Range of Particles Size Collected (in microns) (If applicable)	Basis for Efficiency (Section V Item 5)
Lean Burn Engine Design	NO_x	80%	N/A	Design and
				AP-42

E. Fuels

Type (Be Specific)	Consumption*		Maximum Heat Input (MMBTU/hr)
	avg/hr	max/hr	
Natural Gas	0.0163	0.0163	16.80

*Units: Natural Gas--MMCF/hr; Fuel Oils--gallons/hr; Coal, wood, refuse, others--lbs/hr.

Fuel Analysis:

Percent Sulfur: 0.031 (by weight)* Percent Ash: NA

Density: 0.0455 lb/ft³ lbs/gal Typical Percent Nitrogen: NA

Heat Capacity: 22,637 (based on 1,030 Btu/scf) BTU/lb NA BTU/gal

Other Fuel Contaminants (which may cause air pollution): NA

F. If applicable, indicate the percent of fuel used for space heating.

Annual Average Not applicable Maximum

G. Indicate liquid or solid wastes generated and method of disposal.

Not applicable

*Based on contract limit of 10 gr/100 ft³ and gas at 0.0455 lb/ft³

H. Emission Stack Geometry and Flow Characteristics (Provide data for each stack):

Stack Height: 40 ft. Stack Diameter: 1.438 ft.

Gas Flow Rate: 15,627 ACFM 7,511 DSCFM Gas Exit Temperature: 550 °F.

Water Vapor Content: 8 % Velocity: 160.37 FPS

SECTION IV: INCINERATOR INFORMATION

Not Applicable

Type of Waste	Type 0 (Plastics)	Type II (Rubbish)	Type III (Refuse)	Type IV (Garbage)	Type IV (Patholog-ical)	Type V (Liq.& Gas By-prod.)	Type VI (Solid By-prod.)
Actual lb/hr Inciner-ated							
Uncon-trolled (lbs/hr)							

Description of Waste ______

Total Weight Incinerated (lbs/hr) ______ Design Capacity (lbs/hr) ______

Approximate Number of Hours of Operation per day ______ day/wk ______ wks/yr. ______

Manufacturer ______

Date Constructed ______ Model No. ______

	Volume $(ft)^3$	Heat Release (BTU/hr)	Fuel		Temperature (°F)
			Type	BTU/hr	
Primary Chamber					
Secondary Chamber					

Stack Height: ______ ft. Stack Diamter: ______ Stack Temp. ______

Gas Flow Rate: ______ ACFM ______ DSCFM* Velocity: ______ FPS

*If 50 or more tons per day design capacity, submit the emissions rate in grains per standard cubic foot dry gas corrected to 50% excess air.

Type of pollution control devices: [ ] Cyclone [ ] Wet Scrubber [ ] Afterburner [ ] Other

(specify) ______

Brief description of operating characteristics of control devices: ____________

____

____

____

____

Ultimate disposal of any effluent other than that emitted from the stack (scrubber water, ash, etc.):

____

____

____

____

NOTE: Items 2, 3, 4, 6, 7, 8, and 10 in Section V must be included where applicable.

SECTION V: SUPPLEMENTAL REQUIREMENTS

Please provide the following supplements where required for this application.

1. Total process input rate and product weight -- show derivation [Rule 17-2.100(127)]
   Not Applicable
2. To a construction application, attach basis of emission estimate (e.g., design calculations, design drawings, pertinent manufacturer's test data, etc.) and attach proposed methods (e.g., FR Part 60 Methods, 1, 2, 3, 4, 5) to show proof of compliance with applicable standards. To an operation application, attach test results or methods used to show proof of compliance. Information provided when applying for an operation permit from a construction permit shall be indicative of the time at which the test was made.
   See PSD Report, Section 2.0, Tables 2-1 and 2-2
3. Attach basis of potential discharge (e.g., emission factor, that is, AP42 test).
   See PSD Report, Section 2.0
4. With construction permit application, include design details for all air pollution control systems (e.g., for baghouse include cloth to air ratio; for scrubber include cross-section sketch, design pressure drop, etc.)
   Not Applicable
5. With construction permit application, attach derivation of control device(s) efficiency. Include test or design data. Items 2, 3 and 5 should be consistent: actual emissions = potential (1-efficiency).
   Not Applicable
6. An 8 ½" x 11" flow diagram which will, without revealing trade secrets, identify the individual operations and/or processes. Indicate where raw materials enter, where solid and liquid waste exit, where gaseous emissions and/or airborne particles are evolved and where finished products are obtained.
   See PSD Report, Figure 2-2
7. An 8 ½" x 11" plot plan showing the location of the establishment, and points of airborne emissions, in relation to the surrounding area, residences and other permanent structures and roadways (Examples: Copy of relevant portion of USGS topographic map).
   See PSD Report, Figure 1-2
8. An 8 ½" x 11" plot plan of facility showing the location of manufacturing processes and outlets for airborne emissions. Relate all flows to the flow diagram.
   See PSD Report, Figure 2-1

9. The appropriate application fee in accordance with Rule 17-4.05. The check should be made payable to the Department of Environmental Regulation.

10. With an application for operation permit, attach a Certificate of Completion of Construction indicating that the source was constructed as shown in the construction permit.

SECTION VI: BEST AVAILABLE CONTROL TECHNOLOGY

See PSD report, Sections 3.0 and 6.0

A. Are standards of performance for new stationary sources pursuant to 40 C.F.R. Part 60 applicable to the source?

[ ] Yes [ ] No

Contaminant	Rate or Concentration

B. Has EPA declared the best available control technology for this class of sources (If yes, attach copy)

[ ] Yes [ ] No

Contaminant	Rate or Concentration

C. What emission levels do you propose as best available control technology?

Contaminant	Rate or Concentration

D. Describe the existing control and treatment technology (if any).

1. Control Device/System:
2. Operating Principles:
3. Efficiency:*
4. Capital Costs:

*Explain method of determining

5. Useful Life:

6. Operating Costs:

7. Energy:

8. Maintenance Cost:

9. Emissions:

Contaminant	Rate or Concentration

10. Stack Parameters

a. Height: ft.

b. Diameter ft.

c. Flow Rate: ACFM

d. Temperature: °F.

e. Velocity: FPS

E. Describe the control and treatment technology available (As many types as applicable, use additional pages if necessary).

1.

a. Control Devices:

b. Operating Principles:

c. Efficiency:[1]

d. Capital Cost:

e. Useful Life:

f. Operating Cost:

g. Energy:[2]

h. Maintenance Cost:

i. Availability of construction materials and process chemicals:

j. Applicability to manufacturing processes:

k. Ability to construct with control device, install in available space, and operate within proposed levels:

2.

a. Control Device:

b. Operating Principles:

c. Efficiency:[1]

d. Capital Cost:

e. Useful Life:

f. Operating Cost:

g. Energy:[2]

h. Maintenance Cost:

i. Availability of construction materials and process chemicals:

[1]Explain method of determining efficiency.
[2]Energy to be reported in units of electrical power - KWH design rate.

j. Applicability to manufacturing processes:

k. Ability to construct with control device, install in available space, and operate within proposed levels:

3.

a. Control Device:

b. Operating Principles:

c. Efficiency:[1]

d. Capital Cost:

e. Useful Life:

f. Operating Cost:

g. Energy:[2]

h. Maintenance Cost:

i. Availability of construction materials and process chemicals:

j. Applicability to manufacturing processes:

k. Ability to construct with control device, install in available space, and operate within proposed levels:

4.

a. Control Device:

b. Operating Principles:

c. Efficiency:[1]

d. Capital Cost:

e. Useful Life:

f. Operating Cost:

g. Energy:[2]

h. Maintenance Cost:

i. Availability of construction materials and process chemicals:

j. Applicability to manufacturing processes:

k. Ability to construct with control device, install in available space, and operate within proposed levels:

F. Describe the control technology selected:

1. Control Device:
2. Efficiency:[1]
3. Capital Cost:
4. Useful Life:
5. Operating Cost:
6. Energy:[2]
7. Maintenance Cost:
8. Manufacturer:
9. Other locations where employed on similar processes:

a. (1) Company:

(2) Mailing Address:

(3) City:

(4) State:

[1]Explain method of determining efficiency.
[2]Energy to be reported in units of electrical power - KWH design rate.

(5) Environmental Manager:

(6) Telephone No.:

(7) Emissions:[1]

Contaminant	Rate or Concentration

(8) Process Rate:[1]

b. (1) Company:

(2) Mailing Address:

(3) City: (4) State:

(5) Environmental Manager:

(6) Telephone No.:

(7) Emissions:[1]

Contaminant	Rate or Concentration

(8) Process Rate:[1]

10. Reason for selection and description of systems:

[1]Applicant must provide this information when available. Should this information not be available, applicant must state the reason(s) why.

SECTION VII - PREVENTION OF SIGNIFICANT DETERIORATION

Refer to PSD report

A. Company Monitored Data

1. __________ no. sites __________ TSP ________( ) SO^{2*} ____________ Wind spd/dir

Period of Monitoring ______/___/______ to __________/___/______
month day year month
day year

Other data recorded ____

Attach all data or statistical summaries to this application.

*Specify bubbler (B) or continuous (C).

2. Instrumentation, Field and Laboratory

a. Was instrumentation EPA referenced or its equivalent? [ ] Yes [ ] No

b. Was instrumentation calibrated in accordance with Department procedures?

[ ] Yes [ ] No [ ] Unknown

B. Meteorological Data Used for Air Quality Modeling

1. ______ Year(s) of data from ______/____/______ to ______/____/______
month day year month day year

2. Surface data obtained from (location)______________________________

3. Upper air (mixing height) data obtained from (location) ______________________________

4. Stability wind rose (STAR) data obtained from (location) ______________________________

C. Computer Models Used

1. ______________________________ Modified? If yes, attach description.

2. ______________________________ Modified? If yes, attach description.

3. ______________________________ Modified? If yes, attach description.

4. ______________________________ Modified? If yes, attach description.

Attach copies of all final model runs showing input data, receptor locations, and principle output tables.

D. Applicants Maximum Allowable Emission Data

Pollutant	Emission Rate
TSP	______________________________ grams/sec
SO^2	______________________________ grams/sec

E. Emission Data Used in Modeling

Attach list of emission sources. Emission data required is source name, description of point source (on NEDS point number), UTM coordinates, stack data, allowable emissions, and normal operating time.

F. Attach all other information supportive to the PSD review.

G. Discuss the social and economic impact of the selected technology versus other applicable technologies (i.e, jobs, payroll, production, taxes, energy, etc.). Include assessment of the environmental impact of the sources.

H. Attach scientific, engineering, and technical material, reports, publications, journals, and other competent relevant information describing the theory and application of the requested best available control technology.

PREVENTION OF SIGNIFICANT DETERIORATION REPORT
FLORIDA GAS TRANSMISSION COMPANY
COMPRESSOR STATION NO. 18

TABLE OF CONTENTS
(Page 1 of 3)

TABLE OF CONTENTS
(Page 2 of 3)

TABLE OF CONTENTS
(Page 3 of 3)

LIST OF TABLES
(Page 1 of 2)

LIST OF TABLES
(Page 2 of 2)

LIST OF FIGURES

1.0 INTRODUCTION

Florida Gas Transmission Company (FGTC), a subsidiary of ENRON Corporation of Houston, Texas, is proposing to expand its existing natural gas pipeline Compressor Station No. 18. This proposed expansion is part of FGTC's Phase II expansion project aimed at increasing the natural gas transport capacity of the existing Florida gas pipeline system. The scope of work for Phase II includes expansions by addition of state-of-the-art compressor engines at eight existing compressor stations and at a newly proposed compressor station. The main gas pipeline and the approximate locations of the existing and proposed compressor stations along the main pipeline are shown in Figure 1-1.

Compressor Station No. 18 is located at 7990 Steer Lake Road in the city of Orlando in Orange County, Florida. Figure 1-2 shows the site location of the existing compressor station.

The proposed expansion at this location consists of the addition of one new 2,400 brake horsepower (bhp) natural-gas-fired, reciprocating internal combustion (IC) engine. The proposed engine would be used solely for the purpose of transporting natural gas in the pipeline for distribution in Florida. The proposed engine is a turbocharged Cooper-Bessemer Model GMVR-12C2. Under current federal and state air quality regulations, the proposed engine will constitute a major modification at an existing major stationary source.

This report addresses the requirements of the Prevention of Significant Deterioration (PSD) review procedures pursuant to rules and regulations implementing the Clean Air Act (CAA) Amendments of 1977. The Florida Department of Environmental Regulation (FDER) has PSD review and approval authority in Florida. Based on the proposed emissions from the addition of a 2,400-bhp engine, a PSD review is required for nitrogen oxides (NO_x).

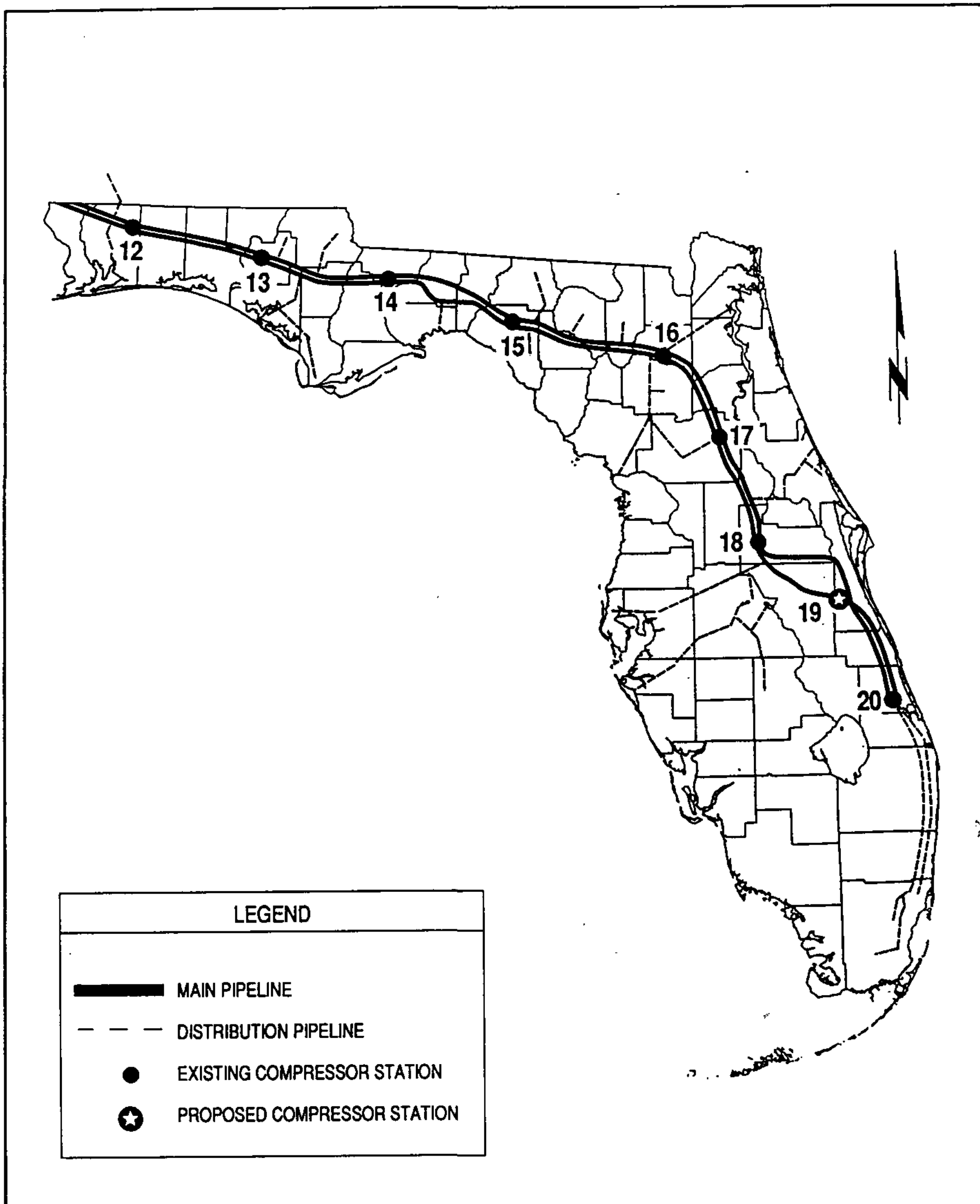

Figure 1-1 FGTC'S GAS TRANSMISSION SYSTEM

Florida Gas Transmission Company

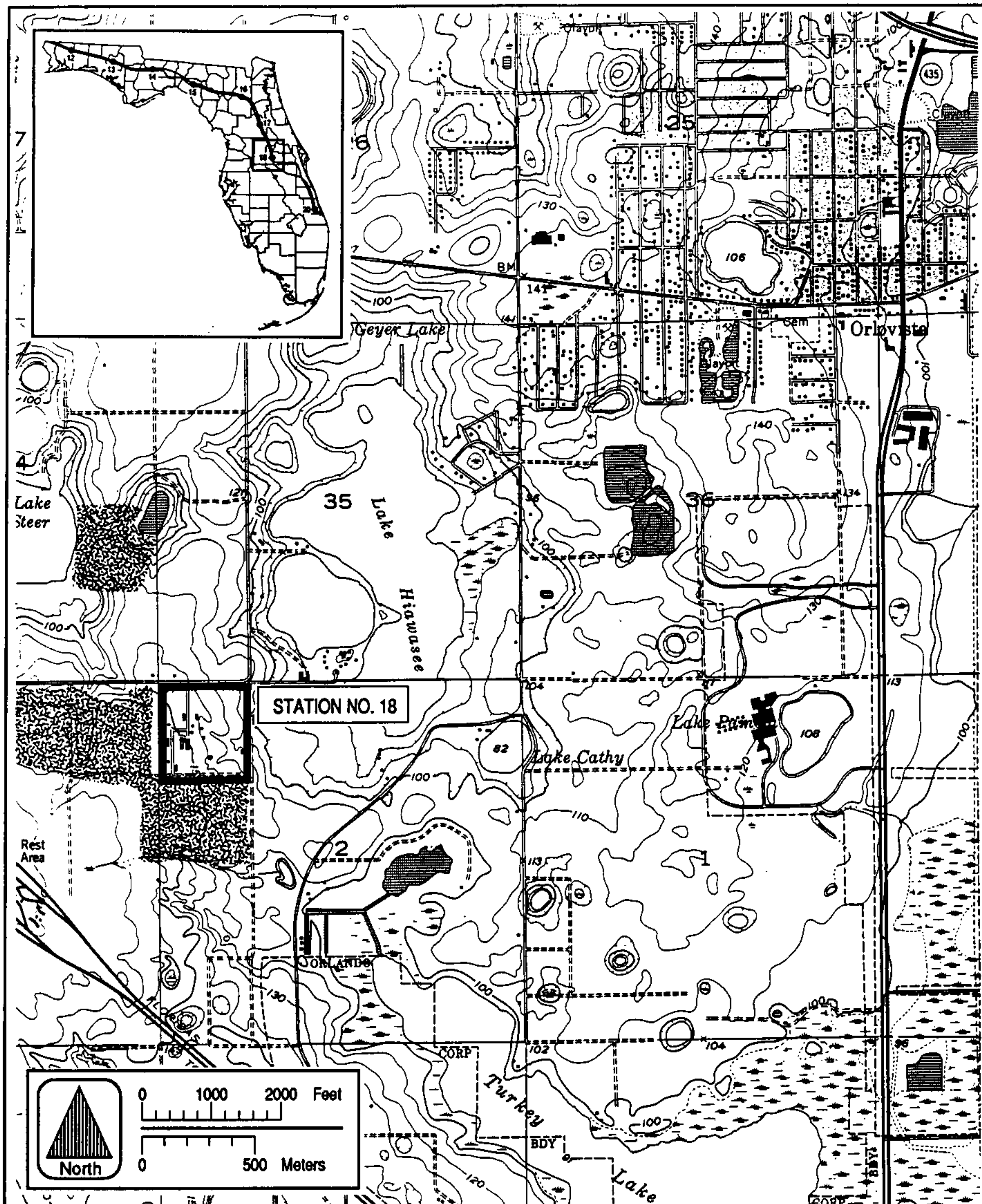

Figure 1-2 SITE LOCATION OF ENRON'S FLORIDA GAS TRANSMISSION LINE COMPRESSOR STATION NO. 18, ORLANDO, ORANGE COUNTY, FLORIDA

Florida Gas Transmission Company

Engineering designs for the proposed expansion project include selection of an engine incorporating lean-burn technology. The lean-burn technology for emission control represents best available control technology (BACT) for the proposed reciprocating IC engine.

This application contains five additional sections. Descriptions of the existing operation at FGTC's Compressor Station No. 18 and the proposed 2,400-bhp engine addition are presented in Section 2.0. The air quality review requirements and source applicability of the proposed engine to the regulations are discussed in Section 3.0. The methodology and results of the air dispersion modeling and air quality impact analysis are presented in Section 4.0, and impacts on soil, vegetation, and visibility are summarized in Section 5.0. The BACT analysis required as part of the PSD permitting process is presented in Section 6.0.

ISCLTK6L MODEL, A VERSION OF
ISCLT (VERSION 90008)
AN AIR QUALITY DISPERSION MODEL IN
SECTION 1. GUIDELINE MODELS.
IN UNAMAP (VERSION 6) JAN 1990.
SOURCE: FILE 7 ON UNAMAP MAGNETIC TAPE FROM NTIS.

CONVERTED BY :
KBN ENGINEERING AND APPLIED SCIENCES, INC.
GAINESVILLE, FLORIDA
(904)331-9000

CARD INPUT FILE IS	ER18LT85.I81
SUMMARY OUTPUT FILE IS	ER18LT85.O81
TITLE OF RUN IS	1985 ENRON STATION 18 / 40 FT STACK 10-29-90

- ISCLT INPUT DATA (CONT.) -

NUMBER OF SOURCES = 1
NUMBER OF X AXIS GRID SYSTEM POINTS = 8
NUMBER OF Y AXIS GRID SYSTEM POINTS = 16
NUMBER OF SPECIAL POINTS = 36
NUMBER OF SEASONS = 1
NUMBER OF WIND SPEED CLASSES = 6
NUMBER OF STABILITY CLASSES = 6
NUMBER OF WIND DIRECTION CLASSES = 16
FILE NUMBER OF DATA FILE USED FOR REPORTS = 1
THE PROGRAM IS RUN IN RURAL MODE
CONCENTRATION (DEPOSITION) UNITS CONVERSION FACTOR =0.10000000E+07
ACCELERATION OF GRAVITY (METERS/SEC**2) = 9.800
HEIGHT OF MEASUREMENT OF WIND SPEED (METERS) = 10.100
CORRECTION ANGLE FOR GRID SYSTEM VERSUS DIRECTION DATA NORTH (DEGREES) = 0.000
DECAY COEFFICIENT =0.00000000E+00
PROGRAM OPTION SWITCHES = 1, 2, 2, 0, 0, 3, 2, 1, 3, 2, 2, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 1, 1, 0,
0,

RANGE X AXIS GRID SYSTEM POINTS (METERS)= 100.00, 200.00, 300.00, 400.00, 500.00, 750.00,
1000.00, 1250.00,

RANGE X SPECIAL DISCRETE POINTS (METERS)= 317.00, 332.00, 357.00, 402.00, 366.00, 323.00,
296.00, 283.00, 277.00, 283.00, 253.00, 171.00, 134.00, 113.00, 98.00, 91.00,
88.00, 85.00, 88.00, 91.00, 101.00, 113.00, 137.00, 134.00, 122.00, 119.00,
116.00, 119.00, 122.00, 134.00, 149.00, 177.00, 229.00, 250.00, 259.00, 311.00,

AZIMUTH BEARING Y AXIS GRID SYSTEM POINTS (DEGREES)= 22.50, 45.00, 67.50, 90.00, 112.50, 135.00,
157.50, 180.00, 202.50, 225.00, 247.50, 270.00, 292.50, 315.00, 337.50, 360.00,

AZIMUTH BEARING Y SPECIAL DISCRETE POINTS (DEGREES)= 10.00, 20.00, 30.00, 40.00, 50.00, 60.00,
70.00, 80.00, 90.00, 100.00, 110.00, 120.00, 130.00, 140.00, 150.00, 160.00,
170.00, 180.00, 190.00, 200.00, 210.00, 220.00, 230.00, 240.00, 250.00, 260.00,
270.00, 280.00, 290.00, 300.00, 310.00, 320.00, 330.00, 340.00, 350.00, 360.00,

- AMBIENT AIR TEMPERATURE (DEGREES KELVIN) -

	STABILITY CATEGORY 1	STABILITY CATEGORY 2	STABILITY CATEGORY 3	STABILITY CATEGORY 4	STABILITY CATEGORY 5	STABILITY CATEGORY 6
SEASON 1	300.0000	300.0000	300.0000	295.0000	290.0000	290.0000

- MIXING LAYER HEIGHT (METERS) -

SEASON 1

	WIND SPEED CATEGORY 1	WIND SPEED CATEGORY 2	WIND SPEED CATEGORY 3	WIND SPEED CATEGORY 4	WIND SPEED CATEGORY 5	WIND SPEED CATEGORY 6
STABILITY CATEGORY 1	0.215100E+04	0.215100E+04	0.215100E+04	0.215100E+04	0.215100E+04	0.215100E+04
STABILITY CATEGORY 2	0.143400E+04	0.143400E+04	0.143400E+04	0.143400E+04	0.143400E+04	0.143400E+04
STABILITY CATEGORY 3	0.143400E+04	0.143400E+04	0.143400E+04	0.143400E+04	0.143400E+04	0.143400E+04
STABILITY CATEGORY 4	0.143400E+04	0.143400E+04	0.143400E+04	0.143400E+04	0.143400E+04	0.143400E+04
STABILITY CATEGORY 5	0.100000E+05	0.100000E+05	0.100000E+05	0.100000E+05	0.100000E+05	0.100000E+05
STABILITY CATEGORY 6	0.100000E+05	0.100000E+05	0.100000E+05	0.100000E+05	0.100000E+05	0.100000E+05

- ISCLT INPUT DATA (CONT.) -

- FREQUENCY OF OCCURRENCE OF WIND SPEED, DIRECTION AND STABILITY -

SEASON 1

STABILITY CATEGORY 1

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.5000MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.00016500	0.00102701	0.00000000	0.00000000	0.00000000	0.00000000
22.500	0.00015500	0.00079900	0.00000000	0.00000000	0.00000000	0.00000000
45.000	0.00001000	0.00022800	0.00000000	0.00000000	0.00000000	0.00000000
67.500	0.00013500	0.00034200	0.00000000	0.00000000	0.00000000	0.00000000
90.000	0.00014500	0.00057100	0.00000000	0.00000000	0.00000000	0.00000000
112.500	0.00003100	0.00068500	0.00000000	0.00000000	0.00000000	0.00000000
135.000	0.00015000	0.00068500	0.00000000	0.00000000	0.00000000	0.00000000
157.500	0.00002100	0.00045700	0.00000000	0.00000000	0.00000000	0.00000000
180.000	0.00026900	0.00068500	0.00000000	0.00000000	0.00000000	0.00000000
202.500	0.00002600	0.00057100	0.00000000	0.00000000	0.00000000	0.00000000
225.000	0.00013000	0.00022800	0.00000000	0.00000000	0.00000000	0.00000000
247.500	0.00014000	0.00045700	0.00000000	0.00000000	0.00000000	0.00000000
270.000	0.00002100	0.00045700	0.00000000	0.00000000	0.00000000	0.00000000
292.500	0.00015000	0.00068500	0.00000000	0.00000000	0.00000000	0.00000000
315.000	0.00004100	0.00091300	0.00000000	0.00000000	0.00000000	0.00000000
337.500	0.00012400	0.00011400	0.00000000	0.00000000	0.00000000	0.00000000

SEASON 1

STABILITY CATEGORY 2

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.5000MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.00088100	0.00216901	0.00159801	0.00000000	0.00000000	0.00000000
22.500	0.00041500	0.00228301	0.00091300	0.00000000	0.00000000	0.00000000
45.000	0.00075400	0.00182601	0.00182601	0.00000000	0.00000000	0.00000000
67.500	0.00007200	0.00262601	0.00171201	0.00000000	0.00000000	0.00000000
90.000	0.00067800	0.00331102	0.00274001	0.00000000	0.00000000	0.00000000
112.500	0.00030100	0.00239701	0.00102701	0.00000000	0.00000000	0.00000000
135.000	0.00030100	0.00239701	0.00182601	0.00000000	0.00000000	0.00000000
157.500	0.00052600	0.00205501	0.00137001	0.00000000	0.00000000	0.00000000
180.000	0.00058500	0.00422402	0.00308202	0.00000000	0.00000000	0.00000000
202.500	0.00075400	0.00182601	0.00102701	0.00000000	0.00000000	0.00000000
225.000	0.00041200	0.00216901	0.00171201	0.00000000	0.00000000	0.00000000
247.500	0.00053200	0.00228301	0.00125601	0.00000000	0.00000000	0.00000000
270.000	0.00064300	0.00205501	0.00125601	0.00000000	0.00000000	0.00000000
292.500	0.00068400	0.00353902	0.00228301	0.00000000	0.00000000	0.00000000
315.000	0.00071500	0.00468002	0.00194101	0.00000000	0.00000000	0.00000000
337.500	0.00065200	0.00239701	0.00159801	0.00000000	0.00000000	0.00000000

- ISCLT INPUT DATA (CONT.) -

- FREQUENCY OF OCCURRENCE OF WIND SPEED, DIRECTION AND STABILITY -

SEASON 1

STABILITY CATEGORY 3

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.5000MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.00032700	0.00296801	0.00593603	0.00022800	0.00000000	0.00000000
22.500	0.00008800	0.00285401	0.00456602	0.00011400	0.00000000	0.00000000
45.000	0.00022700	0.00353902	0.00502302	0.00102701	0.00000000	0.00000000
67.500	0.00024400	0.00411002	0.00867604	0.00148401	0.00000000	0.00000000
90.000	0.00024400	0.00411002	0.01095906	0.00159801	0.00000000	0.00000000
112.500	0.00076900	0.00205501	0.00502302	0.00091300	0.00000000	0.00000000
135.000	0.00030200	0.00216901	0.00194101	0.00068500	0.00000000	0.00000000
157.500	0.00017700	0.00194101	0.00422402	0.00045700	0.00000000	0.00000000
180.000	0.00032300	0.00285401	0.00799104	0.00148401	0.00000000	0.00000000
202.500	0.00005600	0.00182601	0.00411002	0.00068500	0.00000000	0.00000000
225.000	0.00032000	0.00274001	0.00388102	0.00045700	0.00022800	0.00000000
247.500	0.00004600	0.00148401	0.00285401	0.00091300	0.00022800	0.00000000
270.000	0.00004900	0.00159801	0.00559403	0.00137001	0.00011400	0.00000000
292.500	0.00033000	0.00308202	0.00684903	0.00068500	0.00000000	0.00000000
315.000	0.00020900	0.00296801	0.00627903	0.00045700	0.00000000	0.00000000
337.500	0.00028500	0.00159801	0.00342502	0.00011400	0.00000000	0.00000000

SEASON 1

STABILITY CATEGORY 4

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.5000MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.00036500	0.00799104	0.00890404	0.00285401	0.00000000	0.00000000
22.500	0.00030500	0.00605003	0.00582203	0.00148401	0.00000000	0.00000000
45.000	0.00017000	0.00547903	0.00764804	0.00684903	0.00022800	0.00000000
67.500	0.00035500	0.00388102	0.01495407	0.01267106	0.00068500	0.00000000
90.000	0.00014800	0.00479502	0.01917810	0.01575308	0.00034200	0.00000000
112.500	0.00009900	0.00319602	0.01118706	0.00490902	0.00011400	0.00000000
135.000	0.00016700	0.00159801	0.00719204	0.00513703	0.00022800	0.00000000
157.500	0.00017100	0.00171201	0.00707804	0.00662103	0.00034200	0.00000000
180.000	0.00013100	0.00422402	0.01552508	0.01267106	0.00228301	0.00022800
202.500	0.00032700	0.00296801	0.00616403	0.00593603	0.00102701	0.00011400
225.000	0.00006000	0.00194101	0.00764804	0.00502302	0.00148401	0.00011400
247.500	0.00018100	0.00205501	0.00570803	0.00593603	0.00114201	0.00022800
270.000	0.00019200	0.00239701	0.00787704	0.01381307	0.00365302	0.00114201
292.500	0.00017400	0.00182601	0.00684903	0.01038805	0.00148401	0.00011400
315.000	0.00021300	0.00308202	0.00502302	0.00616403	0.00011400	0.00000000
337.500	0.00059400	0.00399502	0.00696304	0.00342502	0.00022800	0.00000000

- ISCLT INPUT DATA (CONT.) -

- FREQUENCY OF OCCURRENCE OF WIND SPEED, DIRECTION AND STABILITY -

SEASON 1

STABILITY CATEGORY 5

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.5000MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.00000000	0.01461207	0.00411002	0.00000000	0.00000000	0.00000000
22.500	0.00000000	0.01290006	0.00182601	0.00000000	0.00000000	0.00000000
45.000	0.00000000	0.01381307	0.00228301	0.00000000	0.00000000	0.00000000
67.500	0.00000000	0.01347007	0.00399502	0.00000000	0.00000000	0.00000000
90.000	0.00000000	0.01563908	0.00468002	0.00000000	0.00000000	0.00000000
112.500	0.00000000	0.00867604	0.00331102	0.00000000	0.00000000	0.00000000
135.000	0.00000000	0.00901804	0.00251101	0.00000000	0.00000000	0.00000000
157.500	0.00000000	0.00582203	0.00365302	0.00000000	0.00000000	0.00000000
180.000	0.00000000	0.01461207	0.00605003	0.00000000	0.00000000	0.00000000
202.500	0.00000000	0.00502302	0.00148401	0.00000000	0.00000000	0.00000000
225.000	0.00000000	0.00513703	0.00159801	0.00000000	0.00000000	0.00000000
247.500	0.00000000	0.00490902	0.00411002	0.00000000	0.00000000	0.00000000
270.000	0.00000000	0.00365302	0.00844704	0.00000000	0.00000000	0.00000000
292.500	0.00000000	0.00274001	0.00616403	0.00000000	0.00000000	0.00000000
315.000	0.00000000	0.00388102	0.00353902	0.00000000	0.00000000	0.00000000
337.500	0.00000000	0.00422402	0.00388102	0.00000000	0.00000000	0.00000000

SEASON 1

STABILITY CATEGORY 6

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.5000MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.01042305	0.01769409	0.00000000	0.00000000	0.00000000	0.00000000
22.500	0.00757004	0.01769409	0.00000000	0.00000000	0.00000000	0.00000000
45.000	0.00831504	0.01803709	0.00000000	0.00000000	0.00000000	0.00000000
67.500	0.00625303	0.01290006	0.00000000	0.00000000	0.00000000	0.00000000
90.000	0.00478002	0.01301407	0.00000000	0.00000000	0.00000000	0.00000000
112.500	0.00292601	0.00468002	0.00000000	0.00000000	0.00000000	0.00000000
135.000	0.00312702	0.00502302	0.00000000	0.00000000	0.00000000	0.00000000
157.500	0.00295401	0.00411002	0.00000000	0.00000000	0.00000000	0.00000000
180.000	0.00507503	0.01027405	0.00000000	0.00000000	0.00000000	0.00000000
202.500	0.00475702	0.00502302	0.00000000	0.00000000	0.00000000	0.00000000
225.000	0.00285501	0.00502302	0.00000000	0.00000000	0.00000000	0.00000000
247.500	0.00394602	0.00719204	0.00000000	0.00000000	0.00000000	0.00000000
270.000	0.00409802	0.00799104	0.00000000	0.00000000	0.00000000	0.00000000
292.500	0.00413702	0.00605003	0.00000000	0.00000000	0.00000000	0.00000000
315.000	0.00345402	0.00388102	0.00000000	0.00000000	0.00000000	0.00000000
337.500	0.00364102	0.00844704	0.00000000	0.00000000	0.00000000	0.00000000

- ISCLT INPUT DATA (CONT.) -

- VERTICAL POTENTIAL TEMPERATURE GRADIENT (DEGREES KELVIN/METER) -

	WIND SPEED CATEGORY 1	WIND SPEED CATEGORY 2	WIND SPEED CATEGORY 3	WIND SPEED CATEGORY 4	WIND SPEED CATEGORY 5	WIND SPEED CATEGORY 6
STABILITY CATEGORY 1	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
STABILITY CATEGORY 2	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
STABILITY CATEGORY 3	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
STABILITY CATEGORY 4	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
STABILITY CATEGORY 5	0.200000E-01	0.200000E-01	0.200000E-01	0.200000E-01	0.200000E-01	0.200000E-01
STABILITY CATEGORY 6	0.350000E-01	0.350000E-01	0.350000E-01	0.350000E-01	0.350000E-01	0.350000E-01

- WIND PROFILE POWER LAW EXPONENTS -

	WIND SPEED CATEGORY 1	WIND SPEED CATEGORY 2	WIND SPEED CATEGORY 3	WIND SPEED CATEGORY 4	WIND SPEED CATEGORY 5	WIND SPEED CATEGORY 6
STABILITY CATEGORY 1	0.700000E-01	0.700000E-01	0.700000E-01	0.700000E-01	0.700000E-01	0.700000E-01
STABILITY CATEGORY 2	0.700000E-01	0.700000E-01	0.700000E-01	0.700000E-01	0.700000E-01	0.700000E-01
STABILITY CATEGORY 3	0.100000E+00	0.100000E+00	0.100000E+00	0.100000E+00	0.100000E+00	0.100000E+00
STABILITY CATEGORY 4	0.150000E+00	0.150000E+00	0.150000E+00	0.150000E+00	0.150000E+00	0.150000E+00
STABILITY CATEGORY 5	0.350000E+00	0.350000E+00	0.350000E+00	0.350000E+00	0.350000E+00	0.350000E+00
STABILITY CATEGORY 6	0.550000E+00	0.550000E+00	0.550000E+00	0.550000E+00	0.550000E+00	0.550000E+00

- SOURCE INPUT DATA -

C A R D	T A P E	SOURCE NUMBER	SOURCE TYPE	X COORDINATE (M)	Y COORDINATE (M)	EMISSION HEIGHT (M)	BASE / ELEV- / ATION / (M) /	- SOURCE DETAILS DEPENDING ON TYPE -
X		1	STACK	0.00	0.00	12.19	0.00	GAS EXIT TEMP (DEG K)= 561.00, GAS EXIT VEL. (M/SEC)= 48.88, STACK DIAMETER (M)= 0.440, HEIGHT OF ASSO. BLDG. (M)= -9.69, WIDTH OF ASSO. BLDG. (M)= 74.92, WAKE EFFECTS FLAG = 0

- DIRECTION SPECIFIC BUILDING DIMENSIONS -

SECTOR	DSBH	DSBW	IWAKE	SECTOR	DSBH	DSBW	IWAKE	SECTOR	DSBH	DSBW	IWAKE	SECTOR	DSBH	DSBW	IWAKE
1	9.7,	75.0,	0	2	9.7,	75.0,	0	3	9.7,	75.0,	0	4	9.7,	75.0,	0
5	9.7,	75.0,	0	6	9.7,	75.0,	0	7	9.7,	75.0,	0	8	9.7,	75.0,	0
9	9.7,	75.0,	0	10	9.7,	75.0,	0	11	9.7,	75.0,	0	12	9.7,	75.0,	0
13	9.7,	75.0,	0	14	9.7,	75.0,	0	15	9.7,	75.0,	0	16	9.7,	75.0,	0

- SOURCE STRENGTHS (GRAMS PER SEC) -

SEASON 1	SEASON 2	SEASON 3	SEASON 4
1.33000E+00			

WARNING - HW/HB > 5 FOR SOURCE 1 PROG. USES LATERAL VIRTUAL DIST. FOR UPPER BOUND OF CONCENTRATION (DEPOSITION) IN SECTOR(S):
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16.
IF LOWER BOUND IS DESIRED SET THE DIRECTION SPECIFIC BUILDING HEIGHT TO < 0 (WAKE EFFECTS FLAG) AND RERUN.

** ANNUAL GROUND LEVEL CONCENTRATION (MICROGRAMS PER CUBIC METER) DUE TO SOURCE 1 **

- GRID SYSTEM RECEPTORS -

- X AXIS (RANGE , METERS) -

Y AXIS (AZIMUTH BEARING, DEGREES)	100.000	200.000	300.000	400.000	500.000	750.000	1000.000	1250.000
	- CONCENTRATION -							
360.000	0.749764	0.656554	0.841737	0.906236	0.866249	0.676788	0.536186	0.440033
337.500	0.303528	0.284474	0.390332	0.431857	0.419226	0.331477	0.261319	0.212743
315.000	0.311541	0.272492	0.351106	0.382453	0.370501	0.295550	0.238536	0.199392
292.500	0.273210	0.273399	0.392898	0.451485	0.452212	0.380454	0.312860	0.260875
270.000	0.654377	0.631280	0.879482	0.989557	0.970492	0.778657	0.617506	0.504569
247.500	0.523958	0.504231	0.701788	0.792724	0.778484	0.625856	0.498872	0.410631
225.000	0.346932	0.323641	0.436849	0.488080	0.480620	0.397639	0.333218	0.288341
202.500	0.160605	0.174285	0.273264	0.319300	0.319927	0.274705	0.242657	0.219185
180.000	0.251369	0.254485	0.373819	0.429458	0.430996	0.376073	0.332071	0.296474
157.500	0.215972	0.203529	0.293971	0.337309	0.337266	0.284100	0.235799	0.198778
135.000	0.360597	0.358677	0.515544	0.560276	0.527239	0.392479	0.297489	0.234800
112.500	0.552521	0.496842	0.652292	0.694710	0.651002	0.484417	0.365059	0.286904
90.000	0.779201	0.633429	0.735081	0.749385	0.691725	0.516151	0.396658	0.317906
67.500	0.383058	0.326146	0.399078	0.418913	0.394655	0.302946	0.238543	0.195819
45.000	0.379253	0.321737	0.406429	0.443652	0.430606	0.340178	0.265367	0.213183
22.500	0.335613	0.300996	0.390668	0.422210	0.404999	0.316711	0.248580	0.201514

- DISCRETE RECEPTORS -

X RANGE (METERS)	Y AZIMUTH BEARING (DEGREES)	CONCENTRATION	X RANGE (METERS)	Y AZIMUTH BEARING (DEGREES)	CONCENTRATION	X RANGE (METERS)	Y AZIMUTH BEARING (DEGREES)	CONCENTRATION
317.0	10.0	0.642515	332.0	20.0	0.453121	357.0	30.0	0.414677
402.0	40.0	0.433133	366.0	50.0	0.428201	323.0	60.0	0.404226
296.0	70.0	0.426129	283.0	80.0	0.554565	277.0	90.0	0.709137
283.0	100.0	0.656647	253.0	110.0	0.580718	171.0	120.0	0.476791
134.0	130.0	0.422314	113.0	140.0	0.340100	98.0	150.0	0.248571
91.0	160.0	0.198164	88.0	170.0	0.205978	85.0	180.0	0.222259
88.0	190.0	0.184875	91.0	200.0	0.154619	101.0	210.0	0.216759
113.0	220.0	0.314945	137.0	230.0	0.400741	134.0	240.0	0.486441
122.0	250.0	0.564514	119.0	260.0	0.616230	116.0	270.0	0.688190
119.0	280.0	0.503438	122.0	290.0	0.332708	134.0	300.0	0.299474
149.0	310.0	0.304348	177.0	320.0	0.290567	229.0	330.0	0.279068
250.0	340.0	0.368960	259.0	350.0	0.560781	311.0	360.0	0.857703

** ANNUAL GROUND LEVEL CONCENTRATION (MICROGRAMS PER CUBIC METER) DUE TO SOURCE 1 (CONT.) **

- 10 CONTRIBUTING VALUES TO PROGRAM DETERMINED MAXIMUM 10 OF ALL SOURCES COMBINED -

X COORDINATE RANGE (METERS)	Y COORDINATE AZIMUTH BEARING (DEGREES)	CONCENTRATION
400.00	270.00	0.989557
500.00	270.00	0.970492
400.00	360.00	0.906236
300.00	270.00	0.879482
500.00	360.00	0.866249
311.00	360.00	0.857703
300.00	360.00	0.841737
400.00	247.50	0.792724
100.00	90.00	0.779201
750.00	270.00	0.778657

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****************************************** END OF ISCLT PROGRAM,     1 SOURCES PROCESSED ******************************************
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ISCLTK6L MODEL, A VERSION OF
ISCLT (VERSION 90008)
AN AIR QUALITY DISPERSION MODEL IN
SECTION 1. GUIDELINE MODELS.
IN UNAMAP (VERSION 6) JAN 1990.
SOURCE: FILE 7 ON UNAMAP MAGNETIC TAPE FROM NTIS.

CONVERTED BY :
KBN ENGINEERING AND APPLIED SCIENCES, INC.
GAINESVILLE, FLORIDA
(904)331-9000

CARD INPUT FILE IS	ER18LT86.I81
SUMMARY OUTPUT FILE IS	ER18LT86.O81
TITLE OF RUN IS	1986 ENRON STATION 18 / 40 FT STACK 10-29-90

- ISCLT INPUT DATA (CONT.) -

NUMBER OF SOURCES = 1
NUMBER OF X AXIS GRID SYSTEM POINTS = 8
NUMBER OF Y AXIS GRID SYSTEM POINTS = 16
NUMBER OF SPECIAL POINTS = 36
NUMBER OF SEASONS = 1
NUMBER OF WIND SPEED CLASSES = 6
NUMBER OF STABILITY CLASSES = 6
NUMBER OF WIND DIRECTION CLASSES = 16
FILE NUMBER OF DATA FILE USED FOR REPORTS = 1
THE PROGRAM IS RUN IN RURAL MODE
CONCENTRATION (DEPOSITION) UNITS CONVERSION FACTOR =0.10000000E+07
ACCELERATION OF GRAVITY (METERS/SEC**2) = 9.800
HEIGHT OF MEASUREMENT OF WIND SPEED (METERS) = 10.100
CORRECTION ANGLE FOR GRID SYSTEM VERSUS DIRECTION DATA NORTH (DEGREES) = 0.000
DECAY COEFFICIENT =0.00000000E+00
PROGRAM OPTION SWITCHES = 1, 2, 2, 0, 0, 3, 2, 1, 3, 2, 2, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 1, 1, 0,
0,

RANGE X AXIS GRID SYSTEM POINTS (METERS)= 100.00, 200.00, 300.00, 400.00, 500.00, 750.00,
1000.00, 1250.00,

RANGE X SPECIAL DISCRETE POINTS (METERS)= 317.00, 332.00, 357.00, 402.00, 366.00, 323.00,
296.00, 283.00, 277.00, 283.00, 253.00, 171.00, 134.00, 113.00, 98.00, 91.00,
88.00, 85.00, 88.00, 91.00, 101.00, 113.00, 137.00, 134.00, 122.00, 119.00,
116.00, 119.00, 122.00, 134.00, 149.00, 177.00, 229.00, 250.00, 259.00, 311.00,

AZIMUTH BEARING Y AXIS GRID SYSTEM POINTS (DEGREES)= 22.50, 45.00, 67.50, 90.00, 112.50, 135.00,
157.50, 180.00, 202.50, 225.00, 247.50, 270.00, 292.50, 315.00, 337.50, 360.00,

AZIMUTH BEARING Y SPECIAL DISCRETE POINTS (DEGREES)= 10.00, 20.00, 30.00, 40.00, 50.00, 60.00,
70.00, 80.00, 90.00, 100.00, 110.00, 120.00, 130.00, 140.00, 150.00, 160.00,
170.00, 180.00, 190.00, 200.00, 210.00, 220.00, 230.00, 240.00, 250.00, 260.00,
270.00, 280.00, 290.00, 300.00, 310.00, 320.00, 330.00, 340.00, 350.00, 360.00,

- AMBIENT AIR TEMPERATURE (DEGREES KELVIN) -

	STABILITY CATEGORY 1	STABILITY CATEGORY 2	STABILITY CATEGORY 3	STABILITY CATEGORY 4	STABILITY CATEGORY 5	STABILITY CATEGORY 6
SEASON 1	300.0000	300.0000	300.0000	295.0000	290.0000	290.0000

- MIXING LAYER HEIGHT (METERS) -

SEASON 1

	WIND SPEED CATEGORY 1	WIND SPEED CATEGORY 2	WIND SPEED CATEGORY 3	WIND SPEED CATEGORY 4	WIND SPEED CATEGORY 5	WIND SPEED CATEGORY 6
STABILITY CATEGORY 1	0.215100E+04	0.215100E+04	0.215100E+04	0.215100E+04	0.215100E+04	0.215100E+04
STABILITY CATEGORY 2	0.143400E+04	0.143400E+04	0.143400E+04	0.143400E+04	0.143400E+04	0.143400E+04
STABILITY CATEGORY 3	0.143400E+04	0.143400E+04	0.143400E+04	0.143400E+04	0.143400E+04	0.143400E+04
STABILITY CATEGORY 4	0.143400E+04	0.143400E+04	0.143400E+04	0.143400E+04	0.143400E+04	0.143400E+04
STABILITY CATEGORY 5	0.100000E+05	0.100000E+05	0.100000E+05	0.100000E+05	0.100000E+05	0.100000E+05
STABILITY CATEGORY 6	0.100000E+05	0.100000E+05	0.100000E+05	0.100000E+05	0.100000E+05	0.100000E+05

- ISCLT INPUT DATA (CONT.) -

- FREQUENCY OF OCCURRENCE OF WIND SPEED, DIRECTION AND STABILITY -

SEASON 1

STABILITY CATEGORY 1

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.5000MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.00038600	0.00034200	0.00000000	0.00000000	0.00000000	0.00000000
22.500	0.00013600	0.00022800	0.00000000	0.00000000	0.00000000	0.00000000
45.000	0.00040100	0.00057100	0.00000000	0.00000000	0.00000000	0.00000000
67.500	0.00029400	0.00079900	0.00000000	0.00000000	0.00000000	0.00000000
90.000	0.00038600	0.00034200	0.00000000	0.00000000	0.00000000	0.00000000
112.500	0.00055900	0.00114200	0.00000000	0.00000000	0.00000000	0.00000000
135.000	0.00029400	0.00079900	0.00000000	0.00000000	0.00000000	0.00000000
157.500	0.00017300	0.00079900	0.00000000	0.00000000	0.00000000	0.00000000
180.000	0.00019500	0.00114200	0.00000000	0.00000000	0.00000000	0.00000000
202.500	0.00004400	0.00068500	0.00000000	0.00000000	0.00000000	0.00000000
225.000	0.00018000	0.00091300	0.00000000	0.00000000	0.00000000	0.00000000
247.500	0.00015100	0.00045700	0.00000000	0.00000000	0.00000000	0.00000000
270.000	0.00027900	0.00057100	0.00000000	0.00000000	0.00000000	0.00000000
292.500	0.00005800	0.00091300	0.00000000	0.00000000	0.00000000	0.00000000
315.000	0.00018700	0.00102700	0.00000000	0.00000000	0.00000000	0.00000000
337.500	0.00027200	0.00045700	0.00000000	0.00000000	0.00000000	0.00000000

SEASON 1

STABILITY CATEGORY 2

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.5000MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.00084300	0.00353900	0.00182600	0.00000000	0.00000000	0.00000000
22.500	0.00077500	0.00171200	0.00137000	0.00000000	0.00000000	0.00000000
45.000	0.00105800	0.00296800	0.00125600	0.00000000	0.00000000	0.00000000
67.500	0.00086800	0.00422400	0.00148400	0.00000000	0.00000000	0.00000000
90.000	0.00148600	0.00490900	0.00205500	0.00000000	0.00000000	0.00000000
112.500	0.00071200	0.00319600	0.00182600	0.00000000	0.00000000	0.00000000
135.000	0.00073700	0.00388100	0.00137000	0.00000000	0.00000000	0.00000000
157.500	0.00070300	0.00296800	0.00228300	0.00000000	0.00000000	0.00000000
180.000	0.00097800	0.00399500	0.00285400	0.00000000	0.00000000	0.00000000
202.500	0.00080900	0.00262600	0.00114200	0.00000000	0.00000000	0.00000000
225.000	0.00021700	0.00262600	0.00205500	0.00000000	0.00000000	0.00000000
247.500	0.00083400	0.00331100	0.00194100	0.00000000	0.00000000	0.00000000
270.000	0.00069500	0.00274000	0.00251100	0.00000000	0.00000000	0.00000000
292.500	0.00059300	0.00319600	0.00262600	0.00000000	0.00000000	0.00000000
315.000	0.00059300	0.00319600	0.00239700	0.00000000	0.00000000	0.00000000
337.500	0.00054200	0.00182600	0.00102700	0.00000000	0.00000000	0.00000000

- ISCLT INPUT DATA (CONT.) -

- FREQUENCY OF OCCURRENCE OF WIND SPEED, DIRECTION AND STABILITY -

SEASON 1

STABILITY CATEGORY 3

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.5000MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.00013600	0.00445200	0.00627899	0.00045700	0.00000000	0.00000000
22.500	0.00029800	0.00205500	0.00422400	0.00000000	0.00000000	0.00000000
45.000	0.00024000	0.00399500	0.00570799	0.00034200	0.00000000	0.00000000
67.500	0.00036100	0.00411000	0.00582199	0.00137000	0.00000000	0.00000000
90.000	0.00073100	0.00468000	0.01107299	0.00091300	0.00000000	0.00000000
112.500	0.00031500	0.00262600	0.00525100	0.00000000	0.00000000	0.00000000
135.000	0.00018000	0.00205500	0.00376700	0.00022800	0.00000000	0.00000000
157.500	0.00020500	0.00285400	0.00422400	0.00034200	0.00000000	0.00000000
180.000	0.00023600	0.00388100	0.00981699	0.00057100	0.00000000	0.00000000
202.500	0.00021900	0.00331100	0.00365300	0.00045700	0.00000000	0.00000000
225.000	0.00019800	0.00262600	0.00353900	0.00068500	0.00000000	0.00000000
247.500	0.00031900	0.00274000	0.00399500	0.00022800	0.00000000	0.00000000
270.000	0.00052300	0.00171200	0.00502300	0.00148400	0.00000000	0.00000000
292.500	0.00032600	0.00296800	0.00570799	0.00045700	0.00000000	0.00000000
315.000	0.00020800	0.00296800	0.00399500	0.00045700	0.00000000	0.00000000
337.500	0.00041600	0.00205500	0.00353900	0.00045700	0.00000000	0.00000000

SEASON 1

STABILITY CATEGORY 4

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.5000MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.00128000	0.01084499	0.01164399	0.00342500	0.00011400	0.00000000
22.500	0.00085200	0.00468000	0.00684899	0.00182600	0.00000000	0.00000000
45.000	0.00079100	0.00650699	0.00730599	0.00353900	0.00000000	0.00000000
67.500	0.00056300	0.00673499	0.00981699	0.00570799	0.00000000	0.00000000
90.000	0.00046700	0.00741999	0.01940598	0.00650699	0.00022800	0.00000000
112.500	0.00087000	0.00525100	0.01050199	0.00445200	0.00000000	0.00000000
135.000	0.00008200	0.00262600	0.00593599	0.00159800	0.00011400	0.00000000
157.500	0.00068500	0.00308200	0.00730599	0.00274000	0.00000000	0.00000000
180.000	0.00070900	0.00764799	0.01974898	0.00696299	0.00022800	0.00000000
202.500	0.00022800	0.00353900	0.01004599	0.00445200	0.00011400	0.00000000
225.000	0.00034200	0.00342500	0.00924699	0.00479500	0.00011400	0.00011400
247.500	0.00036700	0.00422400	0.00844699	0.00627899	0.00068500	0.00000000
270.000	0.00043900	0.00274000	0.00616399	0.00525100	0.00102700	0.00011400
292.500	0.00031700	0.00262600	0.00547899	0.00296800	0.00045700	0.00000000
315.000	0.00059200	0.00388100	0.00502300	0.00091300	0.00011400	0.00000000
337.500	0.00054900	0.00627899	0.00616399	0.00205500	0.00000000	0.00000000

- ISCLT INPUT DATA (CONT.) -

- FREQUENCY OF OCCURRENCE OF WIND SPEED, DIRECTION AND STABILITY -

SEASON 1

STABILITY CATEGORY 5

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.5000MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.00000000	0.01209999	0.00662099	0.00000000	0.00000000	0.00000000
22.500	0.00000000	0.00993199	0.00228300	0.00000000	0.00000000	0.00000000
45.000	0.00000000	0.01095899	0.00308200	0.00000000	0.00000000	0.00000000
67.500	0.00000000	0.01221499	0.00399500	0.00000000	0.00000000	0.00000000
90.000	0.00000000	0.01483999	0.00787699	0.00000000	0.00000000	0.00000000
112.500	0.00000000	0.00719199	0.00319600	0.00000000	0.00000000	0.00000000
135.000	0.00000000	0.00867599	0.00148400	0.00000000	0.00000000	0.00000000
157.500	0.00000000	0.00844699	0.00171200	0.00000000	0.00000000	0.00000000
180.000	0.00000000	0.01404099	0.00433800	0.00000000	0.00000000	0.00000000
202.500	0.00000000	0.00878999	0.00274000	0.00000000	0.00000000	0.00000000
225.000	0.00000000	0.00650699	0.00274000	0.00000000	0.00000000	0.00000000
247.500	0.00000000	0.00833299	0.00365300	0.00000000	0.00000000	0.00000000
270.000	0.00000000	0.00468000	0.00593599	0.00000000	0.00000000	0.00000000
292.500	0.00000000	0.00502300	0.00536499	0.00000000	0.00000000	0.00000000
315.000	0.00000000	0.00216900	0.00228300	0.00000000	0.00000000	0.00000000
337.500	0.00000000	0.00331100	0.00593599	0.00000000	0.00000000	0.00000000

SEASON 1

STABILITY CATEGORY 6

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.5000MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.00829799	0.01757998	0.00000000	0.00000000	0.00000000	0.00000000
22.500	0.00662399	0.01324199	0.00000000	0.00000000	0.00000000	0.00000000
45.000	0.00722099	0.01826498	0.00000000	0.00000000	0.00000000	0.00000000
67.500	0.00742599	0.01426899	0.00000000	0.00000000	0.00000000	0.00000000
90.000	0.00609599	0.01952098	0.00000000	0.00000000	0.00000000	0.00000000
112.500	0.00279300	0.00844699	0.00000000	0.00000000	0.00000000	0.00000000
135.000	0.00241200	0.00582199	0.00000000	0.00000000	0.00000000	0.00000000
157.500	0.00363800	0.00616399	0.00000000	0.00000000	0.00000000	0.00000000
180.000	0.00600499	0.01438399	0.00000000	0.00000000	0.00000000	0.00000000
202.500	0.00329700	0.00741999	0.00000000	0.00000000	0.00000000	0.00000000
225.000	0.00360500	0.00593599	0.00000000	0.00000000	0.00000000	0.00000000
247.500	0.00313200	0.00627899	0.00000000	0.00000000	0.00000000	0.00000000
270.000	0.00403000	0.00616399	0.00000000	0.00000000	0.00000000	0.00000000
292.500	0.00196900	0.00456600	0.00000000	0.00000000	0.00000000	0.00000000
315.000	0.00276900	0.00468000	0.00000000	0.00000000	0.00000000	0.00000000
337.500	0.00477100	0.00947499	0.00000000	0.00000000	0.00000000	0.00000000

- SOURCE INPUT DATA -

C A R D	T A P E	SOURCE NUMBER	SOURCE TYPE	X COORDINATE (M)	Y COORDINATE (M)	EMISSION HEIGHT (M)	BASE / ELEV- / ATION / (M) /	- SOURCE DETAILS DEPENDING ON TYPE -
X		1	STACK	0.00	0.00	12.19	0.00	GAS EXIT TEMP (DEG K)= 561.00, GAS EXIT VEL. (M/SEC)= 48.88, STACK DIAMETER (M)= 0.440, HEIGHT OF ASSO. BLDG. (M)= -9.69, WIDTH OF ASSO. BLDG. (M)= 74.92, WAKE EFFECTS FLAG = 0

- DIRECTION SPECIFIC BUILDING DIMENSIONS -

SECTOR	DSBH	DSBW	IWAKE	SECTOR	DSBH	DSBW	IWAKE	SECTOR	DSBH	DSBW	IWAKE	SECTOR	DSBH	DSBW	IWAKE
1	9.7,	75.0,	0	2	9.7,	75.0,	0	3	9.7,	75.0,	0	4	9.7,	75.0,	0
5	9.7,	75.0,	0	6	9.7,	75.0,	0	7	9.7,	75.0,	0	8	9.7,	75.0,	0
9	9.7,	75.0,	0	10	9.7,	75.0,	0	11	9.7,	75.0,	0	12	9.7,	75.0,	0
13	9.7,	75.0,	0	14	9.7,	75.0,	0	15	9.7,	75.0,	0	16	9.7,	75.0,	0

- SOURCE STRENGTHS (GRAMS PER SEC) -

SEASON 1	SEASON 2	SEASON 3	SEASON 4
1.33000E+00			

WARNING - HW/HB > 5 FOR SOURCE 1 PROG. USES LATERAL VIRTUAL DIST. FOR UPPER BOUND OF CONCENTRATION (DEPOSITION) IN SECTOR(S):
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16.
IF LOWER BOUND IS DESIRED SET THE DIRECTION SPECIFIC BUILDING HEIGHT TO < 0 (WAKE EFFECTS FLAG) AND RERUN.

** ANNUAL GROUND LEVEL CONCENTRATION (MICROGRAMS PER CUBIC METER) DUE TO SOURCE 1 **

- GRID SYSTEM RECEPTORS -

- X AXIS (RANGE , METERS) -

Y AXIS (AZIMUTH BEARING, DEGREES)	100.000	200.000	300.000	400.000	500.000	750.000	1000.000	1250.000
	- CONCENTRATION -							
360.000	0.468692	0.463875	0.677546	0.785197	0.790353	0.666367	0.547727	0.457303
337.500	0.282777	0.264902	0.368666	0.409949	0.400722	0.321056	0.258240	0.214329
315.000	0.208333	0.210829	0.318319	0.360490	0.350829	0.275897	0.221055	0.183985
292.500	0.292856	0.289127	0.428794	0.493518	0.489766	0.403362	0.329469	0.274177
270.000	0.395375	0.425244	0.671043	0.806253	0.824677	0.705903	0.585039	0.492401
247.500	0.348816	0.351246	0.509812	0.581274	0.574448	0.472955	0.391447	0.332171
225.000	0.228046	0.242040	0.378339	0.447382	0.450696	0.380204	0.321006	0.277807
202.500	0.157832	0.161541	0.249474	0.297267	0.304666	0.267947	0.233484	0.206673
180.000	0.268095	0.275909	0.429580	0.517838	0.533725	0.476989	0.418393	0.366929
157.500	0.170817	0.172392	0.254890	0.295839	0.299358	0.265967	0.233266	0.203337
135.000	0.279979	0.258046	0.347407	0.373253	0.355394	0.276280	0.217060	0.174936
112.500	0.356141	0.328752	0.439978	0.468572	0.441627	0.338133	0.265408	0.215872
90.000	0.461718	0.403958	0.500813	0.517655	0.480551	0.363458	0.285174	0.232744
67.500	0.349417	0.317333	0.437882	0.491804	0.483234	0.393061	0.318884	0.264777
45.000	0.339694	0.306604	0.406617	0.448121	0.437258	0.353600	0.284718	0.234740
22.500	0.246003	0.239733	0.350935	0.415904	0.426260	0.365395	0.301508	0.252413

- DISCRETE RECEPTORS -

X RANGE (METERS)	Y AZIMUTH BEARING (DEGREES)	CONCENTRATION	X RANGE (METERS)	Y AZIMUTH BEARING (DEGREES)	CONCENTRATION	X RANGE (METERS)	Y AZIMUTH BEARING (DEGREES)	CONCENTRATION
317.0	10.0	0.538878	332.0	20.0	0.410048	357.0	30.0	0.400955
402.0	40.0	0.434091	366.0	50.0	0.443128	323.0	60.0	0.435925
296.0	70.0	0.434870	283.0	80.0	0.440826	277.0	90.0	0.480026
283.0	100.0	0.444198	253.0	110.0	0.387566	171.0	120.0	0.323564
134.0	130.0	0.305910	113.0	140.0	0.262573	98.0	150.0	0.198531
91.0	160.0	0.163143	88.0	170.0	0.194004	85.0	180.0	0.231970
88.0	190.0	0.189450	91.0	200.0	0.153073	101.0	210.0	0.176803
113.0	220.0	0.222109	137.0	230.0	0.277127	134.0	240.0	0.332840
122.0	250.0	0.378751	119.0	260.0	0.395207	116.0	270.0	0.425496
119.0	280.0	0.367563	122.0	290.0	0.320739	134.0	300.0	0.280024
149.0	310.0	0.241510	177.0	320.0	0.230457	229.0	330.0	0.249857
250.0	340.0	0.331194	259.0	350.0	0.453311	311.0	360.0	0.697108

** ANNUAL GROUND LEVEL CONCENTRATION (MICROGRAMS PER CUBIC METER) DUE TO SOURCE 1 (CONT.) **

- 10 CONTRIBUTING VALUES TO PROGRAM DETERMINED MAXIMUM 10 OF ALL SOURCES COMBINED -

X COORDINATE RANGE (METERS)	Y COORDINATE AZIMUTH BEARING (DEGREES)	CONCENTRATION
500.00	270.00	0.824677
400.00	270.00	0.806253
500.00	360.00	0.790353
400.00	360.00	0.785197
750.00	270.00	0.705903
311.00	360.00	0.697108
300.00	360.00	0.677546
300.00	270.00	0.671043
750.00	360.00	0.666367
1000.00	270.00	0.585039

** END OF ISCLT PROGRAM,   1 SOURCES PROCESSED **

APPENDIX B

APPENDIX B

ECONOMIC IMPACT ANALYSIS METHODOLOGY

In the "top-down" approach, the economic impact along with environmental and energy impacts is one of three main criteria for BACT evaluation in considering any emission control method. The economic analysis determines the cost effectiveness of each applicable emission control alternative.

The economic analysis is based on the cost estimating procedure outlined in EPA's control cost manual (EPA, 1990b). An overall description of this cost estimating methodology is given as follows:

1. The total capital investment consists of direct capital and indirect capital costs. The direct capital cost includes the purchased equipment cost and the direct installation cost. The indirect capital cost accounts for other indirect expenses pertaining to the installation of the emission control device, such as engineering, construction and field expenses, contractor fee, contingencies, and startup and testing.

2. The annualized cost consists of the direct operating cost, the indirect operating cost, and the capital recovery cost. The direct operating cost includes both annual operating and maintenance costs, cost of replacement parts, and fuel costs. The indirect annual operating cost accounts for items such as overhead, property taxes, insurance, and administration. The capital recovery cost is calculated from the total capital investment cost using a capital recovery factor.

3. The total annual operating cost is divided by the total emission reduction of the control system to result in dollars per ton of pollutant removed (i.e., dollars per ton of NO_x in this case). This value is defined as the cost effectiveness of the control method. Incremental cost effectiveness of one control method over

another is also calculated based on the incremental annual cost and incremental emission reduction.

Detailed descriptions of the cost estimates are presented in the following three sections for the SCR system being evaluated as an add-on control device for the lean-burn engine. The discussion includes economic analyses of the lean-burn engine and the NSCR system for the rich-burn engine. The baseline cost estimate is based on the rich-burn engine since it has been defined as the baseline engine on which all emission calculations are based.

SECTION I <u>TOTAL CAPITAL INVESTMENT (TCI)</u>

The TCI cost for the SCR converter covers a complete turn-key system. The basic purchased equipment costs consist of the differential reciprocating IC engine cost and the SCR system cost. The differential engine cost accounts for the difference in cost between the higher cost lean-burn and the lower cost rich-burn engines as quoted by Cooper Industries, Inc. The cost of the SCR system is either a printed cost quotation or a "ball park" estimate of unit cost per brake horsepower obtained directly from the equipment vendors. Subsequently, other direct and indirect capital cost items are estimated from cost factors based on standard cost estimating guidelines (EPA, 1990b). The estimating method provides accuracies on the order of plus or minus 20 percent.

The direct capital costs (DCC) for the SCR converter are comprised of purchased equipment costs and direct installation costs. Purchased equipment costs represent the free on board (FOB) delivery costs of the differential lean-burn engine, the emission control basic equipment, ammonia auxiliary system, exhaust reheat duct burner system, emission monitoring equipment, structure support, instrumentation, freight, and sales tax. The differential engine cost accounts for the difference in costs of the lean-burn engine and an equivalent rich-burn engine (i.e., equivalent in terms of output). Emission control basic equipment consists of all catalyst structure, and mechanical and electrical components required for efficient operation of the device. These include such items as internal piping and exhaust gas ductwork.

The storage tank and delivery equipment costs for the ammonia system were obtained from the ammonia supplier. The ammonia system was designed for a typical 3-month supply of anhydrous ammonia and its auxiliary equipment such as ammonia vaporizer/injection components.

The cost of the auxiliary equipment for reheating the exhaust gas accounts for the duct burner system required to bring the exhaust temperature from 495°F to 700°F. Without raising the temperature, the SCR system would not work properly.

Emission monitoring costs include the cost of NO_x and O_2 continuous monitors, which are not included in the basic equipment costs. These monitors are tied to the ammonia injection system to ensure proper NO_x reduction. These costs are estimated at 15 percent of the SCR basic equipment cost.

Structure support costs account for miscellaneous external piping, auxiliary support, independent flow controllers and indicators for the connection between the basic equipment and the ammonia system. Costs are estimated at 10 percent of the overall equipment cost. Overall equipment includes the engine, emission control device, exhaust reheating heater, monitoring equipment, and any other auxiliary system.

Plant instrumentation and controls are usually not included in the basic equipment cost; typical cost factors range from 10 to 15 percent of the overall equipment cost, depending on the specific application.

The purchased equipment costs are then the basis for determining the direct and indirect installation costs. The installation costs are based on standard cost factors (EPA, 1990b).

The direct installation costs consist of the direct expenditures for materials and labor for site preparation, foundations, structural steel, erection, piping, electrical, painting, and insulation. Direct installation costs are expressed as a percentage of the total basic equipment costs for standard industrial installations.

The indirect capital costs (ICC) typically cover several areas, such as: engineering and supervision, construction and field expenses, construction contractor fee, contingencies, start-up and testing, and working capital. Each of the above items is based on a percentage of the DCC; except for the working capital which is based on the direct operating cost (DOC).

For the proposed lean-burn engine, the TCI cost estimate is also calculated by summing the purchased equipment costs, direct installation costs, and indirect capital costs. In this case, the itemized basic purchased equipment costs only include the differential engine cost, instrumentation, freight, and sales tax. Other direct and indirect installation costs are estimated by multiplying the sum of the basic purchased equipment costs by the standard cost factors.

The TCI cost estimate for the NSCR converter was based on a similar cost estimating procedure. Basic purchased equipment costs for the NSCR system include the basic converter, emission monitoring, structural support, instrumentation, freight, and sales tax. The direct and indirect installation costs follow a similar procedure to the one described above.

SECTION II <u>ANNUALIZED COST (AC)</u>

The AC estimates for each SCR system are comprised of the direct operating costs (DOC), the indirect operating costs (IOC) and the capital recovery cost (CRC). The DOC includes the operating labor, maintenance, replacement catalyst and parts, utilities, and ammonia supply. The IOC includes plant overhead, property taxes, insurance, and administration. The CRC accounts for the annualized cost of the initial capital investment for the emission control system.

2.0 PROJECT DESCRIPTION

A plot plan of FGTC's Compressor Station No. 18, showing the location of the plant boundaries, the existing engines, and the proposed additional engine, is presented in Figure 2-1. The following sections describe the existing operations at this location, as well as a description of the proposed project.

2.1 EXISTING OPERATIONS

FGTC's existing Compressor Station No. 18 consists of four 2,000-bhp natural-gas-fired reciprocating IC engines. All of the engines are Worthington Model SEHG-8. These engines were installed prior to the CAA amendments of 1977: three engines were installed in 1959; and the fourth engine was installed in 1968. These existing engines are not being modified as part of this expansion project; therefore, they are not subject to PSD review.

2.2 PROPOSED COMPRESSOR STATION ADDITION

The proposed engine will be used to drive a gas compressor that is a part of the mechanical prime mover of the main gas transmission line that transports natural gas from source wells in Texas and Louisiana. The proposed engine will play a critical part in recompressing the natural gas for delivery throughout Florida. Without the proposed engine, it would not be possible to increase the volumetric delivery capacity in order to meet both short-term and long-term demands for natural gas in Florida.

FGTC proposes to install one natural-gas-fired engine at the Compressor Station No. 18. The expansion plan currently calls for installation of a Cooper-Bessemer Model GMVR-12C2 integral engine-compressor unit. The engine has 12 power cylinders and is rated at 2,400 bhp at 330 revolutions per minute (rpm). The engine is turbocharged, increasing the air inlet manifold pressure, which allows the engine to operate at a high air-to-fuel ratio. This turbocharging provides more power output from the engine than would otherwise be attained without having to use a larger size engine. A

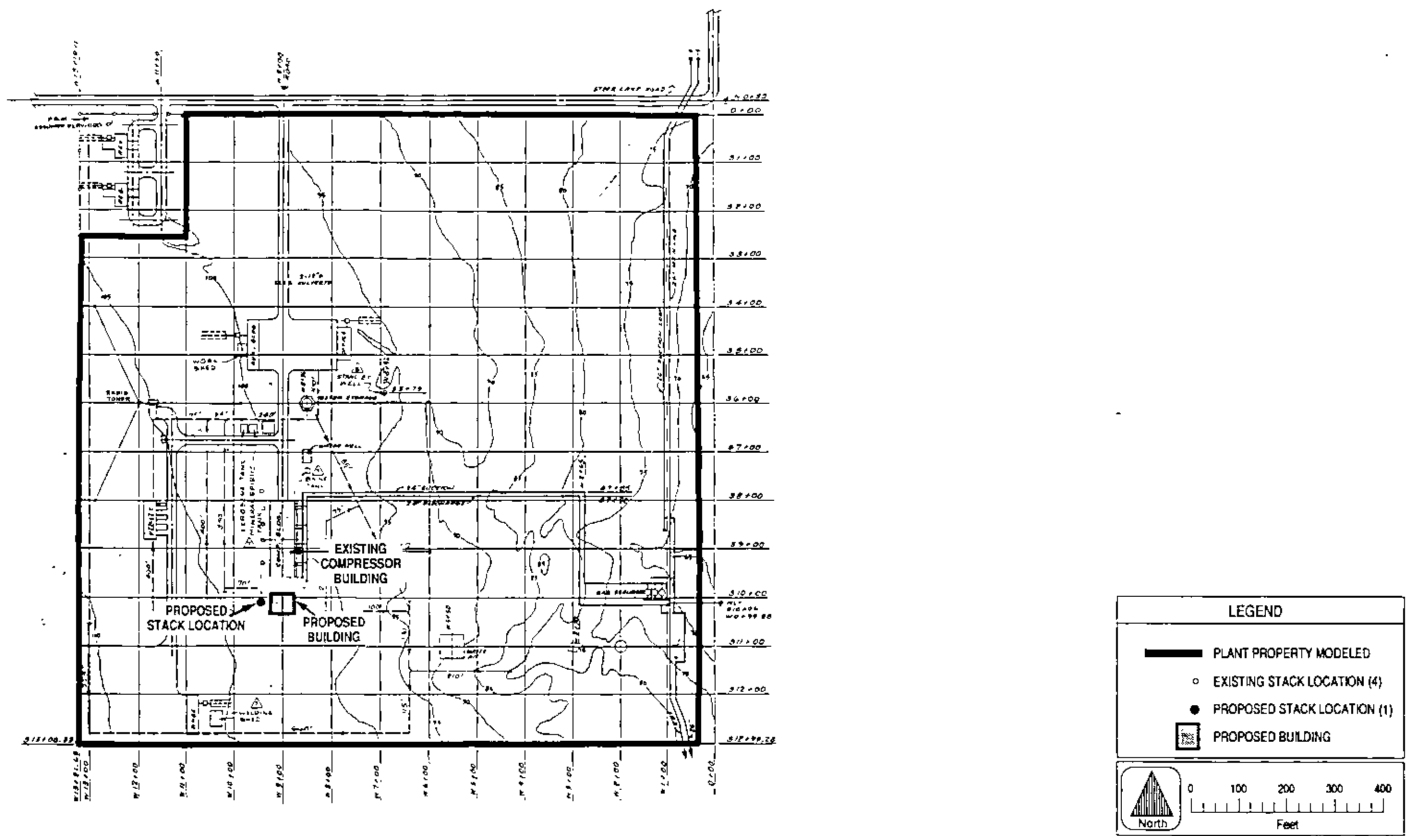

Figure 2-1 PLOT PLAN OF COMPRESSOR STATION NO. 18

Florida Gas Transmission Company

flow diagram of the integral engine compressor unit is presented in Figure 2-2. Fuel fired will be exclusively natural gas, supplied from the FGTC's gas pipeline. Based on the operating characteristics and design, this engine is classified as a high-power, large-bore, slow-speed reciprocating IC engine according to the U.S. Environmental Protection Agency's (EPA's) documented classification (EPA, 1979). Engine specifications and stack parameters for the proposed engine are presented in Table 2-1.

The proposed engine will incorporate "lean-burn" technology, which is state-of-the-art design for minimizing air pollutant concentration in the exhaust gases from gas-fired reciprocating IC engines. In the lean-burn design, a small, fuel-rich mixture is combusted in a pre-ignition chamber. The hot combustion gases from the pre-ignition chamber then pass to the main combustion chamber, where they ignite a lean mixture of fuel. Since most of the fuel entering the engine is burned in a lean state (i.e., high ratio of air to fuel), exhaust NO_x emissions are minimized. However, volatile organic compound (VOC) emissions are approximately 40 to 50 percent higher than standard "rich-burn" engines.

Maximum hourly and annual emissions of regulated pollutants from the proposed engine are presented in Table 2-2. Emissions of NO_x, carbon monoxide (CO), and VOC are based on the engine manufacturer's guarantee. Particulate matter (PM) emissions are based upon EPA publication AP-42 (EPA, 1988d) emission factors for natural gas combustion in boilers. Emissions of sulfur dioxide (SO_2) are based on ENRON's natural gas specification. According to EPA's publication entitled Toxic Air Pollutant Emission Factors--A Compilation for Selected Air Toxic Compounds and Sources, there are no emission factors for other regulated pollutants due to natural gas combustion in stationary IC engines (EPA, 1988a).

In order to accommodate the new engine at the existing compressor station site, a new 40-ft by 53-ft compressor building will be built at approximately 40 ft from the south end of the existing compressor building.

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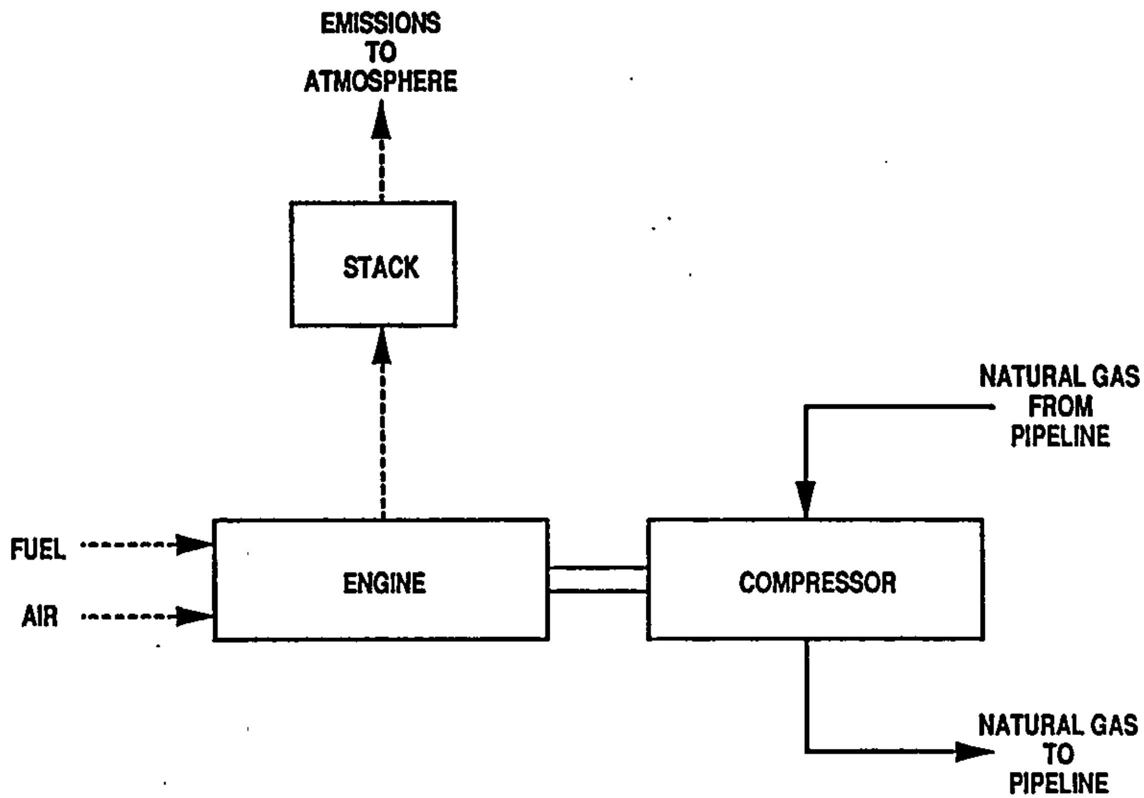

Figure 2-2 PROCESS FLOW DIAGRAM OF AN INTEGRAL ENGINE-COMPRESSOR UNIT

Florida Gas Transmission Company

Table 2-1. Engine Specifications and Stack Parameters for the Proposed Project

Parameter	Design Specification
Engine-Compressor	
Manufacturer	Cooper-Bessemer
Model	GMVR-12C2
Air Charging	Turbocharged
Unit Size	2,400 bhp
Number of Power Cylinders	12 cylinders
Number of Compressor Cylinders	6 cylinders
Power Cylinder Data	
Bore Size	14 inches
Stroke	14 inches
Cylinder Power	200 bhp/cylinder
Specific Heat Input	7,000 Btu/bhp-hr
Maximum Fuel Consumption	16,311 scf/hr[a]
Speed	330 rpm
Stack Parameters	
Stack Height	40 ft
Stack Diameter	17.25 inches
Exhaust Gas FLow	36,860 lb/hr 15,627 acfm
Exhaust Temperature	550°F
Exhaust Gas Velocity	160.37 ft/sec

Note:
acfm = actual cubic feet per minute.
bhp = brake horsepower.
Btu/bhp-hr = British thermal units per brake horsepower per hour.
°F = degrees fahrenheit.
ft = feet.
ft/sec = feet per second.
lb/hr = pounds per hour.
scf = standard cubic feet.
rpm = revolutions per minute.

[a]Based on heating value for natural gas of 1,030 British thermal units per standard cubic foot (Btu/scf).

Source: Cooper Industries, 1990.
ENRON Corporation, 1990.

Table 2-2. Maximum Emissions From FGTC's Proposed Compressor Engine

Pollutant	Emission Factor	Reference	Maximum Emissions lb/hr	Maximum Emissions TPY
Nitrogen Oxides	2.0 g/bhp-hr	Manufacturer's guarantee	10.6	46.3
Carbon Monoxide	2.1 g/bhp-hr	Manufacturer's guarantee	11.1	48.7
Volatile Organic Compounds (non-methane)	0.5 g/bhp-hr	Manufacturer's guarantee	2.6	11.6
Particulate Matter	5 lb/MMscf	AP-42, Table 1.4-1	0.08	0.36
Sulfur Dioxide	10 gr/100 scf	ENRON Specification	0.47	2.04

Note: Maximum natural gas consumption is 16,311 standard cubic feet per hour (scf/hr).

g/bhp-hr = grams per brake horsepower per hour.
gr/100scf = grains per one hundred standard cubic feet.
lb/hr = pounds per hour.
lb/MMscf = pounds per million standard cubic feet.
TPY = tons per year.

The footprint of the newly proposed compressor housing with respect to the current existing plot plan is shown in Figure 2-1. The new engine will be housed inside the newly proposed building. The location of the exhaust stack for the new engine is also shown in Figure 2-1.

3.0 AIR QUALITY REVIEW REQUIREMENTS AND APPLICABILITY

The following discussion pertains to the federal and state air regulatory requirements and their applicability to FGTC's proposed compressor station expansion. These regulations must be satisfied before construction can begin on the proposed source.

3.1 NATIONAL AND STATE AAQS

The existing applicable national and Florida ambient air quality standards (AAQS) are presented in Table 3-1. Primary national AAQS were promulgated to protect the public health, and secondary national AAQS were promulgated to protect the public welfare from any known or anticipated adverse effects associated with the presence of pollutants in the ambient air. Areas of the country in violation of AAQS are designated as "nonattainment" areas, and new sources to be located in or near these areas may be subject to more stringent air permitting requirements.

3.2 PSD REQUIREMENTS

3.2.1 GENERAL REQUIREMENTS

Federal PSD requirements are contained in the Code of Federal Regulations (CFR), 40, 52.21, Prevention of Significant Deterioration of air quality. The state of Florida has adopted PSD regulations [Chapter 17-2.510, Florida Administrative Code (F.A.C.)] that are essentially identical to the federal regulations. PSD regulations require that all new major stationary sources or major modifications to existing major sources of air pollutants regulated under CAA be reviewed and a construction permit issued. Florida's State Implementation Plan (SIP), which contains PSD regulations, has been approved by EPA, and, therefore, PSD approval authority in Florida has been granted to FDER.

A "major facility" is defined under PSD as any one of 28 named source categories which has the potential to emit 100 TPY or more, or any other

Table 3-1. National and State AAQS, Allowable PSD Increments, and Significance Levels ($\mu g/m^3$)

Pollutant	Averaging Time	AAQS National Primary Standard	AAQS National Secondary Standard	AAQS State of Florida	PSD Increments Class I	PSD Increments Class II	Significant Impact Levels
Particulate Matter (TSP)	Annual Geometric Mean	NA	NA	NA	5	19	1
	24-Hour Maximum[a]	NA	NA	NA	10	37	5
Particulate Matter (PM10)	Annual Arithmetic Mean	50	50	50	4[c]	17[c]	1
	24-Hour Maximum[b]	150	150	150	8[c]	30[c]	5
Sulfur Dioxide	Annual Arithmetic Mean	80	NA	60	2	20	1
	24-Hour Maximum[b]	365	NA	260	5	91	5
	3-Hour Maximum[b]	NA	1,300	1,300	25	512	25
Carbon Monoxide	8-Hour Maximum[b]	10,000	10,000	10,000	NA	NA	500
	1-Hour Maximum[b]	40,000	40,000	40,000	NA	NA	2,000
Nitrogen Dioxide	Annual Arithmetic Mean	100	100	100	2.5	25	1
Ozone	1-Hour Maximum[d]	235	235	235	NA	NA	NA
Lead	Calendar Quarter Arithmetic Mean	1.5	1.5	15	NA	NA	NA

[a]Maximum concentration not to be exceeded more than once per year.
[b]Achieved when the expected number of exceedances per year is less than 1.
[c]Proposed by EPA in the Federal Register on October 5, 1989.
[d]Achieved when the expected number of days per year with concentrations above the standard is less than 1.

Note: Particulate matter (TSP) = total suspended particulate matter.
Particulate matter (PM10) = particulate matter with aerodynamic diameter less than or equal to 10 micrometers.
$\mu g/m^3$ = micrograms per cubic meter.
NA = Not applicable, i.e., no standard exists.

Sources: Federal Register, Vol. 43, No. 118, June 19, 1978.
40 CFR 50.
40 CFR 52.21.
Chapter 17-2.400, F.A.C.

stationary facility that has the potential to emit 250 TPY or more of any pollutant regulated under CAA. A "source" is defined as an identifiable piece of process equipment or emissions unit. "Potential to emit" means the capability, at maximum design capacity, to emit a pollutant considering the application of control equipment and any other federally enforceable limitations on the source's capacity. A "major modification" is defined under PSD regulations as a change at an existing major stationary facility which increases emissions by greater than significant amounts. PSD significant emission rates are shown in Table 3-2.

PSD review is used to determine whether significant air quality deterioration will result from the new or modified facility. Major new facilities and major modifications are required to undergo the following analyses related to PSD for each pollutant emitted in significant amounts:

1. Control technology review,
2. Source impact analysis,
3. Air quality analysis (monitoring),
4. Source information, and
5. Additional impact analyses.

In addition to these analyses, a new facility must also be reviewed with respect to good engineering practices (GEP) stack height regulations. If the proposed new source or modification is located in a nonattainment area for any pollutant, the source may be subject to nonattainment new source review requirements. Discussions concerning each of these requirements are presented in the following sections.

3.2.2 INCREMENTS/CLASSIFICATIONS

The 1977 Clean Air Act (CAA) amendments address PSD of air quality. The law specifies that certain increases in air quality concentrations above the baseline concentration level of sulfur dioxide (SO_2) and particulate matter--total suspended particulates [PM(TSP)]--would constitute

Table 3-2. PSD Significant Emission Rates and De Minimis Monitoring Concentrations

Pollutant	Regulated Under	Significant Emission Rate (TPY)	De Minimis Monitoring Concentration ($\mu g/m^3$)
Sulfur Dioxide	NAAQS, NSPS	40	13, 24-hour
Particulate Matter (TSP)	NAAQS, NSPS	25	10, 24-hour
Particulate Matter (PM10)	NAAQS	15	10, 24-hour
Nitrogen Oxides	NAAQS, NSPS	40	14, annual
Carbon Monoxide	NAAQS, NSPS	100	575, 8-hour
Volatile Organic Compounds (Ozone)	NAAQS, NSPS	40	100 TPY[a]
Lead	NAAQS	0.6	0.1, 3-month
Sulfuric Acid Mist	NSPS	7	NM
Total Fluorides	NSPS	3	0.25, 24-hour
Total Reduced Sulfur	NSPS	10	10, 1-hour
Reduced Sulfur Compounds	NSPS	10	10, 1-hour
Hydrogen Sulfide	NSPS	10	0.2, 1-hour
Asbestos	NESHAP	0.007	NM
Beryllium	NESHAP	0.0004	0.001, 24-hour
Mercury	NESHAP	0.1	0.25, 24-hour
Vinyl Chloride	NESHAP	1	15, 24-hour
Benzene	NESHAP	b	NM
Radionuclides	NESHAP	b	NM
Inorganic Arsenic	NESHAP	b	NM

[a]No de minimis concentration; an increase in VOC emissions of 100 TPY or more will require monitoring analysis for ozone.
[b]Any emission rate of these pollutants.

Note: Ambient monitoring requirements for any pollutant may be exempted if the impact of the increase in emissions is below de minimis monitoring concentrations.

NAAQS = National Ambient Air Quality Standards.
NM = No ambient measurement method.
NSPS = New Source Performance Standards.
NESHAP = National Emission Standards for Hazardous Air Pollutants.
$\mu g/m^3$ = micrograms per cubic meter.

Sources: 40 CFR 52.21.
Chapter 17-2, F.A.C.

significant deterioration. The magnitude of the allowable increment depends on the classification of the area in which a new source (or modification) will be located or will have an impact. Congress also directed EPA to evaluate PSD increments for other criteria pollutants and, if appropriate, promulgate PSD increments for such pollutants.

Three classifications were designated, based on criteria established in the CAA Amendments. Certain types of areas (international parks, national wilderness areas, and memorial parks larger than 5,000 acres, and national parks larger than 6,000 acres) were designated as Class I areas. All other areas of the country were designated as Class II. PSD increments for Class III areas were defined, but no areas were designated as Class III. However, Congress made provisions in the law to allow the redesignation of Class II areas to Class III areas.

In 1977, EPA promulgated PSD regulations related to the requirements for classifications, increments, and area designations as set forth by Congress. PSD increments were initially set for only SO_2 and PM(TSP). However, in 1988, EPA promulgated final PSD regulations for nitrogen oxides (NO_x) and established PSD increments for nitrogen dioxide (NO_2).

The current federal PSD increments are shown in Table 3-1. As shown, Class I increments are the most stringent, allowing the smallest amount of air quality deterioration, while the Class III increments allow the greatest amount of deterioration. FDER has adopted the EPA class designations and allowable PSD increments for PM(TSP), SO_2, and NO_2.

On October 5, 1989, EPA proposed PSD increments for PM10. Those proposed increments are shown in Table 3-1. The PM10 increments as proposed are somewhat lower in magnitude than the current PM(TSP) increments.

The term "baseline concentration" evolves from federal and state PSD regulations and refers to a fictitious concentration level corresponding to a specified baseline date and certain additional baseline sources. By definition in the PSD regulations, baseline concentration means the ambient concentration level that exists in the baseline area at the time of the applicable baseline date. A baseline concentration is determined for each pollutant for which a baseline date is established and includes:

1. The actual emissions representative of sources in existence on the applicable baseline date; and
2. The allowable emissions of major stationary sources that began construction before January 6, 1975, for SO_2 and PM(TSP) sources, or February 8, 1988, for NO_x sources; but which were not in operation by the applicable baseline date.

The following emissions are not included in the baseline concentration and therefore affect PSD increment consumption:

1. Actual emissions from any major stationary source on which construction began after January 6, 1975, for SO_2 and PM(TSP) sources, and after February 8, 1988, for NO_x sources; and
2. Actual emission increases and decreases at any stationary source occurring after the baseline date.

In reference to the baseline concentration, the baseline date actually includes three different dates:

1. The major source baseline date, which is January 6, 1975, in the cases of SO_2 and PM(TSP), and February 8, 1988, in the case of NO_2;
2. The minor source baseline date, which is the earliest date after the trigger date on which a major stationary source or major modification subject to PSD regulations submits a complete PSD application; and
3. The trigger date, which is August 7, 1977, for SO_2 and PM(TSP), and February 8, 1988, for NO_2.

The minor source baseline date for SO_2 and PM(TSP) has been set as December 27, 1977, for the entire state of Florida (Chapter 17-2.450, F.A.C.). The minor source baseline date for NO_2 has been set as March 28, 1988, for all of Florida.

3.2.3 CONTROL TECHNOLOGY REVIEW

The control technology review requirements of the federal and state PSD regulations require that all applicable federal and state emission limiting standards be met and that BACT be applied to control emissions from the source [Chapter 17-2.500(5)(c), F.A.C]. The BACT requirements are applicable to all regulated pollutants for which the increase in emissions from the facility or modification exceeds the significant emission rate (see Table 3-2).

BACT is defined in Chapter 17-2.100(25), F.A.C. as:

> An emissions limitation, including a visible emission standard, based on the maximum degree of reduction of each pollutant emitted which the Department, on a case by case basis, taking into account energy, environmental, and economic impacts, and other costs, determines is achievable through application of production processes and available methods, systems, and techniques (including fuel cleaning or treatment or innovative fuel combustion techniques) for control of such pollutant. If the Department determines that technological or economic limitations on the application of measurement methodology to a particular part of a source or facility would make the imposition of an emission standard infeasible, a design, equipment, work practice, operational standard or combination thereof, may be prescribed instead to satisfy the requirement for the application of BACT. Such standard shall, to the degree possible, set forth the emissions reductions achievable by implementation of such design, equipment, work practice, or operation.

The requirements for BACT were promulgated within the framework of PSD in the 1977 amendments of the CAA [Public Law 95-95; Part C, Section 165(a)(4)]. The primary purpose of BACT is to optimize consumption of PSD air quality increments and, thereby, enlarge the potential for future economic growth without significantly degrading air quality (EPA, 1978; 1980). Guidelines for the evaluation of BACT can be found in EPA's Guidelines for Determining Best Available Control Technology (BACT) (EPA, 1978) and in the PSD Workshop Manual (EPA, 1980). These guidelines were promulgated by EPA to provide a consistent approach to BACT and to ensure that the impacts of alternative emission control systems are measured by the same set of parameters. In addition, through implementation of these guidelines, BACT in one area may not be identical to BACT in another area. According to EPA (1980),

> BACT analyses for the same types of emissions unit and the same pollutants in different locations or situations may determine that different control strategies should be applied to the different sites, depending on site-specific factors. Therefore, BACT analyses must be conducted on a case-by-case basis.

The BACT requirements are intended to ensure that the control systems incorporated in the design of a proposed facility reflect the latest in control technologies used in a particular industry and take into consideration existing and future air quality in the vicinity of the proposed facility. BACT must, as a minimum, demonstrate compliance with New Source Performance Standards (NSPS) for a source (if applicable). An evaluation of the air pollution control techniques and systems, including a cost-benefit analysis of alternative control technologies capable of achieving a higher degree of emission reduction than the proposed control technology, is required. The cost-benefit analysis requires the documentation of the materials, energy, and economic penalties associated with the proposed and alternative control systems, as well as the environmental benefits derived from these systems. A decision on BACT is to be based on sound judgment, balancing environmental benefits with energy, economic, and other impacts (EPA, 1978).

Historically, a "bottom-up" approach consistent with the BACT Guidelines and PSD Workshop Manual has been used. With this approach, an initial control level, which is usually NSPS, is evaluated against successively more stringent controls until a BACT level is selected. However, EPA developed a concern that the bottom-up approach was not providing the level of BACT decisions originally intended. As a result, in December 1987, the EPA Assistant Administrator for Air and Radiation mandated changes in the implementation of the PSD program including the adoption of a new "top-down" approach to BACT decision making.

The top-down BACT approach essentially starts with the most stringent (or top) technology and emissions limit that have been applied elsewhere to the same or a similar source category. The applicant must next provide a basis for rejecting this technology in favor of the next most stringent technology or propose to use it. Rejection of control alternatives may be based on technical or economic infeasibility. Such decisions are made on the basis of physical differences (e.g., fuel type), locational differences (e.g., availability of water), or significant differences that may exist in the environmental, economic or energy impacts. The differences between the proposed facility and the facility on which the control technique was applied previously must be justified. Recently, EPA issued a draft guidance document on the top-down approach entitled Top-Down Best Available Control Technology Guidance Document (EPA, 1990a).

3.2.4 AIR QUALITY MONITORING REQUIREMENTS

In accordance with requirements of 40 CFR 52.21(m) and Chapter 17-2.500(f), F.A.C, any application for a PSD permit must contain an analysis of ambient air quality data in the area affected by the proposed major stationary facility or major modification. For a new major facility, the affected pollutants are those that the facility would potentially emit in significant amounts. For a major modification, the pollutants are those for which the net emissions increase exceeds the significant emission rate (see Table 3-2).

Ambient air monitoring for a period of up to 1 year is generally appropriate to satisfy the PSD monitoring requirements. A minimum of

4 months of data is required. Existing data from the vicinity of the proposed source may be utilized if the data meet certain quality assurance requirements; otherwise, additional data may need to be gathered. Guidance in designing a PSD monitoring network is provided in EPA's Ambient Monitoring Guidelines for Prevention of Significant Deterioration (EPA, 1987a).

Under the exemption rule, FDER may exempt a proposed major stationary facility or major modification from the monitoring requirements with respect to a particular pollutant if the emissions increase of the pollutant from the facility or modification would cause, in any area, air quality impacts less than the de minimis levels presented in Table 3-2 [Chapter 17-2.500(3)(e), F.A.C.].

3.2.5 SOURCE IMPACT ANALYSIS

A source impact analysis must be performed for a proposed major source subject to PSD for each pollutant for which the increase in emissions exceeds the significant emission rate (Table 3-2). The PSD regulations specifically provide for the use of atmospheric dispersion models in performing impact analysis, estimating baseline and future air quality levels, and determining compliance with AAQS and allowable PSD increments. Designated EPA models must normally be used in performing the impact analysis. Specific applications for other than EPA-approved models require EPA's consultation and prior approval. Guidance for the use and application of dispersion models is presented in the EPA publication Guideline on Air Quality Models (EPA, 1987b). The source impact analysis for criteria pollutants may be limited to only the new or modified source if the net increase in impacts due to the new or modified source is below significance levels, as presented in Table 3-1.

Various lengths of record for meteorological data can be utilized for impact analysis. A 5-year period can be used with corresponding evaluation of highest, second-highest short-term concentrations for comparison to AAQS or PSD increments. The term "highest, second-highest" (HSH) refers to the highest of the second-highest concentrations at all receptors (i.e., the highest concentration at each receptor is discarded). The second-highest concentration is significant because short-term AAQS specify that the standard should not be exceeded at any location more than once a year. If less than 5 years of meteorological data are used in the modeling analysis, the highest concentration at each receptor must normally be used for comparison to air quality standards.

3.2.6 ADDITIONAL IMPACT ANALYSES

In addition to air quality impact analyses, federal and state of Florida PSD regulations require analysis of the impairment to visibility and the impacts on soils and vegetation that would occur as a result of the proposed source [40 CFR 52.21; Chapter 17-2.500(5)(e), F.A.C.]. These analyses are to be conducted primarily for PSD Class I areas. Impacts due to general commercial, residential, industrial, and other growth associated with the source must also be addressed. These analyses are required for each pollutant emitted in significant amounts (Table 3-2).

3.2.7 GOOD ENGINEERING PRACTICE STACK HEIGHT

The 1977 CAA amendments require that the degree of emission limitation required for control of any pollutant not be affected by a stack height that exceeds GEP, or any other dispersion technique. On July 8, 1985, EPA promulgated final stack height regulations (EPA, 1985). Identical regulations have been adopted by FDER [Chapter 17-2.270, F.A.C.]. GEP stack height is defined as the highest of:

1. 65 meters (m); or
2. A height established by applying the formula:

$$Hg = H + 1.5L$$

where: Hg = GEP stack height,
H = Height of the structure or nearby structure, and
L = Lesser dimension (height or projected width) of nearby structure(s); or

3. A height demonstrated by a fluid model or field study.

"Nearby" is defined as a distance up to five times the lesser of the height or width dimensions of a structure or terrain feature, but not greater than 0.8 kilometers (km). Although GEP stack height regulations require that the stack height used in modeling for determining compliance with AAQS and PSD increments not exceed the GEP stack height, the actual stack height may be greater.

3.3 NONATTAINMENT RULES

Based on the current nonattainment provisions (Chapter 17-2.510, F.A.C.), all major new facilities and modifications to existing major facilities located in a nonattainment area must undergo nonattainment review if the proposed pieces of equipment have the potential to emit 100 TPY or more of the nonattainment pollutant, or if the modification results in a significant net emission increase of the nonattainment pollutant.

For major facilities or major modifications that locate in an attainment or unclassifiable area, the nonattainment review procedures apply if the source or modification is located within the area of influence of a nonattainment area. The area of influence is defined as an area which is outside the boundary of a nonattainment area but within the locus of all points that are 50 km outside the boundary of the nonattainment area. Based on Chapter 17-2.510(2)(a)2.a, F.A.C., all VOC sources which are located within an area of influence are exempt from the provisions of new source review for nonattainment areas. Sources which emit other nonattainment pollutants and are located within the area of influence are subject to nonattainment review unless the maximum allowable emissions from the proposed source do not have a significant impact within the nonattainment area.

3.4 SOURCE APPLICABILITY

3.4.1 PSD REVIEW

3.4.1.1 Pollutant Applicability

FGTC's Compressor Station No. 18 is located in Orange County, which has been designated by EPA and FDER as an attainment area for all criteria pollutants. The nearest nonattainment area is located more than 100 km from the compressor station site. Orange County and surrounding counties are designated as PSD Class II areas for SO_2, PM(TSP), and NO_2. The site is also located more than 100 km from the nearest PSD Class I area.

FGTC's existing Compressor Station No. 18 is considered to be an existing major facility because total potential emissions of any regulated pollutant from the existing facility exceed 250 TPY. As a result, PSD review is required for the proposed expansion for each pollutant for which the net increase in emissions exceeds the PSD significant emission rates presented in Table 3-2 (i.e., major modification).

Table 3-3 presents the maximum hourly and annual emissions from the proposed new compressor engine. As shown, potential NO_x emissions from the engine will exceed the PSD significant emission rate for this regulated pollutant. Therefore, the proposed expansion project is subject to PSD review for NO_x.

3.4.1.2 Ambient Monitoring

Based upon the increase in emissions from FGTC's proposed expansion at Compressor Station No. 18, presented in Table 3-3, a PSD preconstruction ambient monitoring analysis is required for NO_x. However, if the increase in impacts of a pollutant is less than the de minimis monitoring concentration, then an exemption from the preconstruction ambient monitoring requirement may be granted for that pollutant. In addition, if an acceptable ambient monitoring method for the pollutant has not been established by EPA, monitoring is not required.

Table 3-3. Maximum Potential Emissions Due to Proposed Engine at Compressor Station No. 18

Pollutant	Maximum Potential Emissions From Proposed Compressor Engine (lb/hr)	Maximum Potential Emissions From Proposed Compressor Engine (TPY)	Significant Emission Rate (TPY)	PSD Review Applies?
Nitrogen Oxides	10.6	46.3	40	Yes
Carbon Monoxide	11.1	48.7	100	No
Votatile Organic Compounds (non-methane)	2.6	11.6	40	No
Particulate Matter (TSP)	0.08	0.36	25	No
Particulate Matter (PM10)	0.08	0.36	15	No
Sulfur Dioxide	0.47	2.04	40	No

The maximum annual impact associated with the potential NO_x emissions from the proposed IC engine is 0.99 $\mu g/m^3$. The methodology used to predict this value is presented in Section 4.0, along with the impact analysis result. The de minimis concentration level for NO_x is 14 $\mu g/m^3$ annual average. Since the maximum impact of NO_x is less than its de minimis concentration level, the proposed expansion project is exempted from the PSD preconstruction ambient monitoring requirement for NO_x.

3.4.1.3 GEP Stack Height Analysis

The GEP stack height regulations allow any stack to be at least 65 m (213 ft) high. The proposed stack for the new compressor engine will be 40 ft high (12.19 m) and, therefore, does not exceed the GEP stack height. The potential for downwash of the engines' emissions due to nearby structures is discussed in Section 4.0, Source Impact Analysis.

3.4.2 NONATTAINMENT REVIEW

FGTC's Compressor Station No. 18 is not located in any nonattainment area or in any area of influence of a nonattainment area. As a result, nonattainment review does not apply to the proposed expansion project.

4.0 SOURCE IMPACT ANALYSIS

4.1 ANALYSIS APPROACH AND ASSUMPTIONS

4.1.1 GENERAL MODELING APPROACH

The general modeling approach follows EPA and FDER modeling guidelines for determining compliance with AAQS and PSD increments. In general, when model predictions are used to determine compliance with AAQS and PSD increments, current EPA and FDER policies stipulate that the highest annual average concentration and highest, second-highest short-term (i.e., 24 hours or less) concentration can be compared to the applicable standard.

Model predictions for annual average NO_x concentrations were performed using the Industrial Source Complex Long-Term (ISCLT) model (Version 90008). A brief description of the Industrial Source Complex (ISC) model is given in Section 4.1.2.

4.1.2 MODEL SELECTION

The ISC dispersion model (EPA, 1988b) was used to evaluate the NO_x emissions from the proposed compressor engine. This model is contained in the EPA User's Network for Applied Modeling of Air Pollution (UNAMAP), Version 6 (EPA, 1988c). The ISC model was selected primarily for the following reasons:

1. EPA and FDER have approved the general use of the model for air quality dispersion analysis because the model assumptions and methods are consistent with those in the Guideline on Air Quality Models (EPA, 1987b);
2. The ISC model is capable of predicting the impacts from stack, area, and volume sources that are spatially distributed over large areas and located in flat or gently rolling terrain; and
3. The results from the ISC model are appropriate for addressing compliance with AAQS and PSD increments.

The ISCLT model is an extension of the Air Quality Display Model (AQDM) and the Climatological Dispersion Model (CDM). The ISCLT model uses joint frequencies of wind direction, windspeed, and atmospheric stability to calculate seasonal and/or annual average ground-level concentrations. Because the input wind directions are for 16 sectors, with each sector defined as 22.5 degrees, the model calculates concentrations by assuming that the pollutant is uniformly distributed in the horizontal plane within a 22.5-degree sector.

Major features of the ISCLT model are presented in Table 4-1. Concentrations due to stack and volume sources are calculated by the model using the steady-state Gaussian plume equation for a continuous source. The area source equation in the ISC model is based on the equation for a continuous and finite crosswind line source.

The ISC model has rural and urban options which affect the windspeed profile exponent law, dispersion rates, and mixing-height formulations used in calculating ground-level concentrations. The criteria used to determine when the rural or urban mode is appropriate are based on land use near the proposed plant's surroundings (Auer, 1978). If the land use is classified as heavy industrial, light-moderate industrial, commercial, or compact residential for more than 50 percent of the area within a 3-km radius circle centered on the proposed source, the urban option is selected. Otherwise, the rural option is used.

For modeling analyses that will undergo regulatory review, such as PSD permit applications, the following model features are recommended by EPA (1987a) and are referred to as the regulatory options in the ISC model:

1. Final plume rise at all receptor locations,
2. Stack-tip downwash,
3. Buoyancy-induced dispersion,
4. Default windspeed profile coefficients for rural or urban option,
5. Default vertical potential temperature gradients, and

Table 4-1. Major Features of the ISCLT Model

ISCLT Model Features
• Polar or Cartesian coordinate systems for receptor locations
• Rural or one of three urban options that affect windspeed profile exponent, dispersion rates, and mixing height calculations
• Plume rise as a result of momentum and buoyancy as a function of downwind distance for stack emissions (Briggs)
• Procedures suggested by Huber and Snyder (1976), Huber (1977), Schulmann and Hanna (1986), and Schulmann and Scire (1980) for evaluating building downwash and wake effects
• Procedures suggested by Briggs for evaluating stack-tip downwash
• Separation of multiple point sources
• Consideration of the effects of gravitational settling and dry deposition on ambient particulate concentrations
• Capability of simulating point, line, volume, and area sources
• Capability to calculate dry deposition
• Variation of windspeed with height (windspeed-profile exponent law)
• Concentration estimates for annual average
• Terrain-adjustment procedures for elevated terrain including a terrain truncation algorithm
• Receptors located above local terrain (i.e., "flagpole" receptors)
• Consideration of time-dependent exponential decay of pollutants
• The method of Pasquill (1976) to account for buoyancy-induced dispersion
• A regulatory default option to set various model options and parameters to EPA recommended values (see text for regulatory options used)

Source: EPA, 1988a.

6. Reducing calculated SO_2 concentrations in urban areas by using a decay half-life of 4 hours (i.e., reduce the SO_2 concentration by 50 percent for every 4 hours of plume travel time).

In this analysis, the EPA regulatory options were used to address maximum impacts. Based on a review of the land use around the facility, the rural mode was selected based on the degree of residential, industrial, and commercial development within 3 km of the plant site.

4.1.3 METEOROLOGICAL DATA

EPA (1987b) recommends the use of 5 years of representative meteorological data for use in air quality modeling. The most recent, readily available 5-year period is preferred. The meteorological data may be collected either onsite or at the nearest National Weather Service (NWS) station.

Meteorological data used in the analysis were selected based on the recommendations of the FDER for the area in which the project is located. The data consisted of a 5-year record of surface weather observations (1982-1986) from the NWS station located at the Orlando International Airport. The database consists of hourly surface data (i.e., windspeed, wind direction, etc.) that are recorded and then sent to the National Climatic Data Center (NCDC) in Asheville, North Carolina. The NCDC digitizes the recorded data onto magnetic tape for sale to the public.

The NWS station in Orlando, located 20 km east-southeast of the site, is the nearest weather station that routinely records the hourly surface data required by the air dispersion models. Because of the proximity of the Orlando NWS station to the plant site, the Orlando meteorological data are considered to be representative of weather conditions occurring at FGTC's Compressor Station No. 18 site.

The ISCLT model requires annual/seasonal mixing height data and ambient air temperatures. The appropriate values for Orlando for input to the model were obtained from FDER. The Orlando hourly surface data were input into the National Climatic Data Center (NCDC) stability array (STAR) preprocessor program. The STAR program converts the hourly data into the joint frequency of occurrence of wind direction, windspeed and atmospheric stability. The program can produce monthly, seasonal and annual stability arrays.

4.1.4 SOURCE DATA

The model parameters for the proposed compressor engine are given in Table 4-2. The location of the proposed engine stack within the FGTC's Compressor Station No. 18 site are presented in Figure 2-1.

4.1.5 RECEPTOR LOCATIONS

The locations of the receptors were based on identifying the areas in which maximum concentrations would be expected due to the proposed compressor engine. A description of the receptor locations for determining maximum predicted concentrations is as follows:

1. For the ISCLT model, 128 receptors were located on 16 radials centered on the proposed engine's stack location and at downwind distances of 100, 200, 300, 400, 500, 750, 1,000, and 1,250 m.
2. To account for plant boundaries in all directions, 36 discrete receptors were located along 36 radials separated by 10-degree increments. These discrete receptors were located at the nearest plant boundary in each direction. The locations of the discrete receptors are given in Table 4-3.

Only those receptors located outside FGTC's Compressor Station No. 18 plant property were used in the determination of maximum impacts.

4.1.6 BUILDING DOWNWASH CONSIDERATIONS

Based on the dimensions of the compressor building that will house the proposed engine, the stack for the proposed engine will be less than GEP height. Also, based on the location of the proposed engine's exhaust stack in relation to the compressor building, the stack will be in the influence

Table 4-2. Summary of Source Parameters Used in the Modeling Analysis

Modeled Source Number	Stack Dimensions (m)		Operating Parameters		Emissions (g/s)
	Height	Diameter	Temperature (K)	Velocity (m/s)	NO_2
1	12.19	0.44	561	48.88	1.33

Table 4-3. Discrete Plant Boundary Receptors, Compressor Station No. 18[a]

Direction	Distance (km)	Direction	Distance (km)
10	0.317	190	0.088
20	0.332	200	0.091
30	0.357	210	0.101
40	0.402	220	0.113
50	0.366	230	0.137
60	0.323	240	0.134
70	0.296	250	0.122
80	0.283	260	0.119
90	0.277	270	0.116
100	0.283	280	0.119
110	0.253	290	0.122
120	0.171	300	0.134
130	0.134	310	0.149
140	0.113	320	0.177
150	0.098	330	0.229
160	0.091	340	0.250
170	0.088	350	0.259
180	0.085	360	0.311

[a]Relative to the proposed stack located at (0,0) meters.

of the compressor building. Therefore, the potential for building downwash must be considered in the modeling analysis.

The procedures used for addressing the effects of building downwash are those recommended in the ISC Dispersion Model User's Guide. In the ISCLT model, the building height and width are input to the model, which are used to modify the dispersion parameters if the Huber-Snyder building downwash routine is used. The effective width used by the program is the diameter of a circle of equal area to the square of the width input to the model. If a specific width is to be modeled, then the value input to the model must be calculated according to the following formula:

$$M_w = \sqrt{\pi\left(\frac{H_w}{2}\right)^2} = 0.886\ H_w$$

where: M_w = building width input to the model to produce a building width of H_w used in the dispersion calculation.
H_w = the actual building width for which dispersion calculations are desired.

If the Schulman-Scire wake effects method is used, the user inputs the building height and projected width associated with each 22.5-degree wind sector. These building heights and projected widths are the same used for GEP stack height calculations.

Although the proposed engine building (40 ft by 53 ft) is not physically connected to the existing engine housing (160 ft by 55 ft), the close proximity of these two buildings was taken into consideration by assuming a single building of 240 ft by 55 ft (or 73.2 m by 16.8 m) for a conservative prediction. A summary of actual and modeled building dimensions is presented in Table 4-4. Because of the proximity of the proposed stack to the compressor building (approximately 17 ft) and the low ratio of stack height to building height, potential downwash from this structure was assumed to occur. Because the stack-to-building height ratio is less than 1.5, the Schulman-Scire downwash method was used in the analysis. Therefore, directional-specific building height and width for each

Table 4-4. Building Dimensions used in the ISCLT Modeling, Compressor Station No. 18

Building	Building Dimensions Height (m)	Length (m)	Width (m)	Modeled Building Dimensions Height (m)	Projected Width[a] (m)
Compressor Building[b]	9.69	73.2	16.8	9.69	75.0

[a]Maximum projected building width was assumed to be applicable in all wind sectors.
[b]Dimensions are for an assumed footprint area that includes the 460 ft by 55 ft area of the existing building, the 40 ft by 53 ft area of the proposed building, and the 40 ft by 55 ft area between the two buildings.

22.5-degree wind sector was determined for use as input values in this algorithm. In order to be conservative, the diagonal of the projected building (240 ft by 55 ft) was used as the input value for width in all 16 wind sectors.

4.2 MODEL RESULTS

A summary of the five-year maximum annual NO_2 impact concentrations predicted for the proposed compressor engine is presented in Table 4-5. As shown in this table, the maximum annual average NO_2 impact concentration is 0.99 $\mu g/m^3$. This maximum concentration is predicted to occur in a direction of 270° and at a distance of 0.400 km from the proposed engine's stack. Further modeling refinement was not necessary to verify the reported maximum concentration value and the associated receptor location because of the accuracy of the sector-averaging feature in the ISCLT model and the 100 m or less separation distances between all receptors. Since the predicted maximum NO_2 concentration is less than the significant impact level of 1 $\mu g/m^3$ annual average concentration, further modeling for potential NO_2 impacts to the local surroundings of the compressor station is not required. The computer modeling printouts are provided in Appendix C.

Table 4-5. Maximum Predicted Annual Average NO_2 Concentrations Due to the Proposed Station 18 Compressor Engine for Comparison to Significant Impact Levels

Year Modeled	Maximum Concentration ($\mu g/m^3$)	Receptor Location Direction (°)	Receptor Location Distance (km)	NO_2 Significant Impact Level ($\mu g/m^3$)
1982	0.96	360	0.400	1
1983	0.90	360	0.400	
1984	0.97	270	0.400	
1985	0.99	270	0.400	
1986	0.82	270	0.500	

5.0 SOILS, VEGETATION, VISIBILITY AND ASSOCIATED POPULATION GROWTH IMPACTS

5.1 IMPACTS UPON SOILS AND VEGETATION

As demonstrated in Section 4.0, FGTC's proposed IC engine will have a very minimal impact upon ambient air quality in the vicinity of the Compressor Station No. 18 site. Maximum predicted impact of NO_x is below EPA significance level, and emissions of CO and VOC are low. Based on these considerations, there is expected to be no significant impact to soils or vegetation from the proposed engine.

5.2 IMPACTS UPON VISIBILITY

The visibility analysis required by PSD regulations is directed primarily towards Class I areas. Since there are no Class I areas located within 100 km of the site, there will be no impact upon visibility due to this proposed small source. With regard to local visibility impacts, the proposed source will meet Florida visible emission requirement of 20 percent opacity [Chapter 17-2.610(2), F.A.C.]. During normal operations, the expected actual opacity from the IC engine will be much less than 20 percent.

5.3 IMPACTS DUE TO ASSOCIATED POPULATION GROWTH

There will be a small increase in temporary construction workers during construction; however, there will be no increase in permanent employment at Compressor Station No. 18 as a result of adding the new engine. As a result, there will be no permanent impacts on air quality caused by associated population growth.

6.0 BEST AVAILABLE CONTROL TECHNOLOGY EVALUATION

The potential emissions of NO_x from the proposed engine exceed the PSD significant emission rate of 40-TPY; therefore, BACT analysis for NO_x is required. The complete "top-down" BACT evaluation of NO_x includes a description of natural gas prime movers (Section 6.1), the identification of NO_x control technologies for reciprocating internal combustion engines (Section 6.2), the environmental, energy and economic impact evaluations of all technically feasible methods (Section 6.3), and the BACT analysis summary (Section 6.4).

6.1 NATURAL GAS PRIME MOVERS

The prime movers in the natural gas industry are generally heavy duty natural-gas-fired stationary internal combustion (IC) engines. These engines are applied to power compressors used for pipeline transmission, field collection of gas from wells, underground storage, and gas processing plant activities. Stationary IC engines used include both gas turbines and reciprocating IC engines.

The use of gas turbines at new natural gas pipeline compression stations has increased in recent years for a wide variety of reasons. Their primary benefit is that gas turbines typically emit fewer pollutants than reciprocating IC engines (i.e., on g/bhp-hr basis); however, gas turbines are generally 10 to 15 percent less fuel efficient, requiring higher specific heat input rate (i.e., on Btu/bhp/hr basis). Also, gas turbines have been found to use more fuel to produce the same compression efficiency.

A primary limitation of gas turbines is related to their inability to respond quickly and efficiently to varying load changes in service demand. This often precludes the use of turbines when supplemental compression is required at a given compressor station. Furthermore, the use of gas turbines in conjunction with reciprocating IC engines at existing compressor stations is hindered by operating limitations. The mechanical operation of reciprocating IC engines generates a pulse vibration that can be transferred to adjacent equipment through physical connection to the pipeline. Gas turbines are sensitive to this type of vibration due to the destructive interference nature of this vibrational frequency; therefore, their operation and reliability can be adversely effected. Based on the above discussion, the use of gas turbines for FGTC's proposed expansion is not considered further.

The use of reciprocating IC engines has been more widespread in terms of the number of installations at natural gas pipeline compressor stations. A recent Gas Research Institute research study (GRI, 1990) reports that the number of such engines is five times that of gas turbines. Advantages of using reciprocating IC engines are primarily better fuel and compression efficiencies and their capability to operate at variable loads to meet the fluctuating consumptive demands.

Reciprocating IC engines used in gas pipeline transmission are generally integral engine-compressor units designed specifically for such application. The integral units provide greater gas-moving efficiency than separable compressors and offer greater operating flexibility than gas turbines. The engines are either two-cycle or four-cycle and are rated between 900 to 13,500 bhp. Old existing engines include four-cycle rich-burn or two- and four-cycle lean-burn. New engines installed in pipeline compressor stations are generally of lean-burn combustion design, which can achieve 80 percent or greater NO_x emission reduction compared to the older, rich-burn models.

6.2 IDENTIFICATION OF NO_x CONTROL TECHNOLOGIES FOR RECIPROCATING IC ENGINES

In this section, the control technologies capable of reducing NO_x emissions produced by reciprocating IC engines will be evaluated relative to their potential application as BACT for the proposed 2,400-bhp engine. This BACT analysis follows EPA's most recent draft guideline for the top-down approach (EPA, 1990a).

All potentially applicable control technologies for reciprocating IC engines are reviewed. The technologies can be separated into two major groups:

1. Reducing pollutant emissions by process modification (i.e., "low-NO_x" engine design), and
2. Converting NO_x in the exhaust gas by add-on catalytic exhaust gas treatment devices.

The discussion of each potential NO_x control technology includes a description of the technology and the potential NO_x emission reduction, if the technology is concluded to be technically feasible.

6.2.1 TECHNOLOGIES INVOLVING ENGINE MODIFICATION

The concept of low-NO_x reciprocating IC engines is described in the NSPS Background Information Document (BID) for stationary reciprocating IC engines issued by EPA in July 1979 (EPA, 1979). Five types of engine or process modifications have been recognized by EPA as technically viable for reducing NO_x emissions from such engines:

1. Steam injection,
2. Air-to-fuel ratio changes,
3. Retarded ignition timing,
4. Derating power output, and
5. Exhaust gas recirculation.

Each of these is discussed in the following sections.

6.2.1.1 Steam Injection

The concept of designing a low-NO_x reciprocating IC engine focuses on controlling the combustion temperature, since thermal NO_x generally increases as combustion temperature increases. Favorable conditions for thermal oxidation of molecular nitrogen can be reduced by quenching the flame temperature with low quality steam or water. In this method, water or steam is injected at a location downstream from the combustion zone inside each firing cylinder.

However, water or steam injection to reduce NO_x formation does not work well at the high water injection rate required for reciprocating IC engines. Reciprocating IC engines are typically designed with high gas flow rates and operate at high excess air. Also, experiments with large-bore engines have concluded that steam injection for controlling NO_x emissions can cause irreversible structural damage to the engine block (EPA, 1979). Thus, water or steam injection technology for reciprocating IC engines is considered technically infeasible. As a result, this method will not be discussed further.

Potential NO_x Emission Reduction

Not applicable for a technically infeasible process.

6.2.1.2 Air-to-Fuel Ratio Changes

The state-of-the-art concept in designing a low-NO_x reciprocating IC engine involves raising the air-to-fuel ratio to create a lean fuel mixture for the combustion process. The peak combustion temperature is lowered due to lower heat of combustion from burning less fuel, and by the high excess air, which tends to dilute the combustion gases. Such combustion results in less pollutants being emitted (i.e., a cleaner burning process). Cooper-Bessemer was the first original equipment manufacturer of reciprocating IC engines to incorporate this concept into engine design, which was appropriately named CleanBurn® technology.

In general, the high air-to-fuel ratio design is referred to as lean-burn technology (LBT) for gas-fired reciprocating IC engines. The name is derived from the lean mixture of air-to-fuel in the main combustion cylinder. The air-to-fuel ratio can reach as high as 200 for some IC engine designs and operating conditions, according to one of the major reciprocating IC engine suppliers (Dresser-Rand, 1990).

LBT is primarily accomplished by increasing the stoichiometric air-to-fuel ratio over the conventional rich-burn engine. In general, small increases in the air-to-fuel ratio (approximately 10 percent) cause a significant reduction in NO_x (approximately 30 percent) with less than 5 percent fuel penalty (EPA, 1979). On turbocharged engines, this can be accomplished by operating at high manifold pressures, which results in lower combustion temperatures and reduces NO_x formation. However, misfiring and erratic combustion can occur at very lean mixtures. The limits to which the air-to-fuel ratio can be increased are related to three major engine design factors:

1. The capability of the turbocharger to produce higher air manifold pressures for rated engine loading,
2. The ability of the ignition system to light-off the leaner mixtures, and
3. The combustion chamber characteristics to maintain efficient combustion with leaner combustible gaseous mixtures.

With current state-of-the-art engine and turbocharger designs coupled with advanced control technology, all of these three factors can be sufficiently achieved.

Potential NO_x Emission Reduction:

Pollutant	Uncontrolled Emission Level	Guaranteed Emission Level	Potential Percentage Reduction
NO_x	11.0 g/bhp-hr*	1.5-2.0 g/bhp-hr	82-86%

Note: * Represents emission level for the baseline rich-burn engine.

6.2.1.3 Retarded Ignition Timing

Retarding the spark ignition timing of the reciprocating IC engine reduces the peak combustion pressure and temperature, thereby lowering thermal NO_x formation. The timing delay is measured in degrees in reference to the engine's crankshaft rotation. There are limits to how much the ignition timing can be retarded. In general, retard values range from 2 to 6 degrees, depending on engine, and NO_x reduction per degree of retard decreases for increasing levels of retard.

A study by the American Gas Association showed that the NO_x emissions from 10 different gas-fired naturally aspirated engine models ranged from a 7 percent reduction to a 2 percent increase per degree of ignition retardation (Urban and Springer, 1975). EPA's research (1979) reported the percent of NO_x reduction per degree of retard ranged from 0.6 to 8.5 for turbocharged engines. Overall, EPA's report concluded that retarding ignition timing reduced NO_x emissions 15 percent for gas-fired engines.

Potential NO_x Emission Reduction:

Pollutant	Uncontrolled Emission Level	Achievable Emission Level	Potential Percentage Reduction
NO_x	11.0 g/bhp-hr[a]	9.4 g/bhp-hr	15%
	2.0 g/bhp-hr[b]	1.7 g/bhp-hr	15%

Note: [a] Represents emission level for the baseline rich-burn engine.
[b] Represents emission level for a typical lean-burn engine.

6.2.1.4 Derating Power Output

A reciprocating IC engine can be derated by operating at less than full or 100-percent rated power. The effect of derating on an engine is to reduce peak combustion cylinder temperatures and pressures, thus lowering NO_x formation rates.

Reported NO_x reduction levels achieved by derating vary greatly for different reciprocating IC engines primarily as a result of air charging. Data compiled by EPA (1979) show that non-turbocharged engines achieve the largest reduction because derating has a greater effect on air-to-fuel ratios. In contrast, turbocharged engines operate at an already high air-to-fuel ratio and, therefore, very little NO_x reduction is achieved by derating. Normalized NO_x reduction from derating (i.e., percent of NO_x reduction per percent derate) is reported from 0.25 to 6.2 for normally aspirated or blower-charged engines, and 0.01 to 2.6 for turbocharged engines. The EPA report showed that NO_x reduction ranged from 10 percent increase to 90 percent reduction, and averaged approximately 40 percent reduction at a derating of 75 percent of rated torque.

Potential NO_x Emission Reduction:

Pollutant	Uncontrolled Emission Level	Achievable Emission Level	Potential Percentage Reduction
NO_x	11.0 g/bhp-hr[a]	6.6 g/bhp-hr	40%
	2.0 g/bhp-hr[b]	1.2 g/bhp-hr	40%

Note: [a] Represents emission level for the baseline rich-burn engine.
[b] Represents emission level for a typical lean-burn engine.

6.2.1.5 Exhaust Gas Recirculation

Exhaust gas recirculation (EGR) reduces peak combustion temperatures in a reciprocating IC engine by replacing a fraction of the combustion air with exhaust gases. The recirculated exhaust gases serve to absorb heat without providing as much additional oxygen for the oxidation of nitrogen.

EGR can be accomplished by either introducing exhaust gases into the intake manifold or restricting the exit of gases from the cylinder by internal recirculation. Externally recirculated gases must be cooled prior to being reintroduced into the combustion cylinder in order to provide greater heat absorption per charge.

EGR is most effective in reducing NO_x emission from conventional rich-burn engines because its application can increase the air-to-fuel ratio. EPA's research (1979) reported a NO_x reduction of 34 percent for a gas-fired, blower-charged engine with 6 percent EGR rate. Excessive EGR rates can result in increased fuel consumption, high CO emissions, and misfiring (GRI, 1990).

EGR is not effective for a lean-burn engine with a high air intake flow rate since it cannot significantly further dilute the air/fuel mixture. In

Disadvantages of the system are:

1. Formation of ammonia from excess urea treatment rates and/or improper use of reagent catalysts, and
2. SO_3, if present, will react with ammonia created from the urea to form ammonium bisulfate, potentially plugging the cold end equipment downstream.

Commercial application of the NO_xOUT system is limited to three reported cases:

1. Trial demonstration on a 62.5-ton-per-hour (TPH) stoker-fired wood waste boiler with 60 to 65 percent NO_x reduction,
2. A 600-million-British-thermal-unit (MMBtu) CO boiler with 60 to 70 percent NO_x reduction, and
3. A 75-megawatt (MW) pulverized coal-fired boiler with 65 percent NO_x reduction.

The NO_xOUT system has not been demonstrated on any stationary IC engine.

The NO_xOUT process is not technically feasible for the proposed lean-burn engine due to the high application temperature of 1,000°F to 1,950°F. The exhaust gas temperature of a lean-burn engine is typically between 495°F to 700°F. Raising the exhaust temperature to the required temperature level would essentially require the installation of an auxiliary heater. This would be economically prohibitive and would result in an increase in fuel consumption, an increase in the volume of gases that must be treated by the control system, and an increase in uncontrolled air emissions, including NO_x.

6.2.2.2 THERMAL $DeNO_x$

Thermal $DeNO_x$ is Exxon Research and Engineering Company's patented process for NO_x reduction. The process is a high temperature selective noncatalytic reduction (SNCR) of NO_x using ammonia as the reducing agent. Thermal $DeNO_x$ requires the exhaust gas temperature to be above 1,800°F. However, use of ammonia plus hydrogen lowers the temperature requirement to about 1,000°F. For some applications, this must be achieved by additional firing in the exhaust stream prior to ammonia injection.

The only known commercial applications of Thermal DeNO$_x$ are on industrial boilers, large furnaces, and incinerators which consistently produce exhaust gas temperatures above 1,800°F. There are no known applications or experience in the reciprocating IC engine industry. Temperatures of 1,800°F require alloy materials of construction with very large size piping and components since the exhaust gas volume would be increased by several times. As with the NO$_x$OUT process, high capital, operating, and maintenance costs are expected due to material of construction specification, additional duct burner system, and fuel consumption. Uncontrolled emissions would increase because of the additional fuel burning.

Thus, the Thermal DeNO$_x$ process will not be considered for the proposed project because it is technically infeasible due to its high application temperature.

6.2.2.3 Combination of Lean-Burn Engine and Nonselective Catalytic Reduction (NSCR)

Certain manufacturers, such as Engelhard and Johnson-Matthey, market a non-selective catalytic reduction system for NO$_x$ control on reciprocating IC engines. The NSCR process requires a low oxygen content in the exhaust gas stream and high temperature (700°F to 1,400°F) in order to be effective. Rich-burn engines typically achieve low oxygen levels of less than 4 percent and the required temperature and, therefore, can use the NSCR process. Lean-burn engines, on the other hand, have a high air-to-fuel ratio, typical exhaust gas oxygen content of 12 to 15 percent, and the exhaust gas temperature is less than 700°F. As a result, NSCR is not a technically feasible add-on NO$_x$ control device for FGTC's proposed lean-burn engine. Therefore, the combination of a lean-burn engine and NSCR was not considered further in the BACT analysis.

6.2.2.4 Selective Catalytic Reduction with Ammonia Injection

The NO_x abatement technology for oil- and gas-fired combustion sources that is currently receiving considerable attention is the selective catalytic reduction (SCR) process with ammonia injection. Engelhard Corporation's discovery in 1957 that ammonia reacts selectively with NO_x in the presence of a catalyst and excess oxygen has led to the commercialization of SCR technology for industrial boilers of various sizes. The technology has been well developed and applied in Japan, especially for control of emissions from gas-, oil-, and coal-fired utility boilers. It has been applied domestically on combustion sources which generate large quantities of NO_x, such as gas turbines.

SCR catalysts consist of two types: metal oxides and zeolite. In the metal oxides catalytic system, either vanadium or titanium is embedded into a ceramic matrix structure; the zeolite catalysts are ceramic molecular sieves extruded into modules of honeycomb shape. The all-ceramic zeolite catalysts are durable, and less susceptible to catalyst masking or poisoning than the noble metal/ceramic base catalysts. All catalysts exhibit advantages and disadvantages in terms of exhaust gas temperatures, ammonia/NO_x ratio, and optimum exhaust gas oxygen concentrations. A common disadvantage for all catalyst systems is the narrow window of temperature between 600°F and 900°F within which the NO_x reduction process takes place (Schorr, 1989; Steuler, 1990; Engelhard, 1990; Johnson-Matthey, 1990). Operating outside this temperature range results in catastrophic harm to the catalyst system. Chemical poisoning occurs at lower temperature conditions, while thermal degradation occurs at higher temperatures. Reactivity can only be restored through catalyst replacement.

Catalysts are subject to loss of activity over time. Since the catalyst is the most costly component of the SCR system, applications require servicing and cleaning of the catalyst surface every 2,000 to 3,000 hours of operation. The cleaning normally consists of blowing the catalyst surfaces with a compressed air gun or water jet. Most catalyst suppliers guarantee a catalyst life of 3 years, assuming certain operating conditions.

Technically, SCR is potentially applicable to further reduce the already low NO_x emissions (2 g/bhp-hr) from the proposed lean-burn reciprocating engine. SCR is capable of achieving NO_x reduction of 70 to 90 percent. For the proposed lean-burn engine, with already low NO_x concentration in the exhaust gases, vendors guarantee a removal rate of 80 percent. This would result in NO_x emissions of 0.4 g/bhp-hr. This represents an overall NO_x reduction of 96 percent compared to a rich-burn engine (at 11.0 g/bhp-hr).

6.2.2.5 <u>Combination of Rich-Burn Engine and NSCR</u>

Although the draft top-down BACT guideline document dated March 15, 1990, does not require an evaluation of processes that have inherently higher emission rates than the proposed process, the option of using a rich-burn engine equipped with NSCR also was considered in the BACT analysis.

Rich-burn reciprocating IC engines are defined as those which contain less than 4 percent oxygen concentration in the exhaust gas. Rich-burn engines typically are naturally aspirated engines with near stoichiometric air-to-fuel ratios and produce exhaust gas temperatures in the range of 1,200°F to 1,300°F.

NSCR technology uses a precious metal to catalyze the reactions of NO_x with CO and unburned hydrocarbon fuel in the exhaust gas streams to form nitrogen, carbon dioxide, and water vapor. A complete NSCR system includes exhaust gas oxygen sensor, exhaust gas monitor, hydrocarbon fuel injector, automatic air/fuel controller, and temperature sensor for automatic shut-down of the engine if overheating occurs. The engine exhaust entering the catalyst bed is maintained slightly fuel-rich to maximize NO_x reduction. The hydrocarbon fuel injector automatically controls an adjustable valve that supplies a small amount of hydrocarbon fuel to compensate for the changes in engine load or ambient conditions.

Technically, NSCR is potentially applicable to reduce 90 percent or more of the NO_x emissions in the exhaust gas of the rich-burn reciprocating IC engine. In general, vendors guarantee a removal rate of 90 percent for an equivalent NO_x emission level of 1.1 g/bhp-hr (i.e., 10 percent of the rich-burn engine NO_x emission rate of 11.0 g/bhp-hr).

6.2.3 SUMMARY OF TECHNICALLY FEASIBLE NO_x CONTROL METHODS

In summary, there are two basic alternatives for reduction of NO_x emissions from reciprocating IC engines: engine modification and add-on control technology. Presented in Table 6-1 is a summary of the technical evaluation of NO_x emission control methods applicable to reciprocating IC engines.

In the engine modification category, only the alternatives of air-to-fuel ratio change, retard ignition timing, derating power output, and EGR are applicable. EGR is applicable to rich-burn engines only. Steam/water injection and EGR (for lean-burn engines) are considered technically infeasible. In the add-on control technology category, only the lean-burn engine/SCR combination and rich-burn engine/NSCR combination are considered technically feasible. Other methods such as the NO_xOUT process, Thermal DeNO_x, and the lean-burn engine/NSCR combination are considered technically infeasible.

6.3 EVALUATION OF TECHNICALLY FEASIBLE NO_x CONTROL METHODS

This section examines all of the technically feasible NO_x control methods identified in the previous discussion. First, all five remaining control alternatives are ranked according to their total removal effectiveness. Each alternative is then examined further in regards to technical issues, environmental effects, energy requirements and impacts, and economic impacts.

The discussion also reviews current permitting practices for applications similar to FGTC's proposed project. Presented in Table 6-2 is a summary of BACT determinations for NO_x emissions from gas-fired stationary reciprocating IC engines issued since 1985. The information was obtained from BACT/Lowest Achievable Emission Rate (LAER) Clearinghouse documents

Table 6-1 Summary of Technical Feasibility of NOx Emission Controls for Reciprocating Engine

Control Technology	NOx Controlled Emission Rate	Technical Feasibility	Comments
Engine Modification Alternatives			
Steam Injection	Not Applicable	NO	Technically infeasible due to irreversible structural damage to engine block.
Air-to-fuel Ratio Change (or Lean-Burn Technology)	1.5-2.0 g/bhp-hr	YES	Lowest emission rate achievable by engine modification, at least 80% control efficiency.
Retarding Ignition Timing			
Rich-burn Engine	9.4 g/bhp-hr	YES	Engine timing retard between 2° and 6°;
Lean-burn Engine	1.7 g/bhp-hr	YES	average 15% NOx reduction.
Derating Power Output			
Rich-burn Engine	6.6 g/bhp-hr	YES	Average 40% NOx reduction at 25% of engine
Lean-burn Engine	1.2 g/bhp-hr	YES	power derated for gas-fired engines.
Exhaust Gas Recirculation			
Rich-burn Engine	7.3 g/bhp-hr	YES	Maximum 34% NOx reduction for standard engine.
Lean-burn Engine	Not Applicable	NO	Ineffective for lean-burn engine.
Add-on Control Technology*			
NOxOUT Process	Not Applicable	NO	Technically infeasible (1000-1600°F), cost prohibitive for high temperature auxiliary equipment.
THERMAL DeNOx	Not Applicable	NO	Technically infeasible (above 1000°F), cost prohibitive for high temperature auxiliary equipment.
Lean-Burn Engine/NSCR	Not Applicable	NO	Technically infeasible for lean-burn engine, required <4% O_2 conc. in the exhaust stream.
Lean-Burn Engine/SCR	0.4 g/bhp-hr	YES	Applicable to lean-burn engine with control efficiency of 80 percent.
Rich-Burn Engine/NSCR	1.1 g/bhp-hr	YES	Applicable to rich-burn engine only, required greater than 4% O_2 conc. in exhaust gas stream. control efficiency of 90%.

* Except for the rich-burn engine/NSCR option, all add-on control technologies are for lean-burn engines.

Table 6–2 Summary of BACT Determinations for NOx Emissions from Gas-fired Reciprocating Engines

Company Name	State	Permit Number	Date of Permit	Engine Specifications: Fuel* Type	Make	Model	Size (Bhp)	NOx Emission Limit**: (g/Bhp-hr)	(lb/hr)	(ppm)	Control Method	Comments
Source Type: Natural Gas Compressor Station												
Northern Natural Gas Company	IA		05-Sep-90	N.G.	Cooper		4,000	1.8	15.9		Lean burn engine	
same as above	IA		05-Sep-90	N.G.	Cooper		2,000	1.8	7.9		Lean burn engine	
National Fuel Gas Supply Corp.	PA	53-329-001	13-Jun-89	N.G.	Cooper	8015JHC2	3,000	2.0	13.2		Lean burn engine	
Natural Gas Pipeline Company	IL	85100014	01-Mar-89	N.G.	Worthington	MLV-10	4,000	9.0	79.4		Design & oper. practice	
Tennessee Gas Pipeline Company	PA	53-339-002	21-Jun-88	N.G.	Cooper	GMVH-10C	2,250	3.0	14.9		Lean burn engine	
Consolidated Gas Transmission Corp.	PA	59-399-008	10-May-88	N.G.	Dresser-Rand	TCV-10	4,200	3.0	27.8		Lean burn engine	Air to fuel ratio is 4.5:1
ANR Production Company	VA	11064	03-Mar-88	N.G.	Caterpiller	G398TAA	600	1.2	1.6		Catalytic converter	N.G. Compressor Sta.
Southern Natural Gas Company	AL	406-0003-X	19-Feb-88	N.G.	Dresser-Rand	TCVD-10	4,160	2.2	20.2		Lean burn engine	Per. cond.: stack test
National Fuel Gas Supply Corp.	PA	53-399-002	01-Feb-88	N.G.	Dresser-Rand	412 KEV-1	2,850	3.0	18.8		Lean burn engine	
Shell California Production Co.	CA	147853	14-Oct-86	N.G.			600	3.2	4.2		SCR	70% reduction
Northern Natural Gas Company	IA		04-Feb-86	N.G.			4,000			250	Engine design	
Consolidated Gas Transmission Corp.	PA	18-399-009	11-Dec-85	N.G.	Cooper	12W-330-C2	6,000	3.0	39.7		Lean burn engine	
Shell California Production	CA	0041-6	02-Dec-85	N.G.	Caterpiller		225	0.805	0.4	50	NSCR, rich burn engine	90% reduction
Source Type: Power Cogeneration and Other Uses												
University of Illinois, Ch. Cir. Camp.	IL	applying	1990	N.G.	Cooper	LSVB-GDC	8,000	1.9	33.5		Lean burn engine	
Northeast Landfill Power	RI	999-1014	12-Dec-89	L.G.	Waukesha	12V-AT25GL	2,400	1.3	6.6		Lean burn engine	High-speed (900 rpm)
Worcester Company	RI	988-990	27-Sep-89	N.G.	Superior	12-SGTB	2,000	1.5	6.6		Lean burn engine	High-speed (900 rpm)
City of Ventura	CA	1379-1	31-Dec-86	D.G.			773	2.0	3.4		Engine design	Digestive gas
State of Utah Natural Resources	UT		01-Sep-86	N.G.			4,630	3.5	36.0		Lean burn engine	Turbocharger ups fuel eff.
Tricounty Sun Energy Sheraton Hotel	CA	1369-1	07-Aug-86	N.G.	Caterpiller		200			50	NSCR, rich burn engine	90% reduction
Genstar Gas Recovery Systems	CA	30970	29-Aug-85	L.G.			2,650	1.5	8.8		Lean burn engine	Landfilled gas
same as above	CA	30893	29-Aug-85	L.G.			1,100	1.5	3.6		Lean burn engine	Landfilled gas
Pacific Lighting Energy	CA	30336	01-Mar-85	N.G.	Superior	16-SGTA	2,650	1.5	8.8		Lean burn engine	High-speed (900 rpm)

* N.G. = Natural Gas; L.G. = Landfilled Gas; and D.G. = Digestive Gas.

** for a single engine.

from 1985 to 1990, as well as from actual permit applications, issued permits, and personal conversations with personnel of air permitting agencies from various states.

6.3.1 RANKING OF FEASIBLE CONTROL TECHNOLOGIES

The top-down BACT approach requires the ranking of the NO_x emission control alternatives in terms of achievable emission level. The five options, in order of removal effectiveness, are as follows: first, the lean-burn engine equipped with SCR; second, the rich-burn engine equipped with NSCR; third, the lean-burn engine with derating; fourth, the lean-burn engine with retard ignition timing; and fifth, the lean-burn engine.

A baseline condition must be established for BACT ranking and economic analysis purposes. The baseline is defined as the uncontrolled rate of the process being reviewed. Therefore, the baseline condition for the control technologies involving stationary reciprocating IC engine would be a conventional rich-burn engine with a NO_x emission level of 11 g/bhp-hr (EPA, 1988d).

Presented in Table 6-3 is the BACT top-down hierarchy of technically feasible NO_x control technologies, their corresponding NO_x emission rates, and their control efficiencies calculated from the baseline emission level. Only control options that result in an NO_x emission rate lower than the proposed lean-burn engine (2.0 g/bhp-hr) are shown in the table. Only these options are evaluated further for BACT.

6.3.2 ANALYSIS OF LEAN-BURN ENGINE WITH SCR

<u>Technical Issues</u>

As the most effective NO_x abatement process in terms of removal efficiency, SCR has been a more frequently attempted technology for state-of-the-art reciprocating IC engines. However, the reliability of SCR's performance on reciprocating IC engines has not been consistently demonstrated. Data on sustained NO_x reduction performance for reciprocating IC engines are very limited.

Table 6-3 BACT "Top-Down" Hierarchy of NOx Control Technologies

BACT Ranking	Technology	Brake Emission Rate (g/bhp-hr)	Annual Emissions (TPY)	Total Emission Reduction (TPY)*	Total Control Efficiency (%)*
First	Lean-burn Engine with SCR	0.4	9.3	245.7	96%
Second	Rich-burn Engine with NSCR	1.1	25.5	229.4	90%
Third	Lean-burn Engine/Derating Power+	1.2	27.8	227.1	89%
Fourth	Lean-burn Engine/Retard Timing	1.7	39.4	215.5	85%
Fifth	Lean-burn Engine	2.0	46.3	208.6	82%
Baseline	Rich-burn Engine	11.0	254.9	----	----

* Total emission reduction and total control effieciency are calculated from baseline emission level.

\+ The range of control effectiveness is dependent on the percent of engine's rated torque. The calculated values are based on 40% NOx reduction at 25% derated power (or at 75% rated torque).

Technical issues involved in the use of SCR are the narrow operating temperature range and the possible damage to the catalyst and downstream equipment. A stack gas reheat system would be required to heat the exhaust gases up to the operating temperature of the SCR (see further discussion under Energy Requirements and Impacts). This further complicates an already complicated system consisting of SCR components and ammonia handling system. The use of ammonia as a reactant for the NO_x reduction reactions may allow excess ammonia to form ammonium bisulfate compounds under irregular operating conditions. These compounds can serve as catalyst poisoning agents and also cause damage to metal ductwork downstream. Thus, SCR application requires a strict maintenance service schedule. It is expected that the SCR system may require manual cleaning every 2,000 to 2,500 hours of operation (Steuler, 1990). Cleaning consists of blowing the catalyst surfaces with a compressed air gun and vacuuming any soot.

In California, the South Coast Air Quality Management District (SCAQMD, 1984) reported SCR demonstration tests on seven reciprocating engines. The report indicated that only one SCR system was able to complete the 4,000 hours of continuous testing operation; the other six engine/SCR units failed because of various reasons attributed to either poor catalyst performance and/or problematic ammonia injection operation. A recent survey report by the Gas Research Institute on SCR (GRI, 1990) states:

> A total of 13 SCR units are currently installed on reciprocating engines. Only one unit involves gas transmission. A number of operational problems impacting SCR performance and engine operation have been documented. At least three SCR units applied to reciprocating engines are scheduled to be replaced with alternative controls...

In addition, a review of the BACT determinations made to date on gas-fired reciprocating IC engines (Table 6-2) reveals that SCR has never been applied specifically to any large-bore (i.e., greater than 1,000 bhp) and low-speed (i.e., 300 rpm) lean-burn engine due to the already low NO_x

emission rate. The economic consideration is also a significant factor for not using SCR in such applications.

Application of SCR on gas-fired engines has been limited to small-bore, high-speed engines typically less than 1,000 bhp, at 900 rpm or greater (i.e., ANR Production Company's 600-bhp engine, and Shell California Production's 600-bhp engine; see Table 6-2). The only SCR application to a large-bore reciprocating IC engine was reported for Pfizer, Inc.'s cogeneration facility in Massachusetts. This project was for a 6,710-bhp engine with estimated uncontrolled emission rates between 5 and 12 g/bhp-hr for dual-fuel (94 percent natural gas, 6 percent diesel) and diesel fuel, respectively (see Appendix A). However, Pfizer's engine is different than FGTC's proposed engine in both fuel-type and application. Furthermore, the reliability of Pfizer's operation is still in question pending its performance verification based on upcoming stack testing.

The most recent PSD permit for a reciprocating IC engine used in natural gas compression application was issued on September 5, 1990. This permit was issued to Northern Natural Gas Company for a gas-fired 4,000-bhp gas compressor engine in Iowa. It was determined by the permitting agency, the Iowa Department of Natural Resources (IDNR), that "application of SCR systems to the engine as applied for would represent a transfer of technology since none are known to be operational." They further found such "technology transfer to be unreliable at best with a high percentage of down time likely." Therefore, SCR was rejected as BACT by IDNR due to its uncertain reliability.

Environmental Effects

The add-on SCR technology for NO_x control will pose other potential adverse environmental impacts such as accidental spills and emissions of ammonia, and solid waste disposal for the non-inert spent catalyst. These issues are briefly described in the following discussion.

The SCR system requires the use of ammonia as reagent to convert NO_x to nitrogen gas and water. The main environmental impact centers around the issue of delivery, handling, and storage of ammonia, which poses inherent safety and health risks in the event of accidental releases. In proposing NO_x abatement regulations for stationary gas turbines, California's South Coast Air Quality Management District (SCAQMD) has performed a risk assessment study on spill handling and storage of ammonia. The study has concluded that this aspect of SCR operation could realistically present serious consequences, and recommended further consideration of potential impacts and mitigation measures (SCAQMD, 1979). The current practice is to use an aqueous ammonia system (normally between 25 to 29 percent ammonia concentration) at installations located in populated areas. However, such practice increases the complexity, size, and the cost of the ammonia system. Furthermore, ammonia slippage is a normal occurrence during operation of SCR control equipment. NO_x abatement system suppliers generally report an ammonia slippage level of 10 ppm.

Spent catalysts of the metal oxides pellet-type system must be disposed of properly. Ceramic-based honeycomb-shaped catalysts can be landfilled due to the inert intrinsic properties of ceramic materials.

<u>Energy Requirements and Impacts</u>

The add-on technology of SCR imposes further energy penalties. The additional energy requirements are caused by power loss due to additional back pressure from the SCR, electrical requirements for heating the ammonia solution and operating the injection system, and additional energy necessary for reheating the proposed engine exhaust gases from 550°F up to the SCR operating range of 700°F. [SCR manufacturers specify a typical operating temperature window between 600°F to 900°F (Engelhard, 1990; and Steuler, 1990)]. A minimum of 1.80 MMBtu/hr is required for stack gas reheating or 15,768 MMBtu/yr. However, using the lean-burn engine will result in better fuel economy than the baseline rich-burn engine. The heat input savings amounts to 2.4 MMBtu/hr or 21,024 MMBtu/yr. Thus, the net fuel savings is 5,256 MMBtu/yr. Also, an addition of 5.1 megawatt-hour is required for the operation of the ammonia vaporizer and injection system.

Economic Analysis

This section presents the total capital investment (TCI) and the annualized cost (AC) of the SCR NO_x control system for the proposed lean-burn engine. The analysis uses the cost of the conventional rich-burn engine as the baseline cost. The detailed economic analysis procedure is given in Appendix B.

Capital and annualized cost estimates were prepared for two SCR systems:

1. Kleenaire system from Nitrogen Nergas Corporation, which uses the metal oxide-based catalyst and can achieve an 80 percent NO_x reduction on the proposed lean-burn engine; and
2. Engelhard NO_x abatement system which uses the all-ceramic honeycomb catalyst and can achieve an NO_x reduction efficiency of 80 percent on the proposed lean-burn engine.

Capital costs for both systems are tabulated in Table 6-4. In the purchased equipment costs for both SCR systems, the differential engine cost of $50,000 (i.e., Item 1a in Table 6-4) is added to account for the extra cost of the lean-burn engine. The vendor's equipment quote for the Kleenaire system is $137,000. The direct capital cost of the system is calculated to be $405,627, and the indirect capital cost is calculated to be $230,362. The total capital investment is $635,989. The basic equipment cost for the Engelhard System is $168,000. Direct capital cost is $472,727 and the indirect capital cost is $264,309 for a total capital investment of $737,036.

The annualized costs for these two NO_x abatement systems are given in Table 6-5. The calculation basis for cost items are also given in the table. The annualized costs are $406,225 and $409,321 for the Kleenaire system and the Engelhard system, respectively. Current application trend favors the use of the all-ceramic system due to its advantages of higher

Table 6–4 Capital Cost Estimates for SCR Systems for NOx Emission Control

Cost Items	Cost Factors	Costs: Kleenaire System+	Costs: Engelhard System++
DIRECT CAPITAL COSTS (DCC):			
(1) Purchased Equipment			
(a) Differential Engine Cost	See Note 1	$50,000	$50,000
(b) SCR Basic Equipment	Vendor Quote	$137,000	$168,000
(c) Ammonia System	See Note 2	$13,000	$13,000
(d) Auxiliary Equipment (Reheat)*	0.10 x (1b)	$13,700	$16,800
(e) Emission Monitoring	0.15 x (1b)	$20,550	$25,200
(f) Structure Support	0.10 x (1a-1e)	$23,425	$27,300
(g) Instrumentation & controls[1]	0.10 x (1a-1e)	$23,425	$27,300
(h) Freight[1]	0.05 x (1a-1g)	$14,055	$16,380
(i) Sales Tax (Florida)	0.06 x (1a-1g)	$16,866	$19,656
(j) Subtotal	(1a-1i)	$312,021	$363,636
(2) Direct Installation[1]	0.30 x (1j)	$93,606	$109,091
Total DCC:	(1) + (2)	$405,627	$472,727
INDIRECT CAPITAL COSTS (ICC):			
(3) Indirect Installation			
(a) Engineering & Supervision[1]	0.10 x (DCC)	$40,563	$47,273
(b) Construction & Field Expenses[1]	0.05 x (DCC)	$20,281	$23,636
(c) Contruction Contractor Fee[1]	0.10 x (DCC)	$40,563	$47,273
(d) Contigencies[2]	0.25 x (DCC)	$101,407	$118,182
(4) Other Indirect Costs			
(a) Startup & Testing[1]	0.03 x (DCC)	$12,169	$14,182
(b) Working Capital	30-day DOC**	$15,379	$13,763
Total ICC:	(3) + (4)	$230,362	$264,309
TOTAL CAPITAL INVESTMENT (TCI):	DCC + ICC	$635,989	$737,036

\+ Represents a typical first generation catalyst which is metal oxides embeded in ceramic matrix.

++ Represents second generation all ceramic catalyst extruded into honeycomb-shape.

* Duct burner system to reheat the exhaust gas from 550°F up to 700°F.

** 30 days of direct operating costs, calculated from the annualized cost Table 6-5 (i.e., total DOC/12 months).

1 Based on catalytic incinerators, from OAQPS Control Cost Manual, Fourth Edition.

2 Guaranteed efficiency and operation for the installation of SCR on large-bore and low-speed lean-burn engine. Such application is not considered as well-proven technology.

Note 1: Differential engine cost is calculated from vendor's price quotation for a lean-burn engine minus vendor's price quotation for the rich-burn engine being used as baseline.

Note 2: Ammonia vendor's quotation from LaRoche Industries, Inc. for a 2,000-gallon anhydrous ammonia tank, an ammonia evaporator, and a dual-valve pressure regulator.

Table 6-5 Annualized Cost Estimates for SCR Systems for NOx Emission Control

Cost Items	Basis	Costs Kleenair System+	Costs Engelhard System++
DIRECT OPERATING COSTS (DOC):			
(1) Operating Labor			
Operator[2]	5,840 hr/yr @ $20/hr	$116,800	$116,800
Supervisor[1]	15% of operator cost	$17,520	$17,520
(2) Maintenance[2]	5% of direct capital cost	$20,281	$23,636
(3) Replacement Parts (include freight & tax)			
(a) Catalyst	(Part+Labor)xCRF; See Note 1	$31,507	$13,297
(b) Guard Bed	(Part+Labor)xCRF; See Note 2	$4,544	$0
(4) Utilities			
(a) Electricity	0.30 MW-hr/ton NH3; $85/MW-hr	$437	$437
(b) Fuel for stack reheat	$2.06/MMBtu; See Note 3	$32,482	$32,482
(c) Fuel credit	$2.06/MMBtu; See Note 4	-$43,309	-$43,309
(5) Ammonia	0.37 lb NH3/lb NOx; $250/ton NH3	$4,287	$4,287
Total DOC		$184,549	$165,150
INDIRECT OPERATING COSTS (IOC):			
(7) Overhead[1]	60% of operating labor & maintenance	$92,761	$94,774
(8) Property Taxes[1]	1% of total capital investment	$6,360	$7,370
(9) Insurance[1]	1% of total capital investment	$6,360	$7,370
(10) Administration[1]	2% of total capital investment	$12,720	$14,741
Total IOC		$118,201	$124,255
CAPITAL RECOVERY COST (CRC)	CRF of 0.1627 times TCI	$103,475	$119,916
ANNUALIZED COST (AC):	DOC + IOC + CRC	$406,225	$409,321

\+ Represents a typical first generation catalyst which is metal oxides embeded in ceramic matrix.

++ Represents second generation all ceramic catalyst extruded in honeycomb shape.

[1] Based on catalytic incinerators, from OAQPS Control Cost Manual, Fourth Edition.

[2] Based on no existing installation of SCR on large-bore and low-speed lean-burn engine: 5.33 hours per shift are devoted to the emission control system operation and maintenance.

Note 1: Catalyst replacement part cost for the Kleenair System is $69,870 with a service life of 3 years.
Catalyst replacement part cost for the Engelhard system is $29,070 with a service life of 3 years.
Combined freight and tax factor is 11%; and CRF for a 3-year recovery period and 10% interest rate is 0.4021.
Replacement labor cost is $50 per hour for two 8-hour days. Total cost includes both material and labor costs.

Note 2: The Kleenair system includes a guard bed which works as a pre-filter upstream from the metal oxides catalyst; the replacement part cost is $10,000 with an estimated service life of 3 years. Required labor is for 4 hours.

Note 3: Assumed heat transfer efficiency of 80%, heat input required to raise exhaust temperature to 700°F is:
Q = (36,860 lb/hr)(0.26 Btu/lb°F for air)(700°F-550°F)/(0.8) = 1.80 MMBtu/hr.
Annual heat input equals 1.80 MMBtu/hr times 8,760 hr/yr = 15,768 MMBtu/yr.

Note 4: Heat input for lean-burn engine is calculated from 7,000 Btu/bhp-hr times 2,400 bhp = 16.8 MMBtu/hr.
Heat input for rich-burn, naturally aspirated engine is calculated from 8,000 Btu/bhp-hr times 2,400 bhp = 19.2 MMBtu/hr.
Therefore, using a better fuel efficient engine results in saving an annual heat input of:
(19.2 - 16.8) MMBtu/hr x 8,760 hr/yr = 21,024 MMBtu/yr.

removal rates and more reliable catalyst component. In general, the all-ceramic catalyst system is considered the better system since it is less susceptible to catalyst damage and results in less operating costs.

Therefore, subsequent economic cost effectiveness analysis uses the cost values computed for the Engelhard system.

6.3.3 ANALYSIS OF RICH-BURN ENGINE WITH NSCR

Technical Issues

Rich-burn engines operate at near stoichiometric air-to-fuel ratios and, therefore, generate high engine cylinder temperatures in the range of 1,200°F to 1,300°F. Engine manufacturers have found that such high temperatures do not allow loading the engine very high. For greater power output, engine manufacturers have found that engine modifications (i.e., turbocharged engines which can produce more power enhancements with lower emission levels) are the better choice than building larger engine blocks. In the current U.S. market, rich-burn engines over 2,000 bhp are not standard off-the-shelf items; however, a 2,400-bhp engine can be obtained by special order.

All known rich-burn engine/NSCR combination applications are found for small engines of approximately 1,000 bhp or less (i.e., a 600-bhp engine for ANR Production Company, Virginia; a 225-bhp engine for Shell California Production, California; and a 200-bhp engine for Tricounty Sheraton Hotel, California; see Table 6-2).

A significant technical consideration in the use of the rich-burn engine with NSCR is the NSCR's effect upon maintenance, operation, and reliability of the overall system. Any add-on technology requires substantially more maintenance, controls, monitors, and operating personnel compared to a system without add-on technology (i.e., lean-burn engine). The system will have a much greater frequency of downtime and malfunctioning such that the system will have far less operating reliability. Reliability is an extremely important consideration for a compressor station engine, which must be operated nearly continuously throughout the year and usually is located in a remote area.

Environmental Effects

Catalyst disposal may be required when using NSCR, depending on the catalyst type. Most vendors guarantee a service life of 3 years for the catalyst system. Environmental impacts are expected to be minimal for the rich-burn engine/NSCR option since no toxic or hazardous reagents are required. Rich-burn/NSCR technology generally produces lower CO and VOC emissions as compared to a lean-burn engine.

Energy Requirements and Impacts

The NSCR converter does not require any additional fuel other than a small amount of hydrocarbon fuel used for injection into the exhaust gas mixture to ensure fuel rich conditions. However, the fuel economy of the rich-burn, naturally aspirated engine is approximately 8,000 Btu/bhp-hr (EPA, 1979) compared to the 7,000 Btu/bhp-hr for the proposed lean-burn engine. For a 2,400-bhp output, an additional 2.4 MMBtu/hr heat input is required, or approximately 21,024 MMBtu per year for an annual cost of $43,309.

Economic Analysis

Capital and annualized cost estimates were prepared for a NSCR converter. Cost of the NSCR converter was provided by Johnson-Matthey as $48,000. The NSCR can achieve 90 percent NO_x reduction. The resulting NO_x emission rate is 1.1 g/bhp-hr.

The total capital investment cost for a NSCR converter designed for a 2,400-bhp rich-burn engine is tabulated in Table 6-6. The direct capital cost is calculated to be $95,584, and the indirect capital cost is calculated to be $58,453. The total capital investment is $154,037. Also shown in the table is the differential cost of the lean-burn engine over that of the baseline rich-burn engine.

Table 6-6 Capital Cost Estimates for Lean-burn Engine and Rich-burn Engine/NSCR System.

Cost Items	Cost Factors	Costs: Lean-Burn Engine	Costs: Johnson-Matthey NSCR System
DIRECT CAPITAL COSTS (DCC):			
(1) Purchased Equipment			
(a) Differential Engine Cost	See Note 1	$50,000	$0
(b) NSCR Converter	Vendor Quote	$0	$48,000
(c) Emission Monitoring	0.15 x (1b)	$0	$7,200
(d) Structural Support	0.10 x (1b-1c)	$0	$5,520
(e) Instrumentation[1]	0.10 x (1a-1c)	$5,000	$5,520
(f) Freight[1]	0.05 x (1a-1e)	$2,750	$3,312
(g) Sales Tax (Florida)	0.06 x (1a-1e)	$3,300	$3,974
(h) Subtotal	(1a-1g)	$61,050	$73,526
(2) Direct Installation[1]	0.30 x (1h)	$18,315	$22,058
Total DCC:	(1) + (2)	$79,365	$95,584
INDIRECT CAPITAL COSTS (ICC):			
(3) Indirect Installation			
(a) Engineering & Supervision[1]	0.10 x (DCC)	$7,937	$9,558
(b) Construction & Field Expenses[1]	0.05 x (DCC)	$3,968	$4,779
(c) Contruction Contractor Fee[1]	0.10 x (DCC)	$7,937	$9,558
(d) Contigencies	See Note 2	$11,905	$23,896
(4) Other Indirect Costs			
(a) Startup & Testing[1]	0.03 x (DCC)	$2,381	$2,868
(b) Working Capital	30-day DOC*	$0	$7,794
Total ICC:	(3) + (4)	$34,128	$58,453
TOTAL CAPITAL INVESTMENT (TCI):	DCC + ICC	$113,493	$154,037

* 30 days of direct operating costs, calculated from the annualized cost Table 6-7 (i.e., total DOC/12 months).

[1] Based on catalytic incinerators, from OAQPS Control Cost Manual, Fourth Edition.

Note 1: Differential engine cost is calculated from vendor's price quotation for a lean-burn engine minus vendor's price quotation for the rich-burn engine being designated as baseline.

Note 2: For lean-burn engine, 15 percent of DCC is used for a guaranteed efficiency and operation. For NSCR application, 25 percent of DCC is used for contigency based on no existing installtion of NSCR on large-bore rich-burn engine.

Table 6-7 Annualized Cost Estimates for Lean-Burn Engine and Rich-Burn/NSCR System

Cost Items	Basis	Costs: Lean-Burn Engine	Costs: Johnson-Matthey NSCR System
DIRECT OPERATING COSTS (DOC):			
(1) Operating Labor			
Operator[2]	$20/hr (2,920 hr/yr for NSCR)	$0	$58,400
Supervisor[1]	15% of operator cost	$0	$8,760
(2) Maintenance[2]	5% of direct capital cost	$3,968	$4,779
(3) Replacement Parts (include freight & tax)			
Catalyst	(Part+Labor)xCRF; See Note 1	$0	$21,585
(4) Fuel			
Fuel credit (gas)	$2.06/MMBtu; See Note 2	-$43,309	$0
Total DOC		-$39,341	$93,524
INDIRECT OPERATING COSTS (IOC):			
(7) Overhead[1]	60% of operating labor & maintenance	$2,381	$43,163
(8) Property Taxes[1]	1% of total capital investment	$1,135	$1,540
(9) Insurance[1]	1% of total capital investment	$1,135	$1,540
(10) Administration[1]	2% of total capital investment	$2,270	$3,081
Total IOC		$6,921	$49,324
CAPITAL RECOVERY COST (CRC)	CRF of 0.1627 times TCI	$18,465	$25,062
ANNUALIZED COST (AC):	DOC + IOC + CRC	-$13,955	$167,910

[1] Based on catalytic incinerators, from OAQPS Control Cost Manual, Fourth Edition.

[2] Based on no existing installation of NSCR on high-load rich-burn engine: 2.667 hours per shift are devoted to the emission control system operation and maintenance.

Note 1: For NSCR, the catalyst accounts for 95% of the basic cost and has a service life of 3 year; therefore, catalyst replacement part cost is $48,000 times 0.95 plus 11% for the combined freight and tax cost. Replacement labor cost is $50 per hour for one 8-hour day. Total cost includes both material and labor costs. Thus, the annualized catalyst replacement cost is equal to the total replacement cost multiplied by the CRF for a 3-year recovery period and an interest rate of 10%. CRF = 0.4021.

Note 2: Heat input for lean-burn engine is calculated from 7,000 Btu/bhp-hr times 2,400 bhp = 16.8 MMBtu/hr.
Heat input for rich-burn, naturally aspirated engine is calculated from 8,000 Btu/bhp-hr times 2,400 bhp = 19.2 MMBtu/hr.
Therefore, using a better fuel efficient engine results in saving an annual heat input of:
(19.2 - 16.8) MMBtu/hr x 8,760 hr/yr = 21,024 MMBtu/yr.

The annualized cost for the NSCR converter is given in Table 6-7. The calculation basis for cost items are also given in the table. The resulting annualized cost is $167,910. In comparison, the annualized differential cost of the lean-burn engine itself is -$13,955. As computed from Table 6-7, this negative value of the annualized cost for the lean-burn engine resulted from the fuel credit generated by using the proposed fuel-efficient engine.

6.3.4 ANALYSIS OF LEAN-BURN ENGINE WITH DERATING POWER OUTPUT

<u>Technical Issues</u>

Derating power output does not require additional equipment. Derating is accomplished by restricting the engine torque to a level below its normal operating design rate. This is done by making adjustment to the throttle valve setting in order to change the power output. Although a derated engine produces less NO_x emissions, such practice will also reduce the overall engine's efficiency and shorten its service life as much as 25 percent (Dresser-Rand, 1990). In addition, continuous derating operation would require a bigger, more expensive engine to meet the overall power requirement.

Derating power output is not considered BACT for the proposed lean-burn engine because of potential engine reliability problems, shortened engine life, and increased emissions of hydrocarbons.

<u>Environmental Effects</u>

Application of this technology would result in lower NO_x and carbon monoxide (CO) emissions, but emissions of hydrocarbons would increase. For instance, Cooper Industries, Inc., has reported a 23.2 TPY emissions reduction of NO_x and 2.3 TPY decrease in CO with a corresponding emissions increase of 7.0 TPY total hydrocarbons based on a 30 percent derating of the proposed 2,400-bhp lean-burn engine.

Energy Requirements and Impacts

In general, derating an engine will result in less fuel economy. EPA (1979) reported a fuel penalty of 8 percent based on derating power output on a dual-fuel engine by 25 percent. Manufacturers of gas-fired reciprocating engines state that approximately an 8 percent increase in fuel consumption will occur for a derating of 30 percent.

Economic Analysis

If derating is employed, a larger engine would be necessary to meet the FGTC power requirement of 2,400 bhp at Compressor Station No. 18. This will increase both the capital cost and annual operating cost for the engine. A detailed economic analysis was not performed for this technology.

6.3.5 ANALYSIS OF LEAN-BURN ENGINE WITH RETARD IGNITION TIMING

Technical Issues

EPA's research (1979) has reported that retard ignition timing is only effective for dual-fuel and diesel fuel burning engines. Retarding the spark for lean-burn engines will result in misfiring because spark-ignited engines are designed to be sensitive to any small deviation in timing changes. The summary of previous BACT determinations (Appendix A) shows that all ignition timing changes were exclusively applied to diesel burning reciprocating IC engines.

Ignition timing retardation increases exhaust temperatures above the engine's normal operating temperature. The increased engine operating temperature will result in additional maintenance, shorter engine life, and higher initial cost for high temperature exhaust components. Thus, retarding ignition timing for a lean-burn engine is not considered further.

Environmental Effects

Retarding ignition timing can increase the emission level of CO and VOC. This is due to less efficient combustion as the engine timing is changed from the optimal setting. In the event of misfiring, unburned hydrocarbons and CO emissions may increase significantly.

Energy Requirements and Impacts

Not performed--inapplicable technology.

Economic Analysis

Not performed--inapplicable technology. The expected capital cost is equal to the cost of the lean-burn engine.

6.3.6 ANALYSIS OF LEAN-BURN ENGINE

Technical Issues

The proposed turbocharged reciprocating IC engine will operate according to the manufacturer's specified operating parameters listed in Table 6-8. The engine's state-of-the-art design includes small pre-ignition chambers in which a rich fuel mixture is spark-ignited. The hot gases then enter the main combustion chambers and create spontaneous combustion of the lean fuel mixture. As a result, the overall combustion process is conducted under very lean fuel conditions. Operations on the lean side of the air-to-fuel ratio allow the proposed engine to obtain peak fuel economy.

In general, NO_x formation is directly proportional to the combustion temperature and residence time of the combustion gases (EPA, 1988d). The high mass flow rate at full-load, as indicated by the 36,860 pounds per hour of exhaust mass flow rate, reduces the residence time of the combustion gases compared to a rich-burn engine, which operates at an air-to-fuel ratio near unity. High mass flow rate also means the engine operates below the peak temperature region for thermal NO_x formation. The exhaust temperature for the proposed engine is 550°F, which is lower than the exhaust temperature of between 1,200°F and 1,300°F for an equivalent rich-burn engine. Thus, the rate of thermal NO_x formation is lower compared to the conventional rich-burn engine (i.e., 2 g/bhp-hr compared to 11 g/bhp-hr, respectively).

Table 6-8 Summary of the Operating Parameters for the Proposed Engine, Station No. 18

Parameter	Design Specification
Make and Model	Cooper-Bessemer GMVR-12C2
Air/Fuel Ratio	Variable
Exhaust Mass Flow	36,860 lb/hr
Ignition Timing	Variable
Air Manifold Pressure	Variable
Air Ambient Air Temperature	80 °F
Exhaust Temperature	550 °F
Maximum Allowed Back Pressure	3 inches of water
Specific Fuel Consumption	7,000 Btu/bhp-hr

Source: Cooper Industries, Inc. (1990).

The lean-burn engine-compressor has become the most effective method of transporting natural gas in a pipeline system judging by recent construction permits issued by several states (see Page 1 of Appendix A). The engine itself is very reliable and durable in continuous operation without requiring excessive maintenance attention as would be required in the case of additional add-on control technology.

Environmental Effects

There are no adverse environmental impacts expected for using the lean-burn engine, since there is no wastewater or solid waste created.

Energy Requirements and Impacts

The lean-burn engine is more fuel efficient than a comparable rich-burn engine. The fuel saved is 2.4 MMBtu/hr, for a total savings of 21,024 MMBtu/yr.

Economic Analysis

Capital and annualized cost estimates were prepared for the lean-burn engine. The differential engine cost of the lean-burn engine compared to the baseline rich-burn engine was provided by ENRON for the proposed 2,400-bhp Cooper-Bessemer GMVR-12C2 model. The engine has a guaranteed NO_x emission limit of 2 g/bhp-hr.

The differential capital cost of the integral engine-compressor unit is tabulated in Table 6-6. The differential engine cost for the Cooper-Bessemer engine is $50,000, from which the differential direct capital cost is calculated to be $79,365, and the indirect capital cost is calculated to be $34,128. The differential total capital investment is $113,493.

The annualized cost is given in Table 6-7. The calculation basis for cost items is also given. The direct operating cost consists of normal maintenance cost of the lean-burn technology parts for $3,968 and a fuel credit of $43,309 for better fuel efficiency operation. The differential annualized cost is -$13,955 for the lean-burn engine.

6.4 BACT SUMMARY AND CONCLUSION

The BACT analysis for NO_x control has identified three feasible control alternatives: the lean-burn engine with SCR, the rich-burn engine with NSCR, and the lean-burn engine. Elimination of a control technology as BACT will be based on comparison of the overall environmental, energy, and economic impacts. The most effective control alternative not eliminated will be selected as BACT.

6.4.1 COMPARISON OF TECHNICAL ISSUES

Of the three alternatives, the lean-burn engine is the most reliable option for pipeline transmission application. SCR and NSCR require significant routine maintenance and scheduled downtime for replacement service but also may cause unscheduled downtime because of malfunction or failure of SCR/NSCR components. Conversely, the lean-burn engine is highly reliable and requires low maintenance over unattended continuous operation. The lean-burn engine also has the capability of operating under variable load conditions. Since most compressor stations are located in rural areas, the lean-burn engine by itself without any add-on control device is most suitable for such operation.

6.4.2 COMPARISON OF ENVIRONMENTAL EFFECTS

Of the three alternatives, SCR poses the greatest potential for toxic impacts as a result of ammonia handling and storage, and ammonia slip. Comparing potential adverse environmental impacts: the lean-burn engine with SCR option is the worst due to potential ammonia release and disposal of catalysts; the rich-burn engine with NSCR is the next worse option due to disposal of catalyst. The lean-burn engine does not create any waste; therefore, it is the best alternative in terms of the environmental impact analysis.

6.4.3 COMPARISON OF ENERGY IMPACTS

The lean-burn engine equipped with SCR shows a net fuel credit of 5,256 MMBtu/yr for using the fuel-efficient lean-burn engine. In addition, an annual 5.1 MW-hr of electrical power is required for the ammonia vaporizer and injection system. The highest energy requirement is for the rich-burn/NSCR combination. This alternative does not use any additional fuel or energy for the operation of the control device. However, the rich-burn engine is less fuel efficient than the proposed lean-burn engine, making the rich-burn engine/NSCR option the worst ranking in terms of energy impacts. The lean-burn engine shows a savings of 21,024 MMBtu/yr in heat input over the rich-burn engine because of its inherent fuel efficient design. Thus, the lean-burn engine is the best alternative in view of the energy impact analysis.

6.4.4 COMPARISON OF ECONOMIC ANALYSIS

Economic analysis is based on the cost effectiveness of the control method. Economic impact is determined by the total and incremental cost effectiveness values. The detailed cost estimating procedure is presented in Appendix B. Results of the economic impact analysis are summarized in Table 6-9 for all three technically feasible NO_x control methods. Comparing the total cost effectiveness of these three NO_x control alternatives: the lean-burn engine/SCR technology has the highest cost effectiveness value of $1,666 per ton of NO_x removed; the rich-burn engine/NSCR technology is the next highest with $732 per ton of NO_x removed. The lean-burn engine has a total cost effectiveness value of -$67 per ton of NO_x removed.

The incremental cost effectiveness values for the lean-burn engine/SCR technology and the rich-burn engine/NSCR technology are $14,810 and $8,744 per ton of NO_x removed, respectively. The lean-burn engine has an incremental cost effectiveness of -$67 per ton of NO_x removed. Therefore, the lean-burn engine is the most cost effective control option.

6.4.5 SUMMARY AND CONCLUSION

The top-down BACT analysis in terms of environmental, energy and economic impacts for the FGTC's proposed project is summarized in Table 6-9. Both the lean-burn engine/SCR and the rich-burn engine/NSCR control options are eliminated primarily based on the high total and incremental cost

Table 6-9 Summary of Top-Down BACT Impact Analysis Results for NOx

Control Alternative	Total Emission Reduction (TPY)*	Incremental Emission Reduction (TPY)**	Environmental Impacts: Potential toxic air impact?	Environmental Impacts: Potential adverse enviromental impacts?	Energy Impacts (Incremental increase over baseline): Natural gas (MMBtu/yr)	Energy Impacts (Incremental increase over baseline): Electricity (MW-hr/yr)	Economic Impacts: Total Annualized Cost ($/yr)	Economic Impacts: Incremental Annualized Cost ($/yr)	Economic Impacts: Total Cost Effectiveness ($/ton)	Economic Impacts: Incremental Cost Effectiveness ($/ton)
Lean-Burn Engine with SCR	245.7	16.3	Yes	Yes	-5,256	5.1	$409,321	$241,409	$1,666	$14,810
Rich-Burn Engine with NSCR	229.4	20.8	No	Yes	0	0	$167,910	$181,865	$732	$8,744
Lean-Burn Engine	208.6	208.6	No	No	-21,024	0	-$13,955	-$13,955	-$67	-$67
Baseline (rich-burn engine)	----	----	--	--	----	--	----	----	----	----

* Total emission reduction, total annualized cost, and total cost effectiveness are calculated based on similar baseline parameter values.

** Incremental values are based on the next lower control technology's parameter values.

effectiveness for NO_x control. Recently, FDER has determined that incremental cost effectiveness values of \$4,000 to \$5,000 per ton of NO_x removed are unreasonable. These values were established for much larger sources of NO_x, such as utility gas turbine combined-cycle projects. In addition, add-on control technologies have significant energy penalties along with potential adverse environmental impacts, and these systems are not fully proven on IC engines of the size proposed by FGTC. On the other hand, lean-burn engines are the proven method for pipeline transmission application in which minimum maintenance and unattended operation are essential. Currently, lean-burn engines are the state-of-the-art application of reciprocating IC engines capable of achieving low emission without add-on control.

By eliminating lean-burn/SCR and rich-burn/NSCR options, the lean-burn engine is BACT. This is consistent with current BACT determinations shown in Table 6-2 for similar source applications. In the most recent top-down BACT analysis, IDNR has concluded that the inherently low NO_x emitting lean-burn engine is BACT for Northern Natural Gas Company. In its BACT summary, IDNR rejected SCR on the grounds of uncertain reliability and unreasonable cost effectiveness (i.e., total cost effectiveness of \$1,600 and incremental cost effectiveness of \$12,000 per ton NO_x removed).

No other stationary internal combustion sources, whether in natural-gas-related applications or other industrial processes, which use similar fuel and equivalent engines (i.e., natural-gas-fired and 2,400-bhp lean-burn engine) have been required to bear a high incremental cost effectiveness to reduce NO_x emissions. Furthermore, the FGTC's proposed lean-burn engine has low NO_x emissions of 46.3 TPY, and modeling results show an insignificant NO_x impact (less than 1.0 $\mu g/m^3$). In conclusion, the FGTC's proposed Cooper-Bessemer GMVR-12C2 lean-burn engine is BACT.

REFERENCES

Auer, A.H. 1978. Correlation of Land Use and Cover With Meteorological Anomalies. J. Appl. Meteor., Vol 17.

Briggs, G.A. 1969. Plume Rise, USAEC Critical Review Series, TID-25075. National Technical Information Service, Springfield, VA.

Briggs, G.A. 1971. Some Recent Analyses of Plume Rise Observations. In: Proceedings of the Second International Clean Air Congress. Academic Press, New York, NY.

Briggs, G.A. 1972. Discussion on Chimney Plumes in Neutral and Stable Surroundings. Atmos. Environ. 6:507-510.

Briggs, G.A. 1974. Diffusion Estimation for Small Emissions. In: ERL, ARL USAEC Report ATDL-106. U.S. Atomic Energy Commission, Oak Ridge, TN.

Briggs, G.A. 1975. Plume Rise Predictions. In: Lectures on Air Pollution and Environmental Impact Analysis. American Meteorological Society, Boston, MA.

Cooper Industries, Inc. 1987. Cooper-Bessemer Integral Gas Engine-Compressors, Performance Through Innovation (Technical sales literature).

Cooper Industries, Inc. 1990. Personal Communication With Cooper's Sales Engineer on CleanBurn® Technology and Lean-Burn Engine Performance.

Commonwealth of Massachusetts, Department of Environmental Quality Engineering. 1990. Permit application B-87-C-066 for Pfizer, Inc. Diesel Cogen Facility in Adams, MA. Springfield, MA.

Dresser-Rand Company. 1990. Personal Communications With Dresser-Rand's Sales Engineer on Engine Specification and Performance.

Engelhard Corporation. 1990. Catalyst Technology for Cleaner Air.

Engelhard Corporation. 1990. Verbal Budgetary Quotation for NO_x Abatement System.

Engelhard Corporation. 1990. Budgeting Quotation for NO_x/CO Control System.

REFERENCES

Exxon Research and Engineering Company. 1986. Thermal $DeNO_x$: A Commercial Selective Non-Catalytic NO_x Reduction Process for Waste-to-Energy Applications (B.E. Hurst and C.M. White, presented at ASME 12th Biennial National Waste Processing Conference, Denver, Colorado, June 2nd).

Exxon Research and Engineering Company. 1987. Improved ER&E Thermal $DeNO_x$ Process.

Fuel Tech. 1988. Control of Nitrogen Oxides Emissions From Stationary Sources. Presented at the Annual Meeting of the American Power Conference, April 1988.

Fuel Tech. 1989. Standard Technical Sales Literature.

Gas Research Institute. 1990. Evaluation of NO_x Reduction Technology for Natural Gas Industry Prime Movers - Update to Special Report GRI-87/0257 (Compiled by Carlo Castaldini, Acurex Corporation, Mountain View, CA).

Huber, A.H. 1977. Incorporating Building/Terrain Wake Effects on Stack Effluents. Preprint Volume for the Joint Conference on Applications of Air Pollution Meteorology in Boston, MA. American Meteorological Society.

Huber, A.H., and W.H. Snyder. 1976. Building Wake Effects on Short Stack Effluents. Preprint Volume for the Third Symposium on Atmospheric Diffusion and Air Quality in Boston, MA. American Meteorological Society.

Johnson Matthey Catalyst Systems Division. 1990. Standard Technical Sales Literature.

Neveril, R.B, et al. 1978. Capital and Operating Costs of Selected Air Pollution Control Systems (V). J. of the Air Poll. Control Assoc., Vol. 28(12): 1253-1256.

Nitrogen Nergas Corporation. 1990. Kleenaire Process.

Nitrogen Nergas Corporation. 1990. Budgetary Quotation for Kleenaire System.

Pasquill, F. 1976. Atmospheric Dispersion Parameters in Gaussian Plume Modelings, Part II. Possible Requirements for Changes in the Turner Workbook Values. U.S. Environmental Protection Agency, Research Triangle Park, NC. EPA Report No. EPA 600/4/76-030b.

REFERENCES

Schulman, L.L., and S.R. Hanna. 1986. Evaluation of Downwash Modifications to the Industrial Source Complex Model. J. of Air Poll. Control Assoc., 36(3):258-264.

Schulman, L.L., and J.S. Scire. 1980. Buoyant Line and Point Source (BLP) Dispersion Model User's Guide. Environmental Research and Technology, Inc., Concord, MA. Document P-7304B.

Schorr, M.M. 1989. The Real Economics of SCR as BACT for Gas Turbines; Presented at the AWMA 82nd Annual Meeting and Exhibition in Anaheim, CA.

South Coast Air Quality Management District (SCAQMD). 1979. The California Air Resources Board (CARB) Proposal on Control Strategy for Internal Combustion Engines - Ruling 1110.

South Coast Air Quality Management District (SCAQMD). 1984. State of Technology Related to Rule 1100 - Emission from Stationary Internal Combustion Engines (Demonstration). Staff report by L.M. Bowen, E. Larson, and A. Rawuka.

Steuler International Corporation. 1990. Standard Technical Sales Literature.

Steuler International Corporation. 1990. Budgetary Quotation for CER-NO_x System.

Texas Air Control Board (TACB). 1990. Personal Communication with a TACB Air Permitting Engineer. Austin, TX.

Urban, C.M., and K.J. Springer. 1975. Study of Exhaust Emissions From Natural Gas Pipeline Compressor Engines (American Gas Association: Project PR-15-61, p.57). Southwest Research Institute, San Antonio, TX.

U.S. Department of Energy/Energy Information Administration (DOE/EIA). 1987. Cost and Quality of Fuels for Electric Utility Plants, 1989. U.S. Government Printing Office. DOE/EIA-0191(89).

U.S. Environmental Protection Agency (EPA). 1977. User's Manual for Single Source (CRSTER) Model. Research Triangle Park, NC. EPA-450/2-77-013.

U.S. Environmental Protection Agency (EPA). 1978. Guidelines for Determining Best Available Control Technology (BACT). Research Triangle Park, NC.

REFERENCES

U.S. Environmental Protection Agency (EPA). 1979. Stationary Internal Combustion Engine: Standard Support and Environmental Impact Statement. Volume 1: Proposed Standard Performance (Draft). Research Triangle Park, NC. EPA-450/2-78-125a.

U.S. Environmental Protection Agency (EPA). 1980. PSD Workshop Manual. Research Triangle Park, NC.

U.S. Environmental Protection Agency (EPA). 1985. Guideline for Determination of Good Engineering Practice Stack Height (Technical Support Document for the Stack Height Regulations) (Revised). Research Triangle Park, NC. EPA-450/4-80-023.

U.S. Environmental Protection Agency (EPA). 1986. Environmental Assessment of a Reciprocating Engine Retrofitted With Selective Catalytic Reduction (Volume I: Technical Results). Research Triangle Park, NC. EPA-1699/7-86-014a.

U.S. Environmental Protection Agency (EPA). 1987a. Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD). Research Triangle Park, NC. EPA-450/4-87-007.

U.S. Environmental Protection Agency (EPA). 1987b. Guideline on Air Quality Models, Supplement A (Revised). EPA-450/2-78-027.

U.S. Environmental Protection Agency (EPA). 1988a. Toxic Air Pollutant Emission Factors--A Compilation for Selected Air Toxic Compounds and Sources. Research Triangle Park, NC. EPA-450/2-88-006a.

U.S. Environmental Protection Agency (EPA). 1988b. Industrial Source Complex (ISC) Dispersion Model User's Guide (2nd Ed., Revised). EPA-450/4-88-002a.

U.S. Environmental Protection Agency (EPA). 1988c. EPA User's Network for Applied Modeling of Air Pollution (UNAMAP) (Version 6, Change 3, January 4). Research Triangle Park, NC.

U.S. Environmental Protection Agency (EPA). 1988d. Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources (Supplement B, p. 3.1-2) AP-42. Research Triangle Park, NC.

U.S. Environmental Protection Agency (EPA). 1990a. "Top-Down" Best Available Control Technology Guidance Document (Draft). Research Triangle Park, NC.

REFERENCES

U.S. Environmental Protection Agency (EPA). 1990b. OAQPS Control Cost Manual (4th Ed.) EPA Publication: Research Triangle Park, NC. EPA-450/3-90-006.

U.S. Environmental Protection Agency (EPA). 1985 to 1990. BACT/LAER Clearinghouse--A Compilation of Control Technology Determinations. Research Triangle Park, NC.

APPENDIX A

Appendix A Summary of BACT Determinations for NOx Emissions from Stationary Reciprocating Engines (page 1 of 2)

Company Name	State	Permit Number	Date of Permit	Total Capacity	Engine Specifications: Fuel Type	Make	Model	Load (Bhp)	NOx Emission Limit*: (g/Bhp-hr)	(lb/hr)	(ppm)	Control Method	Comments
<u>Source Type: Natural Gas Compressor Station</u>													
Northern Natural Gas Company	IA		05-Sep-90	4,000 Bhp	N.G.	Cooper		4,000	1.8	15.9		Lean burn engine	
same as above	IA		05-Sep-90	4,000 Bhp	N.G.	Cooper		2,000	1.8	7.9		Lean burn engine	
National Fuel Gas Supply Corp.	PA	53-329-001	13-Jun-89	6,000 Bhp	N.G.	Cooper	8015JHC2	3,000	2.0	13.2		Lean burn engine	
Natural Gas Pipeline Company	IL	85100014	01-Mar-89	1,600 Bhp	N.G.	Worthington	MLV-10	4,000	9.0	79.4		Design & oper. practice	
Tennessee Gas Pipeline Company	PA	53-339-002	21-Jun-88	2,250 Bhp	N.G.	Cooper	GMVH-10C	2,250	3.0	14.9		Lean burn engine	
Consolidated Gas Transmission Corp.	PA	59-399-008	10-May-88	8,400 Bhp	N.G.	Dresser-Rand	TCV-10	4,200	3.0	27.8		Lean burn engine	Air to fuel ratio is 4.5:1
ANR Production Company	VA	11064	03-Mar-88	1,800 Bhp	N.G.	Caterpiller	G398TAA	600	1.2	1.6		Catalytic converter	N.G. Compressor Sta.
Southern Natural Gas Company	AL	406-0003-X0	19-Feb-88	4,160 Bhp	N.G.	Dresser-Rand	TCVD-10	4,160	2.2	20.2		Lean burn engine	Per. cond.: stack test
National Fuel Gas Supply Corp.	PA	53-399-002	01-Feb-88	2,850 Bhp	N.G.	Dresser-Rand	412 KEV-1	2,850	3.0	18.8		Lean burn engine	
Shell California Production Co.	CA	147853	14-Oct-86	600 Bhp				600	3.2	4.2		SCR	70% reduction
Northern Natural Gas Company	IA		04-Feb-86	8,000 Bhp	N.G.			4,000			250	Engine design	
Consolidated Gas Transmission Corp.	PA	18-399-009	11-Dec-85	6,000 Bhp	N.G.	Cooper	12W-330-C2	6,000	3.0	39.7		Lean burn engine	
Shell California Production	CA	0041-6	02-Dec-85	225 Bhp	N.G.	Caterpiller		225	0.805	0.4	50	NSCR, rich burn engine	90% reduction

* for a single engine.
N.G. = Natural Gas.

Appendix A Summary of BACT Determinations for NOx Emissions from Stationary Reciprocating Engines (page 2 of 2)

Company Name	State	Permit Number	Date of Permit	Total Capacity	Engine Specifications: Fuel Type	Make	Model	Load (Bhp)	NOx Emission Limit* (g/Bhp-hr)	(lb/hr)	(ppm)	Control Method	Comments
Source Type: Power Cogeneration and Other Uses													
University of Illinois, Ch. Cir. Camp.	IL	applying	1990	16,000 Bhp	N.G.	Cooper	LSVB-GDC	8,000	1.9	33.5		Lean burn engine	
Northeast Landfill Power	RI	999-1014	12-Dec-89	19,200 Bhp	L.G.	Waukesha	12V-AT25GL	2,400	1.3	6.6		Lean burn engine	High-speed (900 rpm)
Pfizer, Inc.	MA	B-87-C-006	16-Nov-89	6,710 Bhp	Dual/Diesel	Cooper	LSVB-16-GDT	6,710	0.7	10.1		SCR	90% reduction
Cogentrix (formerly Xlox)	PA	33-399-004	31-Oct-89	20,904 Bhp	Dual	Wartsila	18V32GD	6,968	5.0	76.8		Engine retardation	
Worcester Company	RI	988-990	27-Sep-89	6,000 Bhp	N.G.	Superior	12-SGTB	2,000	1.5	6.6		Lean burn engine	High-speed (900 rpm)
Citizens Utilities	HI	HI 88-04	19-Sep-89	42,000 Bhp	Diesel			10,500			605	Engine design	
Key West Electric System	FL	PSD-FL-135	05-Jun-89	26,532 Bhp	Diesel			13,266	6.0	175.5		Engine timing retard	
Maui Electric Company, Inc.	HI	HI 87-01	30-Dec-88	33,400 Bhp	Diesel			16,700	7.0	256.1	595	5° ignition retard	20% reduction
Power Ventures	FL	PSD-FL-120	05-Dec-88	8,800 Bhp	Dual	Undetermined			5.0			Engine design	
same as above	FL	PSD-FL-120	05-Dec-88	8,800 Bhp	Diesel	Undetermined			12.0			Engine design	
Maui Pineapple Co., Ltd.	HI	HI 87-02	17-May-88	4,020 Bhp	Diesel			2,010	5.2	23.0	536	2° ignition retard	
same as above	HI	HI 87-02	17-May-88	6,040 Bhp	Diesel			3,020	5.3	35.0	520	2° ignition retard	
Maui Electric Company, Inc.	HI	HI 86-02	17-Nov-87	6,700 Bhp	Diesel			3,350	9.3	68.4	600	4° ignition retard	20% reduction
Hawaii Electric Light Co., Inc.	HI	HI 85-03	17-Nov-87	10,050 Bhp	Diesel			3,350	9.3	68.4	600	4° engine retard	20% reduction
City of Ventura	CA	1379-1	31-Dec-86	773 Bhp	D.G.			773	2.0	3.4		Engine design	Digestive gas
State of Utah Natural Resources	UT		01-Sep-86	18,000 Bhp	N.G.			4,630	3.5	36.0		Lean burn engine	Turbocharger ups fuel eff.
Tricounty Sun Energy Sheraton Hotel	CA	1369-1	07-Aug-86	200 Bhp	N.G.	Caterpillar		200			50	NSCR, rich burn engine	90% reduction
LaJet Energy Company	CA	85096	17-Jul-86	1,385 Bhp	Diesel	Cummins	KTTA-50CC	1,385	5.4	16.5		Engine design	
3M	TX	PSD-TX-674	30-May-86	8,386 Bhp	Dual	Cooper	LSVG-20-GDT	8,386	5.0	92.4		Engine design	
Genstar Gas Recovery Systems	CA	30970	29-Aug-85	2,650 Bhp	L.G.			2,650	1.5	8.8		Lean burn engine	Landfilled gas
same as above	CA	30893	29-Aug-85	1,100 Bhp	L.G.			1,100	1.5	3.6		Lean burn engine	Landfilled gas
Pacific Lighting Energy	CA	30336	01-Mar-85	2,650 Bhp	N.G.	Superior	16-SGTA	2,650	1.5	8.8		Lean burn engine	High-speed (900 rpm)

* for a single engine. Note: N.G. = Natural Gas; L.G. = Landfilled Gas; D.G. = Digestive Gas.

In the DOC category, the annual operating labor includes the operator and supervisor costs for continuous operation. The operator cost for the SCR system was calculated based on 5.33 hours per shift devoted to regular maintenance and safety assurance procedure for the emission control system, which include the operation of the ammonia system. The maintenance requirement is 5 percent of the DCC.

Catalyst replacement cost was calculated using a capital recovery factor (CRF) computed for a three-year recovery period and a 10 percent interest rate. The CRF equation is given below. The total catalyst replacement cost includes the replacement part cost and the labor cost for technical supervision by the catalyst supplier.

The utility costs are the sum of the itemized costs for electricity, natural gas for exhaust stack gas reheat, and a fuel credit for using the more efficient lean-burn engine. Electricity cost is based on the estimated total annual consumption for the ammonia vaporizer/injection system. The unit cost for electrical power is current standard cost value. The price of natural gas is based on current natural gas pricing (DOE/EIA, 1989). The total tonnage of ammonia is calculated by the ammonia molar equivalent required to convert the total estimated NO_x emissions.

Indirect operating costs include the cost of plant overhead, property taxes, insurance, administration, and capital recovery cost. These costs are typically either one or two percent of the total capital investment; except the overhead which is sixty percent of the operating labor and maintenance costs. The capital recovery cost (CRC) is based on the service life of the control system, interest rate, capital depreciation rate, and total capital investment. The CRC is calculated by multiplying the TCI by the capital recovery factor (CRF), which is defined as:

$$CRF = \frac{i(1 + i)^n}{(1 + i)^n - 1}$$

where: i = annual interest rate (in percent), and
n = equipment service life (in years).

The standard estimated equipment service life for each alternative is 10 years, and the average interest rate is assumed to be 10 percent.

The annualized cost is the sum of the DOC, IOC, and CRC.

The annualized cost estimates for the lean-burn engine and the NSCR converter use similar cost estimating procedure as shown for the SCR system, with the exception of the ammonia supply in the DOC category. The DOC of the NSCR system includes the costs of the operating labor, maintenance, and catalyst replacement.

SECTION III <u>COST EFFECTIVENESS</u>

In general, the cost effectiveness of SCR, lean-burn engine, or rich-burn engine/NSCR option is based on the annualized cost of each system and the associated annual pollutant emission reduction. This is determined by dividing the annualized cost by the tonnage of pollutant removed per year.

This cost effectiveness value is presented in terms of total cost effectiveness and incremental cost effectiveness. The total cost effectiveness values are based on the differences in costs and tonnages of NO_x emitted between a given emission control option and the baseline. The incremental cost effectiveness values are based on the difference in costs and tonnages of NO_x emitted between a given emission control option and the next most effective control option.

APPENDIX C

ISCLT PRINTOUTS
FLORIDA GAS TRANSMISSION COMPANY
COMPRESSOR STATION NO. 18

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ISCLTK6L MODEL, A VERSION OF
  ISCLT (VERSION 90008)
  AN AIR QUALITY DISPERSION MODEL IN
  SECTION 1.  GUIDELINE MODELS.
  IN UNAMAP (VERSION 6) JAN 1990.
  SOURCE: FILE 7  ON UNAMAP MAGNETIC TAPE FROM NTIS.


          CONVERTED BY :
KBN ENGINEERING AND APPLIED SCIENCES, INC.
       GAINESVILLE, FLORIDA
            (904)331-9000

          COPYRIGHT 1990 L


  CARD INPUT FILE IS         ER18LT82.I81
  SUMMARY OUTPUT FILE IS     ER18LT82.O81
  TITLE OF RUN IS            1982 ENRON STATION 18 / 40 FT STACK           10-29-90
```

- ISCLT INPUT DATA -

```
NUMBER OF SOURCES =   1
NUMBER OF X AXIS GRID SYSTEM POINTS =   8
NUMBER OF Y AXIS GRID SYSTEM POINTS =  16
NUMBER OF SPECIAL POINTS =  36
NUMBER OF SEASONS =   1
NUMBER OF WIND SPEED CLASSES =  6
NUMBER OF STABILITY CLASSES =  6
NUMBER OF WIND DIRECTION CLASSES = 16
FILE NUMBER OF DATA FILE USED FOR REPORTS =   1
THE PROGRAM IS RUN IN RURAL MODE
CONCENTRATION (DEPOSITION) UNITS CONVERSION FACTOR =0.10000000E+07
ACCELERATION OF GRAVITY (METERS/SEC**2) =  9.800
HEIGHT OF MEASUREMENT OF WIND SPEED (METERS) =  10.100
CORRECTION ANGLE FOR GRID SYSTEM VERSUS DIRECTION DATA NORTH (DEGREES) =   0.000
DECAY COEFFICIENT =0.00000000E+00
PROGRAM OPTION SWITCHES = 1, 2, 2, 0, 0, 3, 2, 1, 3, 2, 2, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 1, 1, 0,
0,
  RANGE X AXIS GRID SYSTEM POINTS (METERS )=    100.00,    200.00,    300.00,    400.00,    500.00,    750.00,
    1000.00,   1250.00,
  RANGE X SPECIAL DISCRETE POINTS (METERS )=   317.00,    332.00,    357.00,    402.00,    366.00,    323.00,
     296.00,    283.00,    277.00,    283.00,    253.00,    171.00,    134.00,    113.00,     98.00,     91.00,
      88.00,     85.00,     88.00,     91.00,    101.00,    113.00,    137.00,    134.00,    122.00,    119.00,
     116.00,    119.00,    122.00,    134.00,    149.00,    177.00,    229.00,    250.00,    259.00,    311.00,
AZIMUTH BEARING Y AXIS GRID SYSTEM POINTS (DEGREES)=     22.50,     45.00,     67.50,     90.00,    112.50,    135.00,
     157.50,    180.00,    202.50,    225.00,    247.50,    270.00,    292.50,    315.00,    337.50,    360.00,
AZIMUTH BEARING Y SPECIAL DISCRETE POINTS (DEGREES)=     10.00,     20.00,     30.00,     40.00,     50.00,     60.00,
      70.00,     80.00,     90.00,    100.00,    110.00,    120.00,    130.00,    140.00,    150.00,    160.00,
     170.00,    180.00,    190.00,    200.00,    210.00,    220.00,    230.00,    240.00,    250.00,    260.00,
     270.00,    280.00,    290.00,    300.00,    310.00,    320.00,    330.00,    340.00,    350.00,    360.00,
```

- AMBIENT AIR TEMPERATURE (DEGREES KELVIN) -

	STABILITY CATEGORY 1	STABILITY CATEGORY 2	STABILITY CATEGORY 3	STABILITY CATEGORY 4	STABILITY CATEGORY 5	STABILITY CATEGORY 6
SEASON 1	300.0000	300.0000	300.0000	295.0000	290.0000	290.0000

- MIXING LAYER HEIGHT (METERS) -

SEASON 1

	WIND SPEED CATEGORY 1	WIND SPEED CATEGORY 2	WIND SPEED CATEGORY 3	WIND SPEED CATEGORY 4	WIND SPEED CATEGORY 5	WIND SPEED CATEGORY 6
STABILITY CATEGORY 1	0.215100E+04	0.215100E+04	0.215100E+04	0.215100E+04	0.215100E+04	0.215100E+04
STABILITY CATEGORY 2	0.143400E+04	0.143400E+04	0.143400E+04	0.143400E+04	0.143400E+04	0.143400E+04
STABILITY CATEGORY 3	0.143400E+04	0.143400E+04	0.143400E+04	0.143400E+04	0.143400E+04	0.143400E+04
STABILITY CATEGORY 4	0.143400E+04	0.143400E+04	0.143400E+04	0.143400E+04	0.143400E+04	0.143400E+04
STABILITY CATEGORY 5	0.100000E+05	0.100000E+05	0.100000E+05	0.100000E+05	0.100000E+05	0.100000E+05
STABILITY CATEGORY 6	0.100000E+05	0.100000E+05	0.100000E+05	0.100000E+05	0.100000E+05	0.100000E+05

- ISCLT INPUT DATA (CONT.) -

- FREQUENCY OF OCCURRENCE OF WIND SPEED, DIRECTION AND STABILITY -

SEASON 1

STABILITY CATEGORY 1

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.5000MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.00001500	0.00045701	0.00000000	0.00000000	0.00000000	0.00000000
22.500	0.00000400	0.00011400	0.00000000	0.00000000	0.00000000	0.00000000
45.000	0.00013300	0.00045701	0.00000000	0.00000000	0.00000000	0.00000000
67.500	0.00001100	0.00034200	0.00000000	0.00000000	0.00000000	0.00000000
90.000	0.00001500	0.00045701	0.00000000	0.00000000	0.00000000	0.00000000
112.500	0.00002200	0.00068501	0.00000000	0.00000000	0.00000000	0.00000000
135.000	0.00001100	0.00034200	0.00000000	0.00000000	0.00000000	0.00000000
157.500	0.00001100	0.00034200	0.00000000	0.00000000	0.00000000	0.00000000
180.000	0.00003400	0.00102701	0.00000000	0.00000000	0.00000000	0.00000000
202.500	0.00001900	0.00057101	0.00000000	0.00000000	0.00000000	0.00000000
225.000	0.00012900	0.00034200	0.00000000	0.00000000	0.00000000	0.00000000
247.500	0.00012500	0.00022800	0.00000000	0.00000000	0.00000000	0.00000000
270.000	0.00000700	0.00022800	0.00000000	0.00000000	0.00000000	0.00000000
292.500	0.00001900	0.00057101	0.00000000	0.00000000	0.00000000	0.00000000
315.000	0.00000400	0.00011400	0.00000000	0.00000000	0.00000000	0.00000000
337.500	0.00024000	0.00011400	0.00000000	0.00000000	0.00000000	0.00000000

SEASON 1

STABILITY CATEGORY 2

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.5000MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.00031500	0.00171202	0.00102701	0.00000000	0.00000000	0.00000000
22.500	0.00006100	0.00137002	0.00137002	0.00000000	0.00000000	0.00000000
45.000	0.00008200	0.00182602	0.00125602	0.00000000	0.00000000	0.00000000
67.500	0.00043901	0.00182602	0.00137002	0.00000000	0.00000000	0.00000000
90.000	0.00063501	0.00353904	0.00308204	0.00000000	0.00000000	0.00000000
112.500	0.00035100	0.00251103	0.00159802	0.00000000	0.00000000	0.00000000
135.000	0.00020600	0.00194102	0.00216903	0.00000000	0.00000000	0.00000000
157.500	0.00008200	0.00182602	0.00182602	0.00000000	0.00000000	0.00000000
180.000	0.00049601	0.00308204	0.00433805	0.00000000	0.00000000	0.00000000
202.500	0.00025200	0.00296804	0.00274003	0.00000000	0.00000000	0.00000000
225.000	0.00049601	0.00308204	0.00194102	0.00000000	0.00000000	0.00000000
247.500	0.00069801	0.00228303	0.00182602	0.00000000	0.00000000	0.00000000
270.000	0.00072401	0.00285403	0.00182602	0.00000000	0.00000000	0.00000000
292.500	0.00046001	0.00228303	0.00068501	0.00000000	0.00000000	0.00000000
315.000	0.00031500	0.00171202	0.00068501	0.00000000	0.00000000	0.00000000
337.500	0.00043901	0.00182602	0.00045701	0.00000000	0.00000000	0.00000000

- ISCLT INPUT DATA (CONT.) -

- FREQUENCY OF OCCURRENCE OF WIND SPEED, DIRECTION AND STABILITY -

SEASON 1

STABILITY CATEGORY 3

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.5000MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.00012200	0.00399505	0.00547907	0.00057101	0.00000000	0.00000000
22.500	0.00053701	0.00216903	0.00411005	0.00068501	0.00000000	0.00000000
45.000	0.00021500	0.00319604	0.00867610	0.00057101	0.00011400	0.00000000
67.500	0.00009800	0.00319604	0.00662108	0.00159802	0.00011400	0.00000000
90.000	0.00021200	0.00308204	0.00742009	0.00159802	0.00000000	0.00000000
112.500	0.00010500	0.00342504	0.00787709	0.00079901	0.00000000	0.00000000
135.000	0.00010100	0.00331104	0.00353904	0.00034200	0.00000000	0.00000000
157.500	0.00004900	0.00159802	0.00456605	0.00057101	0.00000000	0.00000000
180.000	0.00058201	0.00365304	0.01016012	0.00182602	0.00000000	0.00000000
202.500	0.00031200	0.00251103	0.00365304	0.00045701	0.00011400	0.00000000
225.000	0.00005600	0.00182602	0.00456605	0.00045701	0.00000000	0.00000000
247.500	0.00018700	0.00228303	0.00319604	0.00022800	0.00000000	0.00000000
270.000	0.00015300	0.00114201	0.00331104	0.00057101	0.00000000	0.00000000
292.500	0.00018400	0.00216903	0.00353904	0.00045701	0.00000000	0.00000000
315.000	0.00002800	0.00091301	0.00296804	0.00057101	0.00000000	0.00000000
337.500	0.00002800	0.00091301	0.00296804	0.00011400	0.00000000	0.00000000

SEASON 1

STABILITY CATEGORY 4

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.5000MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.00086901	0.00799110	0.01769421	0.01187214	0.00045701	0.00000000
22.500	0.00031300	0.00559407	0.01232915	0.01084513	0.00091301	0.00011400
45.000	0.00064701	0.00502306	0.01655320	0.01586819	0.00079901	0.00000000
67.500	0.00027700	0.00456605	0.01392717	0.01860722	0.00034200	0.00000000
90.000	0.00013900	0.00399505	0.01815122	0.01563919	0.00034200	0.00000000
112.500	0.00037900	0.00411005	0.01118714	0.01073113	0.00011400	0.00000000
135.000	0.00038700	0.00433805	0.01084513	0.00536506	0.00068501	0.00000000
157.500	0.00046201	0.00308204	0.00981712	0.00570807	0.00102701	0.00011400
180.000	0.00041500	0.00513706	0.01518318	0.01255715	0.00148402	0.00022800
202.500	0.00041400	0.00171202	0.00605007	0.00468006	0.00022800	0.00022800
225.000	0.00020600	0.00251103	0.00650708	0.00353904	0.00068501	0.00000000
247.500	0.00009900	0.00285403	0.00456605	0.00331104	0.00022800	0.00022800
270.000	0.00031200	0.00216903	0.00582207	0.00456605	0.00079901	0.00022800
292.500	0.00018200	0.00182602	0.00399505	0.00547907	0.00022800	0.00022800
315.000	0.00040200	0.00137002	0.00490906	0.00559407	0.00022800	0.00000000
337.500	0.00054801	0.00216903	0.00365304	0.00605007	0.00011400	0.00011400

- ISCLT INPUT DATA (CONT.) -

- FREQUENCY OF OCCURRENCE OF WIND SPEED, DIRECTION AND STABILITY -

SEASON 1

STABILITY CATEGORY 5

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.5000MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.00000000	0.01369916	0.01210015	0.00000000	0.00000000	0.00000000
22.500	0.00000000	0.01004612	0.00399505	0.00000000	0.00000000	0.00000000
45.000	0.00000000	0.01210015	0.00547907	0.00000000	0.00000000	0.00000000
67.500	0.00000000	0.00913211	0.00605007	0.00000000	0.00000000	0.00000000
90.000	0.00000000	0.01141614	0.00936111	0.00000000	0.00000000	0.00000000
112.500	0.00000000	0.00799110	0.00445205	0.00000000	0.00000000	0.00000000
135.000	0.00000000	0.00764809	0.00251103	0.00000000	0.00000000	0.00000000
157.500	0.00000000	0.00901811	0.00182602	0.00000000	0.00000000	0.00000000
180.000	0.00000000	0.01621019	0.00125602	0.00000000	0.00000000	0.00000000
202.500	0.00000000	0.00388105	0.00102701	0.00000000	0.00000000	0.00000000
225.000	0.00000000	0.00365304	0.00182602	0.00000000	0.00000000	0.00000000
247.500	0.00000000	0.00388105	0.00137002	0.00000000	0.00000000	0.00000000
270.000	0.00000000	0.00376705	0.00319604	0.00000000	0.00000000	0.00000000
292.500	0.00000000	0.00388105	0.00353904	0.00000000	0.00000000	0.00000000
315.000	0.00000000	0.00182602	0.00228303	0.00000000	0.00000000	0.00000000
337.500	0.00000000	0.00342504	0.00342504	0.00000000	0.00000000	0.00000000

SEASON 1

STABILITY CATEGORY 6

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.5000MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.01031612	0.02488630	0.00000000	0.00000000	0.00000000	0.00000000
22.500	0.00553207	0.01575319	0.00000000	0.00000000	0.00000000	0.00000000
45.000	0.00540307	0.01369916	0.00000000	0.00000000	0.00000000	0.00000000
67.500	0.00347904	0.01153014	0.00000000	0.00000000	0.00000000	0.00000000
90.000	0.00515006	0.01449817	0.00000000	0.00000000	0.00000000	0.00000000
112.500	0.00391605	0.01027412	0.00000000	0.00000000	0.00000000	0.00000000
135.000	0.00415305	0.00799110	0.00000000	0.00000000	0.00000000	0.00000000
157.500	0.00525206	0.00593607	0.00000000	0.00000000	0.00000000	0.00000000
180.000	0.00652308	0.01244315	0.00000000	0.00000000	0.00000000	0.00000000
202.500	0.00328104	0.00422405	0.00000000	0.00000000	0.00000000	0.00000000
225.000	0.00198802	0.00319604	0.00000000	0.00000000	0.00000000	0.00000000
247.500	0.00229803	0.00547907	0.00000000	0.00000000	0.00000000	0.00000000
270.000	0.00435605	0.00833310	0.00000000	0.00000000	0.00000000	0.00000000
292.500	0.00388505	0.00662108	0.00000000	0.00000000	0.00000000	0.00000000
315.000	0.00262903	0.00228303	0.00000000	0.00000000	0.00000000	0.00000000
337.500	0.00238703	0.00593607	0.00000000	0.00000000	0.00000000	0.00000000

- ISCLT INPUT DATA (CONT.) -

- VERTICAL POTENTIAL TEMPERATURE GRADIENT (DEGREES KELVIN/METER) -

	WIND SPEED CATEGORY 1	WIND SPEED CATEGORY 2	WIND SPEED CATEGORY 3	WIND SPEED CATEGORY 4	WIND SPEED CATEGORY 5	WIND SPEED CATEGORY 6
STABILITY CATEGORY 1	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
STABILITY CATEGORY 2	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
STABILITY CATEGORY 3	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
STABILITY CATEGORY 4	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
STABILITY CATEGORY 5	0.200000E-01	0.200000E-01	0.200000E-01	0.200000E-01	0.200000E-01	0.200000E-01
STABILITY CATEGORY 6	0.350000E-01	0.350000E-01	0.350000E-01	0.350000E-01	0.350000E-01	0.350000E-01

- WIND PROFILE POWER LAW EXPONENTS -

	WIND SPEED CATEGORY 1	WIND SPEED CATEGORY 2	WIND SPEED CATEGORY 3	WIND SPEED CATEGORY 4	WIND SPEED CATEGORY 5	WIND SPEED CATEGORY 6
STABILITY CATEGORY 1	0.700000E-01	0.700000E-01	0.700000E-01	0.700000E-01	0.700000E-01	0.700000E-01
STABILITY CATEGORY 2	0.700000E-01	0.700000E-01	0.700000E-01	0.700000E-01	0.700000E-01	0.700000E-01
STABILITY CATEGORY 3	0.100000E+00	0.100000E+00	0.100000E+00	0.100000E+00	0.100000E+00	0.100000E+00
STABILITY CATEGORY 4	0.150000E+00	0.150000E+00	0.150000E+00	0.150000E+00	0.150000E+00	0.150000E+00
STABILITY CATEGORY 5	0.350000E+00	0.350000E+00	0.350000E+00	0.350000E+00	0.350000E+00	0.350000E+00
STABILITY CATEGORY 6	0.550000E+00	0.550000E+00	0.550000E+00	0.550000E+00	0.550000E+00	0.550000E+00

- SOURCE INPUT DATA -

C A R D	T A P E	SOURCE NUMBER	SOURCE TYPE	X COORDINATE (M)	Y COORDINATE (M)	EMISSION HEIGHT (M)	BASE / ELEV- / ATION / (M) /	- SOURCE DETAILS DEPENDING ON TYPE -
X		1	STACK	0.00	0.00	12.19	0.00	GAS EXIT TEMP (DEG K)= 561.00, GAS EXIT VEL. (M/SEC)= 48.88, STACK DIAMETER (M)= 0.440, HEIGHT OF ASSO. BLDG. (M)= -9.69, WIDTH OF ASSO. BLDG. (M)= 74.92, WAKE EFFECTS FLAG = 0

- DIRECTION SPECIFIC BUILDING DIMENSIONS -

SECTOR	DSBH	DSBW	IWAKE	SECTOR	DSBH	DSBW	IWAKE	SECTOR	DSBH	DSBW	IWAKE	SECTOR	DSBH	DSBW	IWAKE
1	9.7,	75.0,	0	2	9.7,	75.0,	0	3	9.7,	75.0,	0	4	9.7,	75.0,	0
5	9.7,	75.0,	0	6	9.7,	75.0,	0	7	9.7,	75.0,	0	8	9.7,	75.0,	0
9	9.7,	75.0,	0	10	9.7,	75.0,	0	11	9.7,	75.0,	0	12	9.7,	75.0,	0
13	9.7,	75.0,	0	14	9.7,	75.0,	0	15	9.7,	75.0,	0	16	9.7,	75.0,	0

- SOURCE STRENGTHS (GRAMS PER SEC) -

SEASON 1	SEASON 2	SEASON 3	SEASON 4
1.33000E+00			

WARNING - HW/HB > 5 FOR SOURCE 1 PROG. USES LATERAL VIRTUAL DIST. FOR UPPER BOUND OF CONCENTRATION (DEPOSITION) IN SECTOR(S):
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16.
IF LOWER BOUND IS DESIRED SET THE DIRECTION SPECIFIC BUILDING HEIGHT TO < 0 (WAKE EFFECTS FLAG) AND RERUN.

** ANNUAL GROUND LEVEL CONCENTRATION (MICROGRAMS PER CUBIC METER) DUE TO SOURCE 1 **

- GRID SYSTEM RECEPTORS -

- X AXIS (RANGE , METERS) -

Y AXIS (AZIMUTH BEARING, DEGREES)	100.000	200.000	300.000	400.000	500.000	750.000	1000.000	1250.000
	- CONCENTRATION -							
360.000	0.812837	0.717730	0.904979	0.956981	0.905309	0.697688	0.547515	0.446699
337.500	0.366571	0.321990	0.417142	0.455667	0.443245	0.357349	0.288777	0.240132
315.000	0.337802	0.294080	0.389781	0.444805	0.448525	0.381356	0.314326	0.262546
292.500	0.425540	0.421463	0.599478	0.673364	0.656437	0.522891	0.413944	0.337779
270.000	0.654363	0.601861	0.806904	0.896787	0.878024	0.710924	0.569347	0.468945
247.500	0.592706	0.553524	0.741779	0.824615	0.803831	0.644018	0.511166	0.417420
225.000	0.529629	0.508194	0.715059	0.815471	0.806053	0.658485	0.530670	0.438954
202.500	0.417062	0.369030	0.485866	0.547798	0.545405	0.461805	0.386170	0.328758
180.000	0.396845	0.377756	0.541985	0.648547	0.672120	0.604588	0.525282	0.459336
157.500	0.189615	0.188037	0.277098	0.311691	0.300320	0.233761	0.185619	0.153400
135.000	0.215377	0.206923	0.287555	0.318221	0.306667	0.238227	0.183520	0.145985
112.500	0.252208	0.241144	0.334297	0.366922	0.350950	0.270990	0.212173	0.173137
90.000	0.333114	0.289839	0.372374	0.396874	0.376837	0.290952	0.227756	0.185704
67.500	0.254245	0.226882	0.305172	0.335979	0.325518	0.257034	0.202665	0.164574
45.000	0.304265	0.280301	0.383019	0.418214	0.400311	0.308182	0.237458	0.188830
22.500	0.378343	0.328786	0.418885	0.442829	0.417057	0.313994	0.238228	0.188122

- DISCRETE RECEPTORS -

X RANGE (METERS)	Y AZIMUTH BEARING (DEGREES)	CONCENTRATION	X RANGE (METERS)	Y AZIMUTH BEARING (DEGREES)	CONCENTRATION	X RANGE (METERS)	Y AZIMUTH BEARING (DEGREES)	CONCENTRATION
317.0	10.0	0.688392	332.0	20.0	0.482779	357.0	30.0	0.423370
402.0	40.0	0.418067	366.0	50.0	0.390827	323.0	60.0	0.335655
296.0	70.0	0.305411	283.0	80.0	0.318733	277.0	90.0	0.353678
283.0	100.0	0.330006	253.0	110.0	0.289557	171.0	120.0	0.241294
134.0	130.0	0.234170	113.0	140.0	0.215540	98.0	150.0	0.185947
91.0	160.0	0.181022	88.0	170.0	0.254538	85.0	180.0	0.335125
88.0	190.0	0.341531	91.0	200.0	0.363033	101.0	210.0	0.444513
113.0	220.0	0.516663	137.0	230.0	0.566557	134.0	240.0	0.593268
122.0	250.0	0.624800	119.0	260.0	0.642280	116.0	270.0	0.681379
119.0	280.0	0.568594	122.0	290.0	0.474666	134.0	300.0	0.413952
149.0	310.0	0.356507	177.0	320.0	0.317316	229.0	330.0	0.307950
250.0	340.0	0.402311	259.0	350.0	0.609252	311.0	360.0	0.919768

** ANNUAL GROUND LEVEL CONCENTRATION (MICROGRAMS PER CUBIC METER) DUE TO SOURCE 1 (CONT.) **

- 10 CONTRIBUTING VALUES TO PROGRAM DETERMINED MAXIMUM 10 OF ALL SOURCES COMBINED -

X COORDINATE RANGE (METERS)	Y COORDINATE AZIMUTH BEARING (DEGREES)	CONCENTRATION
400.00	360.00	0.956981
311.00	360.00	0.919768
500.00	360.00	0.905309
300.00	360.00	0.904979
400.00	270.00	0.896787
500.00	270.00	0.878024
400.00	247.50	0.824615
400.00	225.00	0.815471
100.00	360.00	0.812837
300.00	270.00	0.806904

** END OF ISCLT PROGRAM,   1 SOURCES PROCESSED **

ISCLTK6L MODEL, A VERSION OF
ISCLT (VERSION 90008)
AN AIR QUALITY DISPERSION MODEL IN
SECTION 1. GUIDELINE MODELS.
IN UNAMAP (VERSION 6) JAN 1990.
SOURCE: FILE 7 ON UNAMAP MAGNETIC TAPE FROM NTIS.

CONVERTED BY :
KBN ENGINEERING AND APPLIED SCIENCES, INC.
GAINESVILLE, FLORIDA
(904)331-9000

CARD INPUT FILE IS ER18LT83.I81
SUMMARY OUTPUT FILE IS ER18LT83.O81
TITLE OF RUN IS 1983 ENRON STATION 18 / 40 FT STACK 10-29-90

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                                    - ISCLT INPUT DATA (CONT.) -

        NUMBER OF SOURCES =   1
        NUMBER OF X AXIS GRID SYSTEM POINTS =    8
        NUMBER OF Y AXIS GRID SYSTEM POINTS =   16
        NUMBER OF SPECIAL POINTS =  36
        NUMBER OF SEASONS =   1
        NUMBER OF WIND SPEED CLASSES =   6
        NUMBER OF STABILITY CLASSES =   6
        NUMBER OF WIND DIRECTION CLASSES =  16
        FILE NUMBER OF DATA FILE USED FOR REPORTS =   1
        THE PROGRAM IS RUN IN RURAL MODE
        CONCENTRATION (DEPOSITION) UNITS CONVERSION FACTOR =0.10000000E+07
        ACCELERATION OF GRAVITY (METERS/SEC**2) =  9.800
        HEIGHT OF MEASUREMENT OF WIND SPEED (METERS) =  10.100
        CORRECTION ANGLE FOR GRID SYSTEM VERSUS DIRECTION DATA NORTH (DEGREES) =    0.000
        DECAY COEFFICIENT =0.00000000E+00
        PROGRAM OPTION SWITCHES = 1, 2, 2, 0, 0, 3, 2, 1, 3, 2, 2, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 1, 1, 0,
0,
         RANGE X AXIS GRID SYSTEM POINTS (METERS )=     100.00,     200.00,     300.00,     400.00,     500.00,     750.00,
          1000.00,    1250.00,
         RANGE X SPECIAL DISCRETE POINTS (METERS )=    317.00,     332.00,     357.00,     402.00,     366.00,     323.00,
           296.00,     283.00,     277.00,     283.00,     253.00,     171.00,     134.00,     113.00,      98.00,      91.00,
            88.00,      85.00,      88.00,      91.00,     101.00,     113.00,     137.00,     134.00,     122.00,     119.00,
           116.00,     119.00,     122.00,     134.00,     149.00,     177.00,     229.00,     250.00,     259.00,     311.00,
  AZIMUTH BEARING Y AXIS GRID SYSTEM POINTS (DEGREES)=      22.50,      45.00,      67.50,      90.00,     112.50,     135.00,
           157.50,     180.00,     202.50,     225.00,     247.50,     270.00,     292.50,     315.00,     337.50,     360.00,
  AZIMUTH BEARING Y SPECIAL DISCRETE POINTS (DEGREES)=      10.00,      20.00,      30.00,      40.00,      50.00,      60.00,
            70.00,      80.00,      90.00,     100.00,     110.00,     120.00,     130.00,     140.00,     150.00,     160.00,
           170.00,     180.00,     190.00,     200.00,     210.00,     220.00,     230.00,     240.00,     250.00,     260.00,
           270.00,     280.00,     290.00,     300.00,     310.00,     320.00,     330.00,     340.00,     350.00,     360.00,

                         - AMBIENT AIR TEMPERATURE (DEGREES KELVIN) -

                STABILITY  STABILITY  STABILITY  STABILITY  STABILITY  STABILITY
                CATEGORY 1 CATEGORY 2 CATEGORY 3 CATEGORY 4 CATEGORY 5 CATEGORY 6
        SEASON  1   300.0000   300.0000   300.0000   295.0000   290.0000   290.0000

                                  - MIXING LAYER HEIGHT (METERS) -

                                           SEASON 1
                   WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED
                   CATEGORY 1  CATEGORY 2  CATEGORY 3  CATEGORY 4  CATEGORY 5  CATEGORY 6
STABILITY CATEGORY 10.215100E+040.215100E+040.215100E+040.215100E+040.215100E+040.215100E+04
STABILITY CATEGORY 20.143400E+040.143400E+040.143400E+040.143400E+040.143400E+040.143400E+04
STABILITY CATEGORY 30.143400E+040.143400E+040.143400E+040.143400E+040.143400E+040.143400E+04
STABILITY CATEGORY 40.143400E+040.143400E+040.143400E+040.143400E+040.143400E+040.143400E+04
STABILITY CATEGORY 50.100000E+050.100000E+050.100000E+050.100000E+050.100000E+050.100000E+05
STABILITY CATEGORY 60.100000E+050.100000E+050.100000E+050.100000E+050.100000E+050.100000E+05
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- ISCLT INPUT DATA (CONT.) -

- FREQUENCY OF OCCURRENCE OF WIND SPEED, DIRECTION AND STABILITY -

SEASON 1

STABILITY CATEGORY 1

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.5000MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.00011400	0.00034200	0.00000000	0.00000000	0.00000000	0.00000000
22.500	0.00011400	0.00045700	0.00000000	0.00000000	0.00000000	0.00000000
45.000	0.00000000	0.00034200	0.00000000	0.00000000	0.00000000	0.00000000
67.500	0.00000000	0.00137001	0.00000000	0.00000000	0.00000000	0.00000000
90.000	0.00011400	0.00079901	0.00000000	0.00000000	0.00000000	0.00000000
112.500	0.00000000	0.00022800	0.00000000	0.00000000	0.00000000	0.00000000
135.000	0.00011400	0.00057100	0.00000000	0.00000000	0.00000000	0.00000000
157.500	0.00011400	0.00034200	0.00000000	0.00000000	0.00000000	0.00000000
180.000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
202.500	0.00011400	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
225.000	0.00000000	0.00034200	0.00000000	0.00000000	0.00000000	0.00000000
247.500	0.00000000	0.00034200	0.00000000	0.00000000	0.00000000	0.00000000
270.000	0.00011400	0.00045700	0.00000000	0.00000000	0.00000000	0.00000000
292.500	0.00000000	0.00045700	0.00000000	0.00000000	0.00000000	0.00000000
315.000	0.00000000	0.00045700	0.00000000	0.00000000	0.00000000	0.00000000
337.500	0.00000000	0.00045700	0.00000000	0.00000000	0.00000000	0.00000000

SEASON 1

STABILITY CATEGORY 2

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.5000MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.00076301	0.00251102	0.00148401	0.00000000	0.00000000	0.00000000
22.500	0.00027800	0.00182601	0.00068501	0.00000000	0.00000000	0.00000000
45.000	0.00028900	0.00228302	0.00182601	0.00000000	0.00000000	0.00000000
67.500	0.00030900	0.00308202	0.00194102	0.00000000	0.00000000	0.00000000
90.000	0.00018600	0.00285402	0.00296802	0.00000000	0.00000000	0.00000000
112.500	0.00039500	0.00182601	0.00205502	0.00000000	0.00000000	0.00000000
135.000	0.00015900	0.00171201	0.00274002	0.00000000	0.00000000	0.00000000
157.500	0.00004200	0.00171201	0.00216902	0.00000000	0.00000000	0.00000000
180.000	0.00003900	0.00159801	0.00308202	0.00000000	0.00000000	0.00000000
202.500	0.00028400	0.00205502	0.00137001	0.00000000	0.00000000	0.00000000
225.000	0.00025100	0.00068501	0.00068501	0.00000000	0.00000000	0.00000000
247.500	0.00038400	0.00137001	0.00057100	0.00000000	0.00000000	0.00000000
270.000	0.00027300	0.00159801	0.00114201	0.00000000	0.00000000	0.00000000
292.500	0.00049300	0.00102701	0.00194102	0.00000000	0.00000000	0.00000000
315.000	0.00016100	0.00182601	0.00125601	0.00000000	0.00000000	0.00000000
337.500	0.00014700	0.00125601	0.00079901	0.00000000	0.00000000	0.00000000

- ISCLT INPUT DATA (CONT.) -

- FREQUENCY OF OCCURRENCE OF WIND SPEED, DIRECTION AND STABILITY -

SEASON 1

STABILITY CATEGORY 3

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.5000MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.00019800	0.00274002	0.00833307	0.00114201	0.00000000	0.00000000
22.500	0.00005100	0.00171201	0.00502304	0.00057100	0.00000000	0.00000000
45.000	0.00019200	0.00251102	0.00616405	0.00114201	0.00000000	0.00000000
67.500	0.00019800	0.00274002	0.00684905	0.00194102	0.00011400	0.00000000
90.000	0.00020900	0.00308202	0.00753406	0.00137001	0.00011400	0.00000000
112.500	0.00005100	0.00171201	0.00684905	0.00091301	0.00000000	0.00000000
135.000	0.00004400	0.00148401	0.00513704	0.00091301	0.00000000	0.00000000
157.500	0.00003700	0.00125601	0.00422403	0.00102701	0.00000000	0.00000000
180.000	0.00030900	0.00251102	0.00776306	0.00114201	0.00011400	0.00000000
202.500	0.00002000	0.00068501	0.00319603	0.00057100	0.00000000	0.00000000
225.000	0.00005400	0.00182601	0.00296802	0.00068501	0.00000000	0.00000000
247.500	0.00016100	0.00148401	0.00331103	0.00114201	0.00011400	0.00000000
270.000	0.00005700	0.00194102	0.00468004	0.00148401	0.00057100	0.00000000
292.500	0.00017800	0.00205502	0.00490904	0.00137001	0.00011400	0.00000000
315.000	0.00014400	0.00091301	0.00445204	0.00057100	0.00000000	0.00000000
337.500	0.00003700	0.00125601	0.00525104	0.00079901	0.00011400	0.00000000

SEASON 1

STABILITY CATEGORY 4

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.5000MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.00070701	0.00833307	0.02111917	0.01038808	0.00057100	0.00000000
22.500	0.00031100	0.00456604	0.01506812	0.00821907	0.00057100	0.00011400
45.000	0.00022000	0.00525104	0.01038808	0.00947508	0.00137001	0.00000000
67.500	0.00029600	0.00422403	0.01164409	0.01175809	0.00068501	0.00000000
90.000	0.00043400	0.00468004	0.01735214	0.01506812	0.00125601	0.00011400
112.500	0.00012900	0.00308202	0.01073109	0.01073109	0.00102701	0.00011400
135.000	0.00045700	0.00239702	0.01130109	0.00730606	0.00068501	0.00000000
157.500	0.00011500	0.00274002	0.00981708	0.00810506	0.00068501	0.00011400
180.000	0.00052900	0.00411003	0.01735214	0.01643813	0.00285402	0.00022800
202.500	0.00024800	0.00308202	0.00673505	0.00433803	0.00045700	0.00011400
225.000	0.00012900	0.00308202	0.00901807	0.00559404	0.00114201	0.00000000
247.500	0.00012500	0.00296802	0.00616405	0.00970308	0.00171201	0.00022800
270.000	0.00012000	0.00285402	0.00856207	0.01290010	0.00411003	0.00068501
292.500	0.00008100	0.00194102	0.00662105	0.01175809	0.00319603	0.00011400
315.000	0.00062901	0.00365303	0.00696306	0.00707806	0.00102701	0.00000000
337.500	0.00026300	0.00342503	0.00730606	0.00627905	0.00022800	0.00000000

- ISCLT INPUT DATA (CONT.) -

- FREQUENCY OF OCCURRENCE OF WIND SPEED, DIRECTION AND STABILITY -

SEASON 1

STABILITY CATEGORY 5

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.5000MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.00000000	0.01187210	0.01004608	0.00000000	0.00000000	0.00000000
22.500	0.00000000	0.00970308	0.00593605	0.00000000	0.00000000	0.00000000
45.000	0.00000000	0.00684905	0.00445204	0.00000000	0.00000000	0.00000000
67.500	0.00000000	0.00616405	0.00662105	0.00000000	0.00000000	0.00000000
90.000	0.00000000	0.00844707	0.00799106	0.00000000	0.00000000	0.00000000
112.500	0.00000000	0.00742006	0.00593605	0.00000000	0.00000000	0.00000000
135.000	0.00000000	0.00639305	0.00445204	0.00000000	0.00000000	0.00000000
157.500	0.00000000	0.00753406	0.00239702	0.00000000	0.00000000	0.00000000
180.000	0.00000000	0.01278510	0.00239702	0.00000000	0.00000000	0.00000000
202.500	0.00000000	0.00559404	0.00079901	0.00000000	0.00000000	0.00000000
225.000	0.00000000	0.00433803	0.00159801	0.00000000	0.00000000	0.00000000
247.500	0.00000000	0.00525104	0.00433803	0.00000000	0.00000000	0.00000000
270.000	0.00000000	0.00593605	0.00742006	0.00000000	0.00000000	0.00000000
292.500	0.00000000	0.00399503	0.00593605	0.00000000	0.00000000	0.00000000
315.000	0.00000000	0.00216902	0.00319603	0.00000000	0.00000000	0.00000000
337.500	0.00000000	0.00468004	0.00559404	0.00000000	0.00000000	0.00000000

SEASON 1

STABILITY CATEGORY 6

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.5000MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.00586605	0.02397319	0.00000000	0.00000000	0.00000000	0.00000000
22.500	0.00418803	0.01255710	0.00000000	0.00000000	0.00000000	0.00000000
45.000	0.00223402	0.00947508	0.00000000	0.00000000	0.00000000	0.00000000
67.500	0.00149201	0.00593605	0.00000000	0.00000000	0.00000000	0.00000000
90.000	0.00293702	0.01141609	0.00000000	0.00000000	0.00000000	0.00000000
112.500	0.00238002	0.00844707	0.00000000	0.00000000	0.00000000	0.00000000
135.000	0.00291902	0.00879007	0.00000000	0.00000000	0.00000000	0.00000000
157.500	0.00199202	0.00468004	0.00000000	0.00000000	0.00000000	0.00000000
180.000	0.00512404	0.01187210	0.00000000	0.00000000	0.00000000	0.00000000
202.500	0.00215402	0.00502304	0.00000000	0.00000000	0.00000000	0.00000000
225.000	0.00136301	0.00468004	0.00000000	0.00000000	0.00000000	0.00000000
247.500	0.00294702	0.00662105	0.00000000	0.00000000	0.00000000	0.00000000
270.000	0.00286302	0.00947508	0.00000000	0.00000000	0.00000000	0.00000000
292.500	0.00349303	0.00947508	0.00000000	0.00000000	0.00000000	0.00000000
315.000	0.00190702	0.00262602	0.00000000	0.00000000	0.00000000	0.00000000
337.500	0.00214502	0.00616405	0.00000000	0.00000000	0.00000000	0.00000000

- ISCLT INPUT DATA (CONT.) -

- VERTICAL POTENTIAL TEMPERATURE GRADIENT (DEGREES KELVIN/METER) -

	WIND SPEED CATEGORY 1	WIND SPEED CATEGORY 2	WIND SPEED CATEGORY 3	WIND SPEED CATEGORY 4	WIND SPEED CATEGORY 5	WIND SPEED CATEGORY 6
STABILITY CATEGORY 1	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
STABILITY CATEGORY 2	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
STABILITY CATEGORY 3	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
STABILITY CATEGORY 4	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
STABILITY CATEGORY 5	0.200000E-01	0.200000E-01	0.200000E-01	0.200000E-01	0.200000E-01	0.200000E-01
STABILITY CATEGORY 6	0.350000E-01	0.350000E-01	0.350000E-01	0.350000E-01	0.350000E-01	0.350000E-01

- WIND PROFILE POWER LAW EXPONENTS -

	WIND SPEED CATEGORY 1	WIND SPEED CATEGORY 2	WIND SPEED CATEGORY 3	WIND SPEED CATEGORY 4	WIND SPEED CATEGORY 5	WIND SPEED CATEGORY 6
STABILITY CATEGORY 1	0.700000E-01	0.700000E-01	0.700000E-01	0.700000E-01	0.700000E-01	0.700000E-01
STABILITY CATEGORY 2	0.700000E-01	0.700000E-01	0.700000E-01	0.700000E-01	0.700000E-01	0.700000E-01
STABILITY CATEGORY 3	0.100000E+00	0.100000E+00	0.100000E+00	0.100000E+00	0.100000E+00	0.100000E+00
STABILITY CATEGORY 4	0.150000E+00	0.150000E+00	0.150000E+00	0.150000E+00	0.150000E+00	0.150000E+00
STABILITY CATEGORY 5	0.350000E+00	0.350000E+00	0.350000E+00	0.350000E+00	0.350000E+00	0.350000E+00
STABILITY CATEGORY 6	0.550000E+00	0.550000E+00	0.550000E+00	0.550000E+00	0.550000E+00	0.550000E+00

- SOURCE INPUT DATA -

C A R D	T A P E	SOURCE NUMBER	SOURCE TYPE	X COORDINATE (M)	Y COORDINATE (M)	EMISSION HEIGHT (M)	BASE / ELEV- / ATION / (M) /	- SOURCE DETAILS DEPENDING ON TYPE -
X		1	STACK	0.00	0.00	12.19	0.00	GAS EXIT TEMP (DEG K)= 561.00, GAS EXIT VEL. (M/SEC)= 48.88, STACK DIAMETER (M)= 0.440, HEIGHT OF ASSO. BLDG. (M)= -9.69, WIDTH OF ASSO. BLDG. (M)= 74.92, WAKE EFFECTS FLAG = 0

- DIRECTION SPECIFIC BUILDING DIMENSIONS -

SECTOR	DSBH	DSBW	IWAKE	SECTOR	DSBH	DSBW	IWAKE	SECTOR	DSBH	DSBW	IWAKE	SECTOR	DSBH	DSBW	IWAKE
1	9.7,	75.0,	0	2	9.7,	75.0,	0	3	9.7,	75.0,	0	4	9.7,	75.0,	0
5	9.7,	75.0,	0	6	9.7,	75.0,	0	7	9.7,	75.0,	0	8	9.7,	75.0,	0
9	9.7,	75.0,	0	10	9.7,	75.0,	0	11	9.7,	75.0,	0	12	9.7,	75.0,	0
13	9.7,	75.0,	0	14	9.7,	75.0,	0	15	9.7,	75.0,	0	16	9.7,	75.0,	0

- SOURCE STRENGTHS (GRAMS PER SEC) -

SEASON 1	SEASON 2	SEASON 3	SEASON 4
1.33000E+00			

WARNING - HW/HB > 5 FOR SOURCE 1 PROG. USES LATERAL VIRTUAL DIST. FOR UPPER BOUND OF CONCENTRATION (DEPOSITION) IN SECTOR(S):
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16.
IF LOWER BOUND IS DESIRED SET THE DIRECTION SPECIFIC BUILDING HEIGHT TO < 0 (WAKE EFFECTS FLAG) AND RERUN.

** ANNUAL GROUND LEVEL CONCENTRATION (MICROGRAMS PER CUBIC METER) DUE TO SOURCE 1 **

- GRID SYSTEM RECEPTORS -

- X AXIS (RANGE , METERS) -

Y AXIS (AZIMUTH BEARING, DEGREES)	100.000	200.000	300.000	400.000	500.000	750.000	1000.000	1250.000
	- CONCENTRATION -							
360.000	0.800801	0.676451	0.836270	0.900519	0.867198	0.686077	0.541318	0.440961
337.500	0.430682	0.376227	0.475118	0.508169	0.486105	0.381555	0.301998	0.246590
315.000	0.453821	0.398169	0.504720	0.541395	0.519717	0.411634	0.326698	0.267767
292.500	0.495269	0.448697	0.588390	0.638310	0.612396	0.482210	0.381757	0.312158
270.000	0.714086	0.634083	0.818446	0.891971	0.863029	0.689791	0.548111	0.447049
247.500	0.596274	0.549492	0.709701	0.755800	0.716114	0.555184	0.435261	0.351492
225.000	0.486514	0.437759	0.570900	0.621046	0.598793	0.478648	0.383931	0.315665
202.500	0.320811	0.307912	0.441201	0.520270	0.531725	0.461499	0.387141	0.328683
180.000	0.441654	0.434331	0.629032	0.743582	0.762877	0.670718	0.568243	0.485615
157.500	0.278209	0.273121	0.375437	0.412487	0.398864	0.322115	0.262425	0.218816
135.000	0.353700	0.318881	0.415732	0.444440	0.421222	0.328075	0.258071	0.207867
112.500	0.673407	0.550196	0.634218	0.643157	0.592976	0.442165	0.339365	0.272473
90.000	0.781865	0.625069	0.704860	0.715154	0.661676	0.499585	0.389942	0.317002
67.500	0.441258	0.376365	0.457522	0.481548	0.454894	0.353610	0.280774	0.230642
45.000	0.285114	0.247999	0.316869	0.357287	0.358750	0.303307	0.246667	0.202610
22.500	0.254585	0.230431	0.309083	0.340115	0.329446	0.262774	0.210780	0.173896

- DISCRETE RECEPTORS -

X RANGE (METERS)	Y AZIMUTH BEARING (DEGREES)	CONCENTRATION	X RANGE (METERS)	Y AZIMUTH BEARING (DEGREES)	CONCENTRATION	X RANGE (METERS)	Y AZIMUTH BEARING (DEGREES)	CONCENTRATION
317.0	10.0	0.603245	332.0	20.0	0.378632	357.0	30.0	0.330432
402.0	40.0	0.348728	366.0	50.0	0.371789	323.0	60.0	0.414926
296.0	70.0	0.474822	283.0	80.0	0.563963	277.0	90.0	0.682760
283.0	100.0	0.640426	253.0	110.0	0.591816	171.0	120.0	0.513051
134.0	130.0	0.425081	113.0	140.0	0.342912	98.0	150.0	0.285201
91.0	160.0	0.257863	88.0	170.0	0.309751	85.0	180.0	0.372952
88.0	190.0	0.325701	91.0	200.0	0.289873	101.0	210.0	0.367478
113.0	220.0	0.457890	137.0	230.0	0.520800	134.0	240.0	0.576149
122.0	250.0	0.633180	119.0	260.0	0.673606	116.0	270.0	0.736384
119.0	280.0	0.625333	122.0	290.0	0.532859	134.0	300.0	0.488554
149.0	310.0	0.459090	177.0	320.0	0.416589	229.0	330.0	0.375226
250.0	340.0	0.447635	259.0	350.0	0.601814	311.0	360.0	0.851240

** ANNUAL GROUND LEVEL CONCENTRATION (MICROGRAMS PER CUBIC METER) DUE TO SOURCE 1 (CONT.) **

- 10 CONTRIBUTING VALUES TO PROGRAM DETERMINED MAXIMUM 10 OF ALL SOURCES COMBINED -

X COORDINATE RANGE (METERS)	Y COORDINATE AZIMUTH BEARING (DEGREES)	CONCENTRATION
400.00	360.00	0.900519
400.00	270.00	0.891971
500.00	360.00	0.867198
500.00	270.00	0.863029
311.00	360.00	0.851240
300.00	360.00	0.836270
300.00	270.00	0.818446
100.00	360.00	0.800801
100.00	90.00	0.781865
500.00	180.00	0.762877

** END OF ISCLT PROGRAM,   1 SOURCES PROCESSED **

ISCLTK6L MODEL, A VERSION OF
ISCLT (VERSION 90008)
AN AIR QUALITY DISPERSION MODEL IN
SECTION 1. GUIDELINE MODELS.
IN UNAMAP (VERSION 6) JAN 1990.
SOURCE: FILE 7 ON UNAMAP MAGNETIC TAPE FROM NTIS.

CONVERTED BY :
KBN ENGINEERING AND APPLIED SCIENCES, INC.
GAINESVILLE, FLORIDA
(904)331-9000

CARD INPUT FILE IS ER18LT84.181
SUMMARY OUTPUT FILE IS ER18LT84.081
TITLE OF RUN IS 1984 ENRON STATION 18 / 40 FT STACK 10-29-90

- ISCLT INPUT DATA (CONT.) -

```
        NUMBER OF SOURCES =    1
        NUMBER OF X AXIS GRID SYSTEM POINTS =    8
        NUMBER OF Y AXIS GRID SYSTEM POINTS =   16
        NUMBER OF SPECIAL POINTS =   36
        NUMBER OF SEASONS =    1
        NUMBER OF WIND SPEED CLASSES =    6
        NUMBER OF STABILITY CLASSES =    6
        NUMBER OF WIND DIRECTION CLASSES =  16
        FILE NUMBER OF DATA FILE USED FOR REPORTS =    1
        THE PROGRAM IS RUN IN RURAL MODE
        CONCENTRATION (DEPOSITION) UNITS CONVERSION FACTOR =0.10000000E+07
        ACCELERATION OF GRAVITY (METERS/SEC**2) =  9.800
        HEIGHT OF MEASUREMENT OF WIND SPEED (METERS) =  10.100
        CORRECTION ANGLE FOR GRID SYSTEM VERSUS DIRECTION DATA NORTH (DEGREES) =   0.000
        DECAY COEFFICIENT =0.00000000E+00
        PROGRAM OPTION SWITCHES = 1, 2, 2, 0, 0, 3, 2, 1, 3, 2, 2, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 1, 1, 0,
0,
         RANGE X AXIS GRID SYSTEM POINTS (METERS )=     100.00,     200.00,     300.00,     400.00,     500.00,     750.00,
          1000.00,    1250.00,
         RANGE X SPECIAL DISCRETE POINTS (METERS )=     317.00,     332.00,     357.00,     402.00,     366.00,     323.00,
           296.00,     283.00,     277.00,     283.00,     253.00,     171.00,     134.00,     113.00,      98.00,      91.00,
            88.00,      85.00,      88.00,      91.00,     101.00,     113.00,     137.00,     134.00,     122.00,     119.00,
           116.00,     119.00,     122.00,     134.00,     149.00,     177.00,     229.00,     250.00,     259.00,     311.00,
    AZIMUTH BEARING Y AXIS GRID SYSTEM POINTS (DEGREES)=      22.50,      45.00,      67.50,      90.00,     112.50,     135.00,
           157.50,     180.00,     202.50,     225.00,     247.50,     270.00,     292.50,     315.00,     337.50,     360.00,
    AZIMUTH BEARING Y SPECIAL DISCRETE POINTS (DEGREES)=      10.00,      20.00,      30.00,      40.00,      50.00,      60.00,
            70.00,      80.00,      90.00,     100.00,     110.00,     120.00,     130.00,     140.00,     150.00,     160.00,
           170.00,     180.00,     190.00,     200.00,     210.00,     220.00,     230.00,     240.00,     250.00,     260.00,
           270.00,     280.00,     290.00,     300.00,     310.00,     320.00,     330.00,     340.00,     350.00,     360.00,
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- AMBIENT AIR TEMPERATURE (DEGREES KELVIN) -

	STABILITY CATEGORY 1	STABILITY CATEGORY 2	STABILITY CATEGORY 3	STABILITY CATEGORY 4	STABILITY CATEGORY 5	STABILITY CATEGORY 6
SEASON 1	300.0000	300.0000	300.0000	295.0000	290.0000	290.0000

- MIXING LAYER HEIGHT (METERS) -

```
                                                SEASON 1
                              WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED
                              CATEGORY 1  CATEGORY 2  CATEGORY 3  CATEGORY 4  CATEGORY 5  CATEGORY 6
STABILITY CATEGORY 10.215100E+040.215100E+040.215100E+040.215100E+040.215100E+040.215100E+04
STABILITY CATEGORY 20.143400E+040.143400E+040.143400E+040.143400E+040.143400E+040.143400E+04
STABILITY CATEGORY 30.143400E+040.143400E+040.143400E+040.143400E+040.143400E+040.143400E+04
STABILITY CATEGORY 40.143400E+040.143400E+040.143400E+040.143400E+040.143400E+040.143400E+04
STABILITY CATEGORY 50.100000E+050.100000E+050.100000E+050.100000E+050.100000E+050.100000E+05
STABILITY CATEGORY 60.100000E+050.100000E+050.100000E+050.100000E+050.100000E+050.100000E+05
```

- ISCLT INPUT DATA (CONT.) -

- FREQUENCY OF OCCURRENCE OF WIND SPEED, DIRECTION AND STABILITY -

SEASON 1

STABILITY CATEGORY 1

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.5000MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.00023500	0.00113800	0.00000000	0.00000000	0.00000000	0.00000000
22.500	0.00001100	0.00011400	0.00000000	0.00000000	0.00000000	0.00000000
45.000	0.00019100	0.00068300	0.00000000	0.00000000	0.00000000	0.00000000
67.500	0.00022400	0.00102500	0.00000000	0.00000000	0.00000000	0.00000000
90.000	0.00030500	0.00056900	0.00000000	0.00000000	0.00000000	0.00000000
112.500	0.00015800	0.00034200	0.00000000	0.00000000	0.00000000	0.00000000
135.000	0.00003300	0.00034200	0.00000000	0.00000000	0.00000000	0.00000000
157.500	0.00027200	0.00022800	0.00000000	0.00000000	0.00000000	0.00000000
180.000	0.00037000	0.00125200	0.00000000	0.00000000	0.00000000	0.00000000
202.500	0.00005500	0.00056900	0.00000000	0.00000000	0.00000000	0.00000000
225.000	0.00018000	0.00056900	0.00000000	0.00000000	0.00000000	0.00000000
247.500	0.00011000	0.00113800	0.00000000	0.00000000	0.00000000	0.00000000
270.000	0.00020200	0.00079700	0.00000000	0.00000000	0.00000000	0.00000000
292.500	0.00023500	0.00113800	0.00000000	0.00000000	0.00000000	0.00000000
315.000	0.00008800	0.00091100	0.00000000	0.00000000	0.00000000	0.00000000
337.500	0.00018000	0.00056900	0.00000000	0.00000000	0.00000000	0.00000000

SEASON 1

STABILITY CATEGORY 2

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.5000MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.00102600	0.00307401	0.00193501	0.00000000	0.00000000	0.00000000
22.500	0.00058300	0.00170801	0.00068300	0.00000000	0.00000000	0.00000000
45.000	0.00102600	0.00307401	0.00148000	0.00000000	0.00000000	0.00000000
67.500	0.00076400	0.00273201	0.00125200	0.00000000	0.00000000	0.00000000
90.000	0.00081100	0.00352901	0.00296001	0.00000000	0.00000000	0.00000000
112.500	0.00070400	0.00375701	0.00170801	0.00000000	0.00000000	0.00000000
135.000	0.00107900	0.00193501	0.00250501	0.00000000	0.00000000	0.00000000
157.500	0.00095800	0.00193501	0.00284601	0.00000000	0.00000000	0.00000000
180.000	0.00032900	0.00352901	0.00296001	0.00000000	0.00000000	0.00000000
202.500	0.00074400	0.00239101	0.00045500	0.00000000	0.00000000	0.00000000
225.000	0.00056300	0.00136600	0.00102500	0.00000000	0.00000000	0.00000000
247.500	0.00049000	0.00216301	0.00113800	0.00000000	0.00000000	0.00000000
270.000	0.00063000	0.00250501	0.00113800	0.00000000	0.00000000	0.00000000
292.500	0.00138700	0.00307401	0.00193501	0.00000000	0.00000000	0.00000000
315.000	0.00079100	0.00318801	0.00193501	0.00000000	0.00000000	0.00000000
337.500	0.00052300	0.00273201	0.00068300	0.00000000	0.00000000	0.00000000

- ISCLT INPUT DATA (CONT.) -

- FREQUENCY OF OCCURRENCE OF WIND SPEED, DIRECTION AND STABILITY -

SEASON 1

STABILITY CATEGORY 3

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.5000MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.00036100	0.00330101	0.00569202	0.00068300	0.00000000	0.00000000
22.500	0.00022200	0.00273201	0.00546402	0.00079700	0.00000000	0.00000000
45.000	0.00050100	0.00387101	0.00535102	0.00079700	0.00000000	0.00000000
67.500	0.00016400	0.00432601	0.00831102	0.00204901	0.00000000	0.00000000
90.000	0.00029900	0.00478101	0.01013203	0.00204901	0.00000000	0.00000000
112.500	0.00008600	0.00227701	0.00785502	0.00125200	0.00000000	0.00000000
135.000	0.00020900	0.00239101	0.00523702	0.00079700	0.00000000	0.00000000
157.500	0.00005200	0.00136600	0.00478101	0.00056900	0.00000000	0.00000000
180.000	0.00034400	0.00284601	0.00603402	0.00102500	0.00000000	0.00000000
202.500	0.00018700	0.00182101	0.00204901	0.00056900	0.00000000	0.00000000
225.000	0.00008200	0.00216301	0.00216301	0.00045500	0.00011400	0.00000000
247.500	0.00020000	0.00216301	0.00227701	0.00045500	0.00011400	0.00000000
270.000	0.00031000	0.00193501	0.00398501	0.00216301	0.00000000	0.00000000
292.500	0.00009900	0.00261801	0.00421201	0.00068300	0.00000000	0.00011400
315.000	0.00022200	0.00273201	0.00626102	0.00068300	0.00000000	0.00000000
337.500	0.00007800	0.00204901	0.00421201	0.00045500	0.00000000	0.00000000

SEASON 1

STABILITY CATEGORY 4

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.5000MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.00092700	0.00592002	0.01707705	0.01001803	0.00125200	0.00000000
22.500	0.00048400	0.00489501	0.00865203	0.00694402	0.00034200	0.00000000
45.000	0.00048400	0.00489501	0.00967703	0.00876603	0.00034200	0.00000000
67.500	0.00057700	0.00284601	0.01070103	0.01536905	0.00068300	0.00000000
90.000	0.00067400	0.00580602	0.01821505	0.01434404	0.00022800	0.00000000
112.500	0.00030800	0.00250501	0.01081503	0.00842403	0.00022800	0.00000000
135.000	0.00044700	0.00273201	0.00683102	0.00352901	0.00045500	0.00011400
157.500	0.00016000	0.00216301	0.00466801	0.00307401	0.00034200	0.00022800
180.000	0.00056500	0.00432601	0.01161203	0.00637502	0.00113800	0.00034200
202.500	0.00013500	0.00182101	0.00341501	0.00421201	0.00102500	0.00011400
225.000	0.00014300	0.00193501	0.00614802	0.00523702	0.00182101	0.00022800
247.500	0.00024000	0.00159400	0.00580602	0.00375701	0.00079700	0.00022800
270.000	0.00055200	0.00250501	0.00660302	0.01070103	0.00216301	0.00056900
292.500	0.00038800	0.00193501	0.00500902	0.00626102	0.00068300	0.00000000
315.000	0.00026500	0.00193501	0.00648902	0.00296001	0.00034200	0.00000000
337.500	0.00048000	0.00318801	0.00740002	0.00592002	0.00056900	0.00000000

- ISCLT INPUT DATA (CONT.) -

- FREQUENCY OF OCCURRENCE OF WIND SPEED, DIRECTION AND STABILITY -

SEASON 1

STABILITY CATEGORY 5

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.5000MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.00000000	0.01149803	0.00466801	0.00000000	0.00000000	0.00000000
22.500	0.00000000	0.01070103	0.00227701	0.00000000	0.00000000	0.00000000
45.000	0.00000000	0.01195404	0.00330101	0.00000000	0.00000000	0.00000000
67.500	0.00000000	0.01275004	0.00512302	0.00000000	0.00000000	0.00000000
90.000	0.00000000	0.01320604	0.00819702	0.00000000	0.00000000	0.00000000
112.500	0.00000000	0.00774102	0.00512302	0.00000000	0.00000000	0.00000000
135.000	0.00000000	0.00694402	0.00341501	0.00000000	0.00000000	0.00000000
157.500	0.00000000	0.00671702	0.00056900	0.00000000	0.00000000	0.00000000
180.000	0.00000000	0.01206704	0.00159400	0.00000000	0.00000000	0.00000000
202.500	0.00000000	0.00500902	0.00056900	0.00000000	0.00000000	0.00000000
225.000	0.00000000	0.00603402	0.00045500	0.00000000	0.00000000	0.00000000
247.500	0.00000000	0.00557802	0.00136600	0.00000000	0.00000000	0.00000000
270.000	0.00000000	0.00421201	0.00466801	0.00000000	0.00000000	0.00000000
292.500	0.00000000	0.00284601	0.00193501	0.00000000	0.00000000	0.00000000
315.000	0.00000000	0.00239101	0.00284601	0.00000000	0.00000000	0.00000000
337.500	0.00000000	0.00352901	0.00671702	0.00000000	0.00000000	0.00000000

SEASON 1

STABILITY CATEGORY 6

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.5000MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.01320504	0.02060606	0.00000000	0.00000000	0.00000000	0.00000000
22.500	0.01089603	0.01992306	0.00000000	0.00000000	0.00000000	0.00000000
45.000	0.00727002	0.01457204	0.00000000	0.00000000	0.00000000	0.00000000
67.500	0.00806702	0.01377504	0.00000000	0.00000000	0.00000000	0.00000000
90.000	0.00799902	0.01593805	0.00000000	0.00000000	0.00000000	0.00000000
112.500	0.00427601	0.00694402	0.00000000	0.00000000	0.00000000	0.00000000
135.000	0.00533302	0.00888003	0.00000000	0.00000000	0.00000000	0.00000000
157.500	0.00355401	0.00512302	0.00000000	0.00000000	0.00000000	0.00000000
180.000	0.00660702	0.00865203	0.00000000	0.00000000	0.00000000	0.00000000
202.500	0.00326101	0.00466801	0.00000000	0.00000000	0.00000000	0.00000000
225.000	0.00380101	0.00352901	0.00000000	0.00000000	0.00000000	0.00000000
247.500	0.00434701	0.00717202	0.00000000	0.00000000	0.00000000	0.00000000
270.000	0.00566102	0.00944903	0.00000000	0.00000000	0.00000000	0.00000000
292.500	0.00439601	0.00637502	0.00000000	0.00000000	0.00000000	0.00000000
315.000	0.00301101	0.00387101	0.00000000	0.00000000	0.00000000	0.00000000
337.500	0.00485501	0.00831102	0.00000000	0.00000000	0.00000000	0.00000000

- ISCLT INPUT DATA (CONT.) -

- VERTICAL POTENTIAL TEMPERATURE GRADIENT (DEGREES KELVIN/METER) -

	WIND SPEED CATEGORY 1	WIND SPEED CATEGORY 2	WIND SPEED CATEGORY 3	WIND SPEED CATEGORY 4	WIND SPEED CATEGORY 5	WIND SPEED CATEGORY 6
STABILITY CATEGORY 1	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
STABILITY CATEGORY 2	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
STABILITY CATEGORY 3	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
STABILITY CATEGORY 4	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
STABILITY CATEGORY 5	0.200000E-01	0.200000E-01	0.200000E-01	0.200000E-01	0.200000E-01	0.200000E-01
STABILITY CATEGORY 6	0.350000E-01	0.350000E-01	0.350000E-01	0.350000E-01	0.350000E-01	0.350000E-01

- WIND PROFILE POWER LAW EXPONENTS -

	WIND SPEED CATEGORY 1	WIND SPEED CATEGORY 2	WIND SPEED CATEGORY 3	WIND SPEED CATEGORY 4	WIND SPEED CATEGORY 5	WIND SPEED CATEGORY 6
STABILITY CATEGORY 1	0.700000E-01	0.700000E-01	0.700000E-01	0.700000E-01	0.700000E-01	0.700000E-01
STABILITY CATEGORY 2	0.700000E-01	0.700000E-01	0.700000E-01	0.700000E-01	0.700000E-01	0.700000E-01
STABILITY CATEGORY 3	0.100000E+00	0.100000E+00	0.100000E+00	0.100000E+00	0.100000E+00	0.100000E+00
STABILITY CATEGORY 4	0.150000E+00	0.150000E+00	0.150000E+00	0.150000E+00	0.150000E+00	0.150000E+00
STABILITY CATEGORY 5	0.350000E+00	0.350000E+00	0.350000E+00	0.350000E+00	0.350000E+00	0.350000E+00
STABILITY CATEGORY 6	0.550000E+00	0.550000E+00	0.550000E+00	0.550000E+00	0.550000E+00	0.550000E+00

- SOURCE INPUT DATA -

C A R D	T A P E	SOURCE NUMBER	SOURCE TYPE	X COORDINATE (M)	Y COORDINATE (M)	EMISSION HEIGHT (M)	BASE / ELEV- / ATION / (M) /	- SOURCE DETAILS DEPENDING ON TYPE -
X		1	STACK	0.00	0.00	12.19	0.00	GAS EXIT TEMP (DEG K)= 561.00, GAS EXIT VEL. (M/SEC)= 48.88, STACK DIAMETER (M)= 0.440, HEIGHT OF ASSO. BLDG. (M)= -9.69, WIDTH OF ASSO. BLDG. (M)= 74.92, WAKE EFFECTS FLAG = 0

- DIRECTION SPECIFIC BUILDING DIMENSIONS -

SECTOR	DSBH	DSBW	IWAKE	SECTOR	DSBH	DSBW	IWAKE	SECTOR	DSBH	DSBW	IWAKE	SECTOR	DSBH	DSBW	IWAKE
1	9.7,	75.0,	0	2	9.7,	75.0,	0	3	9.7,	75.0,	0	4	9.7,	75.0,	0
5	9.7,	75.0,	0	6	9.7,	75.0,	0	7	9.7,	75.0,	0	8	9.7,	75.0,	0
9	9.7,	75.0,	0	10	9.7,	75.0,	0	11	9.7,	75.0,	0	12	9.7,	75.0,	0
13	9.7,	75.0,	0	14	9.7,	75.0,	0	15	9.7,	75.0,	0	16	9.7,	75.0,	0

- SOURCE STRENGTHS (GRAMS PER SEC) -

SEASON 1	SEASON 2	SEASON 3	SEASON 4
1.33000E+00			

WARNING - HW/HB > 5 FOR SOURCE 1 PROG. USES LATERAL VIRTUAL DIST. FOR UPPER BOUND OF CONCENTRATION (DEPOSITION) IN SECTOR(S):
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16.
IF LOWER BOUND IS DESIRED SET THE DIRECTION SPECIFIC BUILDING HEIGHT TO < 0 (WAKE EFFECTS FLAG) AND RERUN.

** ANNUAL GROUND LEVEL CONCENTRATION (MICROGRAMS PER CUBIC METER) DUE TO SOURCE 1 **

- GRID SYSTEM RECEPTORS -

- X AXIS (RANGE , METERS) -

Y AXIS (AZIMUTH BEARING, DEGREES)	100.000	200.000	300.000	400.000	500.000	750.000	1000.000	1250.000
	- CONCENTRATION -							
360.000	0.555114	0.485193	0.617707	0.658492	0.625931	0.486231	0.386275	0.318323
337.500	0.341902	0.298540	0.378019	0.393915	0.367460	0.273378	0.210321	0.170092
315.000	0.346429	0.310278	0.401536	0.433397	0.418386	0.333207	0.266715	0.221042
292.500	0.406243	0.407726	0.585436	0.654172	0.633107	0.494311	0.385241	0.311154
270.000	0.653110	0.624407	0.860049	0.965636	0.948231	0.768115	0.616146	0.508146
247.500	0.604840	0.577261	0.776979	0.848854	0.811780	0.624741	0.487107	0.397536
225.000	0.387622	0.370730	0.521663	0.592267	0.585079	0.477941	0.389692	0.327545
202.500	0.268761	0.270708	0.394122	0.457264	0.458325	0.384766	0.321068	0.276523
180.000	0.516282	0.465401	0.627573	0.713231	0.713849	0.599237	0.492416	0.414234
157.500	0.270188	0.263866	0.380506	0.431200	0.423625	0.343968	0.278255	0.230927
135.000	0.317860	0.309841	0.432153	0.470884	0.449405	0.342487	0.259677	0.203598
112.500	0.411911	0.368810	0.477098	0.505490	0.475017	0.352613	0.263781	0.206374
90.000	0.619419	0.522121	0.617547	0.631785	0.583410	0.433241	0.332166	0.266852
67.500	0.314758	0.269181	0.334203	0.355174	0.338921	0.263160	0.206980	0.169701
45.000	0.367567	0.296365	0.350945	0.373792	0.359503	0.282148	0.221566	0.179737
22.500	0.255660	0.225913	0.293391	0.316472	0.301746	0.230825	0.179376	0.145495

- DISCRETE RECEPTORS -

X RANGE (METERS)	Y AZIMUTH BEARING (DEGREES)	CONCENTRATION	X RANGE (METERS)	Y AZIMUTH BEARING (DEGREES)	CONCENTRATION	X RANGE (METERS)	Y AZIMUTH BEARING (DEGREES)	CONCENTRATION
317.0	10.0	0.473932	332.0	20.0	0.338726	357.0	30.0	0.325367
402.0	40.0	0.356655	366.0	50.0	0.362417	323.0	60.0	0.341914
296.0	70.0	0.356844	283.0	80.0	0.464687	277.0	90.0	0.594718
283.0	100.0	0.522864	253.0	110.0	0.433756	171.0	120.0	0.370572
134.0	130.0	0.354230	113.0	140.0	0.316774	98.0	150.0	0.273058
91.0	160.0	0.260510	88.0	170.0	0.350631	85.0	180.0	0.451968
88.0	190.0	0.347537	91.0	200.0	0.255285	101.0	210.0	0.301237
113.0	220.0	0.371969	137.0	230.0	0.454911	134.0	240.0	0.558005
122.0	250.0	0.640820	119.0	260.0	0.652554	116.0	270.0	0.686789
119.0	280.0	0.563827	122.0	290.0	0.459182	134.0	300.0	0.407040
149.0	310.0	0.365104	177.0	320.0	0.324827	229.0	330.0	0.297779
250.0	340.0	0.351234	259.0	350.0	0.451383	311.0	360.0	0.628502

** ANNUAL GROUND LEVEL CONCENTRATION (MICROGRAMS PER CUBIC METER) DUE TO SOURCE 1 (CONT.) **

- 10 CONTRIBUTING VALUES TO PROGRAM DETERMINED MAXIMUM 10 OF ALL SOURCES COMBINED -

X COORDINATE RANGE (METERS)	Y COORDINATE AZIMUTH BEARING (DEGREES)	CONCENTRATION
400.00	270.00	0.965636
500.00	270.00	0.948231
300.00	270.00	0.860049
400.00	247.50	0.848854
500.00	247.50	0.811780
300.00	247.50	0.776979
750.00	270.00	0.768115
500.00	180.00	0.713849
400.00	180.00	0.713231
116.00	270.00	0.686789