NORTH CAROLINA
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
DIVISION OF AIR QUALITY

PREVENTION OF SIGNIFICANT DETERIORATION PRECONSTRUCTION REVIEW AND PRELIMINARY DETERMINATION

FOR

UNIT 2 BOILER
AT
PROGRESS ENERGY CAROLINAS, INC.
H. F. LEE STEAM ELECTRIC PLANT
GOLDSBORO, WAYNE COUNTY
NORTH CAROLINA

THIS REVIEW WAS PERFORMED BY THE
AIR PERMITS SECTION
IN ACCORDANCE WITH 15A NCAC 2D .0530 - NCDAQ REGULATION
FOR
PREVENTION OF SIGNIFICANT DETERIORATION OF AIR QUALITY

February 10, 2006

Mailing List

NEWSPAPER	Classified Ads Goldsboro News-Argus 310 North Berkeley Blvd. Goldsboro, NC 27534 (919) 778-3411 Fax: (919) 739-7779	Public Notice
OFFICIALS	Mr. Joseph R. Huffman City Manager 214 North Center Street City Hall Goldsboro, NC 27530 (919) 580-4330	Public Notice
	Mr. William "Lee" Smith, III County Manager 224 East Walnut Street P. O. Box 227 Goldsboro, NC 27533 (919) 731-1435	Public Notice
LIBRARY	Ms. Jane Rustin Director Wayne County Public Library 1001 Ash Street Goldsboro, NC 27530 (919) 735-1824 x 5108	Preliminary Determination & Application
SOURCE	Mr. Arun Kapur Senior Environmental Specialist Progress Energy, Inc. P. O. Box 1551 Raleigh, NC 27602 (919) 546-5888	Preliminary Determination & Public Notice
EPA	Mr. James Little Air Permits Section U.S. EPA Region 4 Sam Nunn Atlanta Federal Building 61 Forsyth Street, S.W. Atlanta, Georgia 30303-3104 (404) 562-9118	Preliminary Determination & Public Notice

	Preliminary Determination and Public Notice via electronic mail to: little.james@epa.gov with cc to: miller.scott@epa.gov worley.gregg@epa.gov	
FLM	Ms. Catherine Collins Environmental Engineer U.S. Fish and Wildlife Service Air Quality Branch 7333 W. Jefferson Ave., Suite 375 Lakewood, CO 80235-2034 (303) 914-3807	None
WASHINGTON REGIONAL OFFICE	Mr. Robert Fisher NCDAQ Air Quality Regional Supervisor 943 Washington Square Mall Washington, NC 27889	Preliminary Determination & Public Notice

TABLE OF CONTENTS

Fact Sheet

Applicant:

Progress Energy Carolinas, Inc.
H. F. Lee Steam Electric Plant
1677 Old Smithfield Road
Goldsboro, NC 27530
Contact: Arun Kapur
(919) 546-5888

Consultant:

URS Corporation
Morrisville, NC
Contact: Joe W. Sullivan, P.E.
(919) 461-1259

- Progress Energy Carolinas, Inc., Goldsboro, NC, submitted a Prevention of Significant Deterioration (PSD) application to the North Carolina Division of Air Quality (NCDAQ), on December 7, 2005.

- The application was deemed complete by NCDAQ for review purposes pursuant to 40 CFR 51.166 (q)(1) and 15A NCAC 2D .0530(o) on December 7, 2005.

- The facility is a PSD major stationary source. The facility emits or has the potential to emit 100 tons per year of particulate matter (PM), $PM_{10,}$ $PM_{2.5,}$ sulfur dioxide (SO_2), nitrogen oxides (NO_x), carbon monoxide (CO), and volatile organic compounds (VOC). It has been classified under the category of "fossil fuel-fired steam electric plants of more than 250 million Btu per hour heat input".

- The application includes a request to construct and operate a low-NOx burner system (LNB) on existing Unit 2 boiler. This project will create a beneficial effect through reduction in NOx emissions at a rate of approximately 569 tons/yr. However, it will also result into approximate increases in PM emissions (138 tons/yr), PM_{10} emissions (93 tons/yr), and carbon monoxide emissions (246 tons/yr). Each of these increases exceeds their respective PSD significance thresholds: 25 tons/yr for PM, 15 tons/yr for $PM_{10,}$ and 100 tons/yr for CO.

- The following "Best Available Control Technology" (BACT) emission limits and control techniques have been proposed by NC DAQ for the modified Unit 2 boiler:

EMISSION SOURCE	POLLUTANT	BACT EMISSION LIMITS	CONTROL TECHNOLOGY
Unit 2 Boiler	PM/PM10	0.1228 lb/million btu (filterable only) 0.14 lb/million btu (filterable and condensible both)	Good Combustion Control with (existing) ESP
Unit 2 Boiler	CO	0.15 lb/million btu	Good Combustion Control

SECTION 1.0
INTRODUCTION

Progress Energy Carolinas, Inc. (“Progress Energy”) has submitted to the North Carolina Division of Air Quality (NCDAQ) a Prevention of Significant Deterioration (PSD) permit application (9600017.05D) for the construction and operation of a new low-NOx burner system (LNB) on the existing Unit 2 boiler at H. F. Lee Steam Electric Plant.

Progress Energy facility is located in Goldsboro, Wayne County, NC. It operates under the current air permit 01812T27.

Permitted equipment at the facility are the following: three coal/No. 2 fuel oil/recycled No. 2 fuel oil fired electric utility boilers, four No. 2 fuel oil fired simple cycle turbines, four No. 2 fuel oil/natural gas fired simple cycle turbines, two fuel oil storage tanks, one natural gas fired heater, and numerous insignificant emission sources.

The facility is a PSD major stationary source, as per 40 CFR 51.166(b)(1)(i)(a), classified under the category of "fossil fuel-fired steam electric plants of more than 250 million Btu per hour heat input". The facility emits or has the potential to emit 100 tons per year of particulate matter (PM), $PM_{10,}$ $PM_{2.5,}$ sulfur dioxide (SO_2), nitrogen oxides (NO_x), carbon monoxide (CO), and volatile organic compounds (VOC).

The proposed project will create a beneficial effect in reduction in NOx emissions at a rate of approximately 569 tons/yr. However, it will also result into approximate increases in PM emissions (138 tons/yr), PM_{10} emissions (93 tons/yr), and carbon monoxide emissions (246 tons/yr). Each of these increases exceeds their respective PSD significance thresholds: 25 tons/yr for PM, 15 tons/yr for $PM_{10,}$ and 100 tons/yr for CO. Thus, it is subject to review and processing under the NCAC 2D .0530 "Prevention of Significant Deterioration". The facility must also comply with other specific NC DAQ air pollution regulations where applicable.

Pursuant to the Federal Register notice on February 23, 1982, North Carolina (NC) has full authority from the Environmental Protection Agency (EPA) to implement the PSD regulations in the State effective May 25, 1982. Accordingly, the NCDAQ will conduct a full PSD review and process the PSD permit application for the proposed project. NC's State Implementation Plan (SIP) - approved PSD regulations have been codified in 15A NCAC 2D .0530, which implement the requirements of 40 CFR 51.166.

In accordance with PSD requirements, Progress Energy has conducted a best available control technology (BACT) analysis, source impact analysis, additional impacts (soils, vegetation, visibility) analysis, and Class I area analysis.

The BACT analysis concluded the following emission limits and controls for the modified Unit 2 boiler:

EMISSION SOURCE	POLLUTANT	BACT EMISSION LIMITS	CONTROL TECHNOLOGY
Unit 2 Boiler	PM/PM10	0.1228 lb/million btu (filterable only) 0.14 lb/million btu (filterable and condensible both)	Good Combustion Control with (existing) ESP
Unit 2 Boiler	CO	0.15 lb/million btu	Good Combustion Control

The source impact and additional impact analysis, and Class I area evaluation concluded that the proposed project will not cause adverse air quality impacts in the surrounding community or the nearest Class I area; Swanquarter National Wilderness Area.

1.1 Preliminary Determination

Progress Energy's PSD application has been reviewed by the NCDAQ, Permits Section staff, to determine compliance with the requirements of all NCDAQ air pollution regulations. The review was performed for the following:

- PSD including determination of BACT with consideration of non-PSD regulated toxic pollutants, source impact analysis, additional impact analysis on soils, vegetation and visibility, and Class I analysis;

- Compliance with the North Carolina Air Quality Rules at 15A NCAC 2D and 2Q.

The NCDAQ, Permits Section staff has conducted a preconstruction review of the application and made a preliminary determination that the proposed project will comply will all applicable North Carolina air quality regulations including the PSD requirements. Therefore, the NCDAQ proposes to issue an air permit for the modification described in Section 1 above, with specific permit conditions and emission limits. Preliminary preconstruction approval under the PSD requirements was contingent upon the following findings:

- A demonstration that the BACT is applied to each emission unit that will contribute to increase in emissions of any pollutant above the significance threshold.

- A demonstration that National Ambient Air Quality Standards (NAAQS) and PSD Class II increments will not be violated as a result of emissions from the proposed project.

- A demonstration that emissions from the proposed project will neither cause adverse impacts to soils and vegetation nor cause degradation of visibility, and that economic growth associated with the project will not cause a significant increase in regional air pollutant levels.

- A demonstration that air emissions resulting from the proposed project will not adversely impact any PSD Class I area.

The remainder of this report contains a review by NCDAQ of the demonstration and analyses presented by Progress Energy. Sections 2 and 3 of this report present a general description of the proposed project and a description of the site location. Section 4 presents a regulatory analysis

of the North Carolina and Federal air quality regulations that apply to the project construction and operation. Section 5 contains the BACT analysis and Section 6 presents the results of the air quality analysis. The emission calculations for PSD applicability have been included in Appendix A while the NCDAQ draft air permit is contained in Appendix B.

In addition to the regulatory analysis, the application must undergo adequate public participation. The NCDAQ solicits and encourages participation by the general public, industry, and other affected persons impacted by the proposed project. Specific public notice requirements and a 30-day public comment period are required before the NCDAQ can take final action on this application. Appendix C contains a copy of the public notice.

SECTION 2.0
GENERAL DESCRIPTION

2.1 Process Description

2.1.1 Existing Operations

Progress Energy operates an electric power production facility at its H. F. Lee Steam Electric Plant. The facility has been classified under the Standard Industrial Classification (SIC) 4911 "Electric Services". It operates as a peak electric power generation plant. The peaking season is January/February and July/August. As indicated in Section 1 above, the existing operations at the facility comprise of three coal/No. 2 fuel oil/recycled No. 2 fuel oil fired electric utility boilers, four No. 2 fuel oil fired simple cycle combustion turbines, four No. 2 fuel oil/natural gas fired simple cycle combustion turbines, two fuel oil storage tanks, one natural gas fired heater, and numerous insignificant emission sources.

In brief, Unit 2 boiler has been permitted to fire coal/No. 2 fuel oil/recycled No. 2 fuel oil. The nominal heat input rate for the boiler is 1,062 million btu/hr. Particulate emissions from this boiler are currently being controlled by a hot-side electrostatic precipitator.

2.1.2 Proposed Modifications

As included in Section 1, Progress Energy is proposing to construct and operate an LNB system on Unit 2 boiler (ID No. Unit 2 Boiler). It will help the company to meet the Clean Smokestacks Act requirements for system-wide NOx emissions (i.e., collective emissions of NOx from all coal-fired boilers owned or operated by Progress Energy in NC) reduction beginning 2007.

In general, NOx is formed during combustion by oxidation of fuel-bound and atmospheric nitrogen at high temperatures. The LNB system will reduce the rate of NOx formation by staging the mixing of fuel and air, and reducing maximum flame temperatures. Emissions of carbon monoxide (CO)

are expected to increase due to partial combustion of small fraction of carbon at the lower flame temperatures. In addition, the LNB will result into an increase in amount of residual unburned carbon fly ash referred to as loss of ignition (LOI), and hence, the emissions of particulate matter (PM or TSP) and PM_{10} are expected to increase.

2.2 Emissions

Emissions from Progress Energy facility include PM, $PM_{10,}$ $PM_{2.5,}$ SO_2, NO_x, CO, and VOC. Detailed emission summary for actual emissions and increase in emissions due to proposed project are included in Section 4.

SECTION 3.0
REGIONAL DESCRIPTION

3.1 Area Classification

The facility is located in Wayne County. The approximate UTM coordinates of the facility are Zone 17, 764.5 km East and 3918.88 km North at an elevation of approximately 80 feet above mean sea level. The site is bordered by Quaker Neck Lake and the Neuse River. The terrain surrounding the site increases in elevation as much as 70 feet within a kilometer of the plant site.

Air Quality in Wayne County is classified with respect to the NAAQS as listed below:

Pollutant	**Attainment Status**
PM_{10}	Attainment
$PM_{2.5}$	Attainment
Sulfur Dioxide	Attainment
Nitrogen Dioxide	Attainment
Carbon Monoxide	Attainment
Ozone	Attainment

Wayne County is considered a Class II Area with ambient air increments for PM_{10}, SO_2, and NO_x.

The closest Class I Area from this facility is Swanquarter National Wilderness Area, which is located approximately 160 kilometers east of the facility.

SECTION 4.0
REGULATORY ANALYSIS

The following discussion pertains to the regulatory requirements that must be met for the proposed modification of the Progress Energy facility. These requirements include both PSD regulations and other State air quality regulations.

4.1 PSD Applicability and Required Analysis

The basic goal of the PSD regulations is to ensure that the air quality in clean (i.e. attainment) areas does not significantly deteriorate while maintaining a margin for future industrial growth. The PSD regulations focus on industrial facilities, both new and modified, that create large increases in the emission of certain pollutants.

US Environmental Protection Agency (EPA)'s latest revisions governing the PSD regulation are included in the Federal Register (67 FR 80186, December 31, 2002 and 68 FR 63021, November 7, 2 003)[1]. As indicated above in Section 1, effective May 25, 1982, the NCDAQ received full authority from the EPA to implement PSD regulations in the State.

Under PSD requirements, all major new or modified stationary sources of air pollutants as defined in Section 169 of the Federal Clean Air Act (CAA) must be reviewed and permitted prior to construction by EPA or permitting authority, as applicable, in accordance with Section 165 of CAA. A "major stationary source" is defined as any one of 28 named source categories, which emits or has a potential to emit (PTE) 100 tons per year of any regulated pollutant, or any other stationary source, which emits or has the potential to emit 250 tons per year of any PSD regulated pollutant.

The Progress Energy facility is an existing PSD major stationary source. It emits or has the potential to emit 100 tons per year of PM, $PM_{10,}$ $PM_{2.5,}$ SO_2, NO_x, CO, and VOC. It has been

[1] The PSD regulation revisions in 40 CFR 51.166 as included in 15A NCAC 2D .0530, are currently not applicable in North Carolina.

classified under the category of "fossil fuel-fired steam electric plants of more than 250 million Btu per hour heat input".

Because the existing facility is considered a major stationary source, modification to an existing major source which results into emission increases for regulated pollutants in the amounts equal or greater than the significance levels, is subject to PSD review and must meet certain review requirements. Thus, the emission increases as a result of this modification must be compared to the "significance levels" as listed in 40 CFR 51.166(b)(23)(i) to determine which pollutants must undergo PSD review.

The company has performed the PSD applicability analysis using the following two steps:

Step 1 Determine whether the project results into an hourly emission increase for any NSPS regulated pollutant.

The Permittee has used the last five years' PM actual emissions data and utilization data for Unit 2 boiler, as reported to DAQ through annual emission inventories, to determine the baseline emission factor for this boiler. The baseline emission factor has been derived as the highest value from the last five years' (2000-2004) PM emission factors. It is then compared with the future emission factor (established as BACT emission limit) to calculate the change in emission factor. The change is then multiplied with maximum heat input of boiler to arrive at an hourly PM emission increase of approximately 64 lbs. Hence, it has been concluded that PSD applicability review must be performed for this modification.

Step 2 Determine whether project results into emission increase of any PSD regulated pollutant above the respective significance thresholds.

Using the WEPCO rule (57 FR 32314, July 21, 1992), the Permittee has performed calculations for actual (pre change) and future actual (after change) emissions for all PSD regulated pollutants. The actual emissions have been estimated using the selected baseline period (2002-

2003)'s emissions and utilization data. Then, the future actual emissions have been estimated using the projected future utilization and operating data for the boiler. From the initial estimate of future actual annual emissions, the Permittee has deducted those emissions which could have been accommodated during the baseline period and which are unrelated to the project. The example of such emission deductions can be increase in utilization of the boiler due to demand growth. In brief, the company has used the provisions of 40 CFR 51.166(b)(21) "Actual Emissions" and (b)(32) "Representative Actual Annual Emissions" to perform the PSD major modification applicability analysis.

Table 4-1 Emission Increases for the Proposed Project

Compounds	PSD Significant Net Emissions Increase Tons Per Year	Net Emissions Increase/Decrease Tons Per Year	PSD Major Modification Review Required?
PM	25	138	**Yes**
PM_{10}	15	93	**Yes**
SO_2	40	0	No
NOx	40	-569	No
CO	100	246	**Yes**
VOC (ozone)	40	0	No
Lead	0.6	0	No
Sulfuric Acid Mist	7	0	No

Using this procedure and as shown in Table 4-1 above, the following can be concluded:

- The change in emissions due to the project for PM, PM_{10}, and CO will exceed their respective significance thresholds, and hence, PSD major modification review is required for these pollutants.

- NOx emissions will be reduced due to the project, and

- For all other remaining pollutants - VOC, lead, SO_2, and sulfuric acid mist; the change in emissions will be zero.

Thus, Progress Energy performed the following reviews and analysis related to PSD for the emissions of PM, $PM_{10,}$ and CO, for modified Unit 2 boiler:

- BACT determination[2]
- source impact analysis
- air quality impact analysis
- additional impacts analysis including effects on soils, vegetation, and visibility.
- Class I analysis.

Under PSD regulations, the determination of the necessary emission control equipment is developed through a BACT review. BACT is defined, in pertinent part, at 40 CFR 51.166 (b)(12) as:

> *An emissions limitation... based on the maximum degree of reduction for each pollutant... which would be emitted from any proposed major stationary source or major modification which the reviewing authority, on a case-by-case basis, taking into account energy, environment, and economic impacts and other costs, determines is achievable... for control of such a pollutant.*

The BACT requirements are intended to ensure that the control systems incorporated in the design of the proposed facility reflect the latest control technologies used in a particular industry and take into consideration existing and future air quality in the vicinity of the facility. Additionally, the BACT analysis must consider the impacts of noncriteria pollutants and unregulated toxic air pollutants, if any are emitted, when making the BACT decision for regulated pollutants. Under the BACT requirements of the PSD regulations, all BACT emission limits must, at a minimum, comply with any applicable standard of performance under 40 CFR

[2] Required for each affected new or modified emission unit at which emission increase of any regulated air pollutant equal or exceed its significance threshold.

Part 60 (New Source Performance Standards) and Part 61 (National Emission Standards for Hazardous Air Pollutants), and the North Carolina State Implementation Plan (SIP). A discussion of the BACT determination can be found in Section 5 of this document.

Finally, the future actual annual emissions projections for year 2006 to 2010 for SO_2 and sulfuric acid mist are larger than their respective significance thresholds when emissions unrelated to the project are counted. Therefore, the Permittee must report actual emissions for these two pollutants for five years after the modified boiler resumes operation as per 40 CFR 51.166(b)(21)(v), in order to verify that the project does not increase the representative actual annual emissions. Because the emission factors for SO_2 and sulfuric acid mist are not expected to change due to the project, the DAQ will require reporting of actual annual utilization data as a method of tracking post-change emissions for these pollutants (See 57 FR 32325, July 21, 1992). For VOC and lead, the maximum emissions for the time period (2006-2010) after the modification do not exceed the significance thresholds for VOC and lead, hence there is no possibility that there will be an increase above the representative annual emissions for these pollutants after installation of LNB. Hence, reporting of actual emissions for five years for VOC and lead is not required.

The emission calculations for PSD applicability can be found in Appendix A.

4.2 NCDAQ Air Pollution Regulations

In addition to the PSD requirements, the NCDAQ has promulgated air quality rules under Title 15A NCAC Subchapter 2D and 2Q.

The NCDAQ emission control regulations that affect the proposed modification are summarized below:

Regulation	Affected Sources	Comment
2Q .0101	Modified Unit 2 Boiler	A permit is required for all sources of air emissions not specifically exempted.
2D .0503	Same as Above	Particulate emissions cannot exceed 0.1228 lb/million Btu.
2D .0516	Same as Above	SO_2 emissions cannot exceed 2.3 lb/million Btu.

2D .0519	Same as Above	NOx emissions cannot exceed 1.8 lb/million Btu (when burning coal) and 0.8 lb/million Btu (when burning oil).
2D .0521	Same as Above	Visible emissions cannot exceed 40 percent opacity.
2D .0530	Same as Above	PSD review is required for a major modification.
2D .0535	Same as Above	Emissions in excess of established permit limits that last for more than 4 hours require notification to the Director within 24 hours.
2D .0536	Same as Above	Particulate emissions cannot exceed 0.13 lb/million Btu. (state-enforceable only) Average annual opacity cannot exceed 11 percent. (state-enforceable only)
2D .0606	Same as Above	Quarterly excess emissions reports are to be used as an indication of good operations and maintenance practices of ESP.
2D .0614	Same as Above	CAM submittal is required for any large pollutant specific emission unit.
2D .1100	Same as Above	Ammonia emissions (combined total of Unit 1 and Unit 2 boilers) cannot exceed 24 lbs/hr. Formaldehyde emissions (combined total of Unit 1 and Unit 2 boilers) cannot exceed 14.4 lbs/hr.
2D .1416	Same as Above	NOx emissions cannot exceed 150 tons/ozone season. System-wide emissions of NOx (collective NOx emissions from all coal fired boilers and combustion turbines owned or operated in NC by the company and not listed in 2D .1417) cannot exceed 11,320 tons/ozone season.
2Q .0402	Same as Above	Current permit includes SO_2 allocations for different years and NOx emission limit of 0.65 lb/million Btu. These limits cannot be exceeded.

4.2.1 15A NCAC 2Q .0101 - Required Air Quality Permits

This regulation requires the owner or operator of all sources for which there is an ambient air quality or emission control standard, that is not exempted from permit requirements, to apply for an air quality permit The owner or operator of a source required to have a permit shall not begin construction or operation of the source without first obtaining a permit. The Unit 2 boiler is a permitted source and its proposed modification is not exempt from permitting. Thus, Progress Energy is required to file an air permit application and obtain a revised permit prior to any construction or change in method of operation of the source. Progress Energy has submitted the

required application and information sufficient to obtain an air quality permit, including all information required pursuant to 15A NCAC 2D .0530 "Prevention of Significant Deterioration".

4.2.2 15A NCAC 2D .0503 - Particulates from Fuel Burning Indirect Heat Exchangers

This regulation establishes PM emission standard for all indirect heat exchangers except for electric utility boilers. The PM emissions from electric utility boilers are subject to the requirements of 15A NCAC 2D .0536. However, the PM emission limits established for electric utility boilers at the Progress Energy facility have specifically been not approved by the EPA. Hence, the Unit 2 boiler is subject to this applicable requirement.

The current permit includes an emission limit of 0.1228 lb/million Btu. The modified Unit 2 boiler will continue to be subject to this limit. Based on 2004 emission inventory information on heat input rate (2,904,480 million Btu/yr) and PM emissions (115 tons/yr), it can be concluded that the PM emission rate is 0.079 lb/million Btu, which is less than the above emission limit. Hence, compliance with this applicable requirement is expected.

4.2.3 15A NCAC 2D .0516 - Sulfur Dioxide Emissions from Combustion Sources

This regulation establishes emission standard of 2.3 lb/million Btu for SO_2 emissions. The current permit includes this standard. The modified Unit 2 boiler will continue to be subject to it.

Based on 2004 emission inventory information on heat input rate (2,904,480 million Btu/yr) and SO_2 emissions (2,100 tons/yr), it can be concluded that the SO_2 rate is 1.45 lb/million Btu, which is less than the above emission standard. Hence, compliance with this applicable requirement is expected.

4.2.4 15A NCAC 2D .0521 - Control of Visible Emissions

The intent of this Rule is to prevent, abate and control emissions generated from fuel burning operations and industrial processes where an emission can be reasonably expected to occur, except during startup, shutdowns, and malfunctions approved as such according to procedures approved under 15A NCAC 2D .0535.

For sources manufactured as of July 1, 1971, visible emissions shall not be more than 40 percent opacity when averaged over a six-minute period. For sources required to install, operate, and maintain continuous opacity monitoring systems (COMS), compliance with the 40 percent opacity limit shall be determined as follows:

i. No more than four six-minute periods shall exceed the opacity standard in any one day; and

ii. The percent of excess emissions (defined as the percentage of monitored operating time in a calendar quarter above the opacity limit) shall not exceed 0.8 percent of the total operating hours. If a source operates less than 500 hours during a calendar quarter, the percent of excess emissions shall be calculated by including hours operated immediately previous to this quarter until 500 operational hours are obtained.

Excess emissions during startup and shutdown shall be excluded from the determinations in paragraphs i. and ii. above, if the excess emissions are exempted according to the procedures set out in 2D .0535(g). Excess emissions during malfunctions shall be excluded from the determinations in paragraphs i. and ii. above, if the excess emissions are exempted according to the procedures set out in 2D .0535(c).

All periods of excess emissions shall be included in the determinations in paragraphs i. and ii. above until such time that the excess emissions are exempted according to the procedures in 2D .0535.

The modified Unit 2 boiler will continue to be subject to the above standard.

4.2.5 15A NCAC 2D .0530 - Prevention of Significant Deterioration

Facilities classified as major for PSD and applying for a significant modification are subject to all the requirements as defined in 40 CFR 51.166. These requirements include:

- A demonstration that the BACT is applied to each emission unit that will emit any PSD regulated pollutant above the significant threshold, including a demonstration that emissions of air toxics will not exceed the acceptable ambient levels (AAL's) as regulated by the NCDAQ.

- A demonstration that neither allowable PSD ambient air increments nor NAAQS will be violated as a result of emissions from the proposed project.

- A demonstration that emissions from the proposed project will neither cause adverse impacts to soils and vegetation nor cause degradation of visibility, and that economic growth associated with the project will not cause a significant increase in regional air pollutant levels.

- A demonstration that air emissions resulting from the proposed facility will not adversely impact any PSD Class I area.

For additional details on PSD regulatory analysis, please refer to Section 4.1 above.

4.2.6 15A NCAC 2D .0535 - Excess Emissions Reporting and Malfunctions

This regulation applies to all permitted facilities and outlines the procedures of reporting excess emissions as a result of malfunctions or operational upsets. The facility owner/operator must notify the appropriate regional office of any excess emissions that last for greater than four hours. This report must be made within 24 hours of becoming aware of the occurrence.

4.2.7 15A NCAC 2D .0536 - Particulate Emissions from Electric Utility Boilers

The purpose of this regulation is to establish particulate and visible emission standards for electric utility boilers. The visible emissions standards for all electric utility boilers in NC have been disapproved by EPA and hence, they are state-enforceable only. The modified Unit 2 boiler will continue to be subject to 11 percent average annual opacity. In addition, the particulate emissions of electric utility boilers located at the Progress Energy facility, including for Unit 2 boiler, have been disapproved by EPA and hence, the PM emission limit of 0.13 lb/million Btu for this boiler is state-enforceable only.

4.2.8 15A NCAC 2D .0614 - Compliance Assurance Monitoring

This regulation implements the requirements of 40 CFR 64 "Compliance Assurance Monitoring". The requirements of this regulation are applicable to any pollutant-specific emission unit (PSEU), if the following three conditions are satisfied:

- the unit is subject to any non-exempt emission limitation or standard for the applicable regulated pollutant.

- the unit uses any control device to achieve compliance with any such emission limitation or standard.

- unit's precontrol potential emission rate exceeds either 100 tons/yr (for criteria pollutants) or 10/25 tons/yr (for HAP(s)).

Also per Section 64.5, the Permittee must analyze whether any proposed emission unit undergoing a "significant permit revision", be deemed as a large PSEU and therefore a CAM plan needs to be submitted. Large PSEUs are those emission units, which have after control PTE equal to or greater than either 100 tons (for criteria pollutants) or 10/25 tons (for HAPs).

The modified Unit 2 boiler is a large PSEU for PM and NOx, and emissions for these pollutants are subject to the requirements of 15A NCAC 2D .0503 and .0519, respectively. It will be equipped with control devices for PM (ESP) and NOx. The ESP can be classified as active control device but not LNB under Part 64 of 40 CFR. This application is being processed using the "first-step" of 15A NCAC 2Q .0501(c)(2) - using the 15A NCAC 2Q .0300 procedures. Hence, at this time, CAM plan is not required for ESP on Unit 2 boiler.

4.2.9 15A NCAC 2D .1100 - Control of Toxic Air Pollutants

Pursuant to the State Air Toxic program, any source that emit air toxics in quantities greater than the de minimis levels (listed in 15A NCAC 2Q .0711) must demonstrate compliance with the ambient concentrations listed in 15A NCAC 2D .1104(a). For a modification, only those toxic air pollutants emitted with a net increase need to be assessed for compliance.

The current permit includes modeled ammonia and formaldehyde emission rates (combined total of Unit 1 Unit 2 boilers) of 24 lbs/hr and 14.4 lbs/hr, respectively to assure compliance with 15A NCAC 2Q .1100 which is a State-enforceable only requirement. These emission rates were modeled due to burning of wood waste (adulterated fuel). The DAQ has removed the capability of firing this fuel from the permit and hence, these emission rates are not applicable now.

In brief, the modified Unit 2 boiler will be using only unadulterated fossil fuels (coal and No. 2/recycled No.2 fuel oil). Hence, any increase in emissions of ammonia or formaldehyde are not subject to air toxics review under the NCAC 2Q .0702(a)(18).

4.2.10 15A NCAC 2D .1416 - Emission Allocations for Utility Companies

This regulation is NC's NOx SIP-Call requirement. NOx emissions from Unit 2 boiler cannot exceed 150 tons per ozone season for 2006 and later. System-wide emissions of NOx (collective NOx emissions from all coal fired boilers and combustion turbines owned or operated in NC by the company and not listed in 2D .1417) also cannot exceed 11,320 tons per ozone season for 2006 and later. The modified Unit 2 boiler will continue to comply with the above NOx allocations.

4.2.11 15A NCAC 2Q .0402 - Acid Rain Permitting Procedures

Unit 2 boiler is subject to Acid Rain program requirements under the CAA. The current permit includes SO_2 allocations for different years and NOx emission limit of 0.65 lb/million Btu for the boiler. The modification to Unit 2 boiler will not change this requirement.

SECTION 5.0
BEST AVAILABLE CONTROL TECHNOLOGY ANALYSIS

5.1 Introduction

Each pollutant subject to a PSD review must meet the criteria of BACT, which refers to the maximum amount of emission reduction currently possible with respect to technical application and economic, energy, and environmental considerations. Given the variation between emission sources, facility configuration, local airsheds, and other case-by case considerations, Congress determined that it was impossible to establish a single BACT determination for a particular pollutant or source. Economics, energy, and environmental impact are mandated in the CAA to be considered in the determination of case-by-case BACT for specific emission sources. In most instances, BACT may be defined through an emission limitation. In cases where this is impossible, BACT can be defined by the use of a particular type of control device and its achievable emission reduction efficiency. In no event can a technology be recommended which would not comply with any applicable standard of performance under 40 CFR Part 60 and 61.

Additionally, as a result of the EPA remand involving the North County Resource Recovery project in Region IX, the effects of non-regulated PSD pollutants, such as toxic air pollutants, are to be accounted for in determining if the BACT otherwise being prescribed for a regulated pollutant still represents an appropriate level and type of control. There is no specific formula for making PSD decisions for unregulated pollutants; this is a case-by-case process involving the judgment of the reviewing authority. If the reviewing authority judges the potential environmental effects of such unregulated pollutants to be of possible concern to the public, then the final BACT decision for a regulated pollutant should address these efforts and reflect, as appropriate, the control technology beyond what might otherwise be chosen as BACT.

To assist in bringing consistency to the BACT process, the EPA has issued guidance encouraging all PSD applicants to use the "top-down" approach to BACT. In this case, the applicant's BACT analysis is consistent with the EPA based "top-down" approach. However,

NC DAQ does not strictly adhere to EPA's top-down guidance. Rather DAQ implements BACT in strict accordance with the statutory and regulatory language. As such, DAQ's BACT conclusions may differ from those of the applicant or EPA.

In general, the top-down approach consists of five basic steps. These are:

1) Identify all control technologies,
2) Eliminate technically infeasible options,
3) Rank remaining control technologies by control efficiencies,
4) Evaluate the most effective controls and document results, and
5) Select BACT

The first step in this approach is a comprehensive listing of control technologies for each applicable pollutant. Step two is a demonstration of technical feasibility to ensure the technology evaluated was appropriate for the characteristic gas stream to be treated. Step three ranks the remaining control technologies by control effectiveness, including the control efficiencies (percent of pollutant removed), expected emission rate (tons per year), expected emission reduction (tons per year), economic impacts (total cost effectiveness, incremental cost effectiveness), environmental impacts (including emissions of toxic or hazardous air contaminants), and energy impacts (benefits or disadvantages). Step four is a case-by-case evaluation of energy, environmental, and economic impacts. Step five requires the selection of the most effective option not rejected as BACT for the emission source.

The PSD regulated pollutants, which are emitted above their respective significance thresholds for the project - the modified Unit 2 boiler, are PM, PM_{10}, and CO. Hence, the BACT analysis will focus on applicable control techniques for these pollutants only.

5.2 Previous BACT/LAER Determinations

DAQ searched the RACT/BACT/LAER Clearinghouse for the time period from 2001 to present, to identify current BACT/LAER determinations for PM/PM_{10} and CO emissions for evaluating

BACT for the modified Unit 2 boiler at the Progress Energy facility. In this database, currently, there are a total of 13 BACT determinations for PM and 15 determinations for CO, for coal-fired electric utility boilers larger than 250 million Btu/hr.

For PM, most of the determinations (a total of 11) were for projects comprising new coal-fired boilers. Only 1-2 determinations were for projects involving modification to the existing boilers. Out of 13 projects, 2 projects were approved with good combustion control as BACT with emission limits of 0.085 lb/million Btu and 0.15 lb/million Btu, respectively. The remaining 11 projects had either fabric filter (majority) or ESP (minority) as approved BACT with emission limits ranging between 0.01-0.03 lb/million btu. Only two projects provided cost effectiveness for fabric filter of $6/ton PM and $252/ton PM removed, and no cost effectiveness information was available for ESP.

For CO, from a total of 15 projects, 13 projects were for new coal fired boilers, 2 projects were for modified boilers, and the remaining 2 projects were for installation of LNB and/or over-fire air (OFA) on existing boilers. 13 projects were approved with good combustion control as BACT with emission limits of 0.1-0.44 lb/million Btu. The remaining two projects involving LNB and/or OFA were also approved with good combustion control as BACT with emission limits of 0.42 lb/million Btu (project for LNB and OFA) and 1.26 lb/million Btu (project for OFA only), respectively. The BACT determination (0.42 lb/million Btu) for the project involving LNB and OFA closely match the modification involved at the Unit 2 boiler at this facility. It should be noted that these projects (LNB and/or OFA) triggered only CO and not PM for requirement of BACT as per the database.

The RBLC printouts for these 15 BACT determinations have been included in Appendix D.

5.3 BACT Analysis for CO

The Pemittee has indicated that the only technically feasible method for reducing CO emissions from this boiler is optimization of burner performance to maximize complete fuel combustion.

This technique is generally known as good combustion practice. The Permittee adds that add-on control techniques such as afterburners are widely regarded as impracticable for this type of source category. Finally, the Permittee contends that Progress Energy has self-interest in optimization of burner performance, because it will not only reduce NOx emissions but also will reduce fuel costs associated with excessive LOI.

The vendor of the LNB system has provided a guarantee of CO concentration of 200 ppm at 3% O_2. Using the baseline flow rate of 410,000 acfm, the above concentration can be converted to a mass emission rate of 156.5 lbs/hr or approximately 0.15 lb/million Btu using the maximum heat input rate of 1,062 million Btu/hr.

Based on the above, summarized, recent BACT determinations for CO emissions from a similar coal-fired boiler modified with LNB, it can be concluded that good combustion control does represent BACT for this modified boiler. Hence, DAQ will approve good combustion control as BACT with an emission limit of 0.15 lb/million Btu for Unit 2 boiler.

5.4 BACT Analysis for PM/PM-10

The Permittee has considered three control options for PM/PM_{10} emissions based on maximum degree of reduction achievable. These options are: (i) installation of a bag house downstream of the existing ESP, (ii) addition of one electric field in the existing ESP, and (iii) good combustion control.

Fabric Filter

Fabric filtration has been widely applied on coal combustion sources since 1970. It consists of a number of filtering elements (bags) along with a bag cleaning system. Fabric filters use bags as filters to remove particulate emissions. The particulate laden gas enters the fabric filter compartment and passes through a layer of particulate and filter bags. The collected particulates enhance the bag's filtering efficiency. But excessive cake can also increase the pressure drop across the fabric filter and thus increase the cost of operation.

The particulate removal efficiency of fabric filters depends upon particle size distribution, particle cohesion characteristics, air-to-cloth ratio, operating pressure loss, cleaning sequence, interval between cleanings, cleaning method, and cleaning intensity, and fabric characteristics.

Fabric filters have excellent removal efficiency for dry particles even for smaller than micron size particles. Collection efficiencies of fabric filters can be as high as 99.9 percent. Fabric filters are considered the most effective control device among particulate matter control devices for removal of filterable PM but they are not effective in controlling condensible PM emissions. Hence, it can be assumed that condensible PM will pass through the fabric filter.

Cost

The cost of controlling PM/PM_{10} with the fabric filter was based on a conservatively assumed removal efficiency of 99.886% (Note that baseline PM removal efficiency of the existing ESP is 99.24%). This removal efficiency accounts for remaining filterable particulates at 100% removal rate and assuming no removal for condensible particulates. At the Progress Energy facility, condensible particulates from the coal-fired boilers have been measured at approximately 15% of the total PM flue gas stream.

The baseline emission rate for PM (emission rate from the existing ESP) is approximately 265.3 tons/yr. However, the Unit 2 boiler is projected to emit PM at a rate of 312.7 tons/yr (or 0.067 lb/million btu) in 2006 after the modification. Hence, the emission rate after installation of fabric filter would be approximately 46.9 tons/yr (or 0.01 lb/million btu). This represents a reduction of approximately 265.8 tons/yr of PM/PM_{10}.

The total capital investment of the control system was estimated to be $6,606,960. Total annualized cost was estimated to be $2,136,790. These costs are significantly higher than the cost associated with the option for additional electric field in the existing ESP (see below) due to higher equipment and installation costs.

The cost effectiveness for this technology will be approximately $8,040 per ton of PM/$PM_{10}$ removed.

Environmental Impacts

The Clean Air Act requires the permitting authority to consider environmental impacts when making a BACT determination. *See* 42 U.S.C. 7479(3). The EPA issued guidance on BACT determinations including the appropriate use of the statutory BACT factors. The use of a bag house will result in further reduction in PM emissions and therefore, there will be more mass of waste dust (ash) to be disposed of. Provided the bag house is properly sized and properly maintained, the resulting environmental impact from the bag house will not be significant.

Energy Impacts

The Clean Air Act requires the permitting authority to consider energy impacts when making a BACT determination. *See* 42 U.S.C. 7479(3). The EPA issued guidance on BACT determinations including the appropriate use of the statutory BACT factors. This guidance is contained in a manual entitled "New Source Review Workshop Manual" (Draft, October 1990). On p.B.29, EPA describes the type of energy impacts that can be considered. They state, "Applicants should examine the energy requirements of the control technology and determine whether the use of that technology results in any significant or unusual energy penalties or benefits." The operation of the bag house will incur an electrical cost of $449,000 associated with the fan power and cleaning of bags. However, these costs are not overwhelmingly significant.

ESP

The electrostatic precipitator (ESP) is a widely recognized technology for removal of PM emissions from a variety of coal combustion sources. ESP removes particulate emissions from the flue gas stream by charging particles in the exhaust gases with high DC voltage and then attracting these particles to the charged collection plates. The operating parameters that influence ESP performance include fly ash electrical resistivity, and precipitator voltage and current. Other factors that determine ESP collection efficiency are collection plate area, gas flow

velocity, and cleaning cycle. ESPs are very efficient in reducing filterable PM emissions. Data for ESPs applied to coal-fired sources show efficiencies greater than 99 for fine (less than 0.1 micron) and coarse (greater than 10 microns) particulate matter.

Cost

The existing hot-side ESP on Unit 2 boiler is a high-efficiency PM control device, rated at 99.24% efficiency. Based on GE Energy, the most practical option for further reduction in emissions from the existing ESP, is to add another field to the ESP. The additional field will result into an increase in efficiency of ESP from 99.24% to 99.85%.

The baseline emission rate for PM (emission rate from existing ESP) is approximately 265.3 tons/yr. However, the Unit 2 boiler is projected to emit PM at a rate of 312.7 tons/yr (or 0.067 lb/million Btu) in 2006 after the modification. Hence, the emission rate after installation of additional ESP field would be approximately 61.7 tons/yr (or 0.013 lb/million Btu). This represents a reduction of approximately 251 tons/yr of PM/PM_{10}.

The total capital investment due to addition of an ESP field was estimated to be $2,500,000. Total annualized cost was estimated to be $610,000. The cost effectiveness for this technology will be approximately $2,430 per ton of PM/$PM_{10}$ removed.

Environmental Impacts

The Clean Air Act requires the permitting authority to consider environmental impacts when making a BACT determination. *See* 42 U.S.C. 7479(3). The EPA issued guidance on BACT determinations including the appropriate use of the statutory BACT factors. Similar to previous option, the additional ESP field will result in further reduction in PM emissions and therefore, there will be more mass of waste dust (ash) to be disposed. The environmental impact from the addition of ESP field will not be significant.

Energy Impacts

The Clean Air Act requires the permitting authority to consider energy impacts, when making a BACT determination. *See* 42 U.S.C. 7479(3). The EPA issued guidance on BACT determinations including the appropriate use of the statutory BACT factors. This guidance is contained in a manual entitled "New Source Review Workshop Manual" (Draft, October 1990). On p.B.29, EPA describes the type of energy impacts that can be considered. They state, "Applicants should examine the energy requirements of the control technology and determine whether the use of that technology results in any significant or unusual energy penalties or benefits."

The addition of an ESP field will incur electric cost - approximately $40,000 due to fan power and rappers. However, these costs are not overwhelmingly significant.

Good Combustion Practices with Existing ESP

As was the case with CO BACT, optimization of burner settings and fuel/combustion air settings results in improved fuel combustion in the LNB system and thus PM (along with CO) emissions are minimized. For this control option, the Permittee has established a BACT PM limit of 0.1412 lb/million Btu, based on the SIP limit of 0.1228 lb/million Btu (filterable PM only) and accounting for condensible PM (additional 15 percent above filterable PM).

PM/PM_{10} BACT Selection

The Permittee has eliminated the first two options (option for new fabric filter and option for additional ESP field) from further consideration due to higher cost effectiveness, and also based on high capital and installation costs. The company has thus proposed the baseline option of good combustion control combined with existing ESP as BACT, with an emission limit of 0.14 lb/million btu for PM/PM_{10} for the modified Unit 2 boiler.

After careful consideration of all environmental, economic, and energy impacts associated with the above PM/PM10 control options, the NCDAQ concludes that no new add-on controls will be required and that good combustion control combined with existing ESP, with an emission limit of 0.14 lb/million btu, is deemed to be BACT for PM emissions from the modified Unit 2 boiler.

It should be noted that this limit is higher than either of the emission limits for PM specified in NSPS Subpart D or Da. The requirement that the BACT standard must be at least as stringent as the applicable NSPS, however, only applies to units that are subject to the NSPS. In this case, the modification that is being made to the boiler is exempted from being a modification under NSPS pursuant to 40 CFR 60.14(e)(5).

5.5 BACT Summary

The following Table presents a BACT determination for the modified Unit 2 boiler, which includes emission limits and technologies proposed by DAQ to be approved.

EMISSION SOURCE	POLLUTANT	BACT EMISSION LIMITS	CONTROL TECHNOLOGY
Unit 2 Boiler	PM/PM10	0.1228 lb/million btu (filterable only) 0.14 lb/million btu (filterable and condensible both)	Good Combustion Control with (existing) ESP
Unit 2 Boiler	CO	0.15 lb/million btu	Good Combustion Control

SECTION 6.0
AIR QUALITY IMPACT ANALYSIS

Progress Energy submitted a PSD modeling analysis to support the installation of a low NOx burner for the No. 2 boiler at the H.F. Lee Steam Electric Plant located in Wayne County. This project will help Progress Energy meet requirements of the Clean Smokestacks Act. No changes to currently permitted operating capacities for the facility are included in the project. Although there will be a significant reduction of NOx as a result of the project. There will also be an increase in the emission of PM10, TSP, and CO, and these increases require a PSD modeling demonstration. The analysis shows that this project will not cause or contribute to an exceedence of the National Ambient Air Quality Standards (NAAQS), Class II PSD Increment, Class I PSD Increment, nor NC's Acceptable Ambient Levels (AAL) for toxic pollutants. Furthermore, the Federal Land Manager, Meredith Bond, in coordination with NC DAQ has determined that the project is small enough, as presented, to not require a regional haze or acid deposition analysis for the nearest CLASS I area, Swanquarter National Wildlife Refuge, which is about 160 km to the East of the facility.

6.1 Air Quality Impact Analysis

Location and Topography

The Progress Energy facility is located in Wayne County, near Goldsboro. It is a predominantly rural area in the coastal plain of North Carolina with generally flat terrain. In the modeling, full terrain was included, based on digital elevation data.

Operations

The project consists of installing a low NOx burner on an existing boiler, No. 2. Three boilers exist at the facility, as well as four small combustion turbines, for a total capacity of 498 megawatts. Three load scenarios (100, 75, & 50 percent) were evaluated to determine the maximum impact from the project.

Table 6.1 Pollutant Netting Analysis

Pollutant	Net Emissions Change (tons/yr)	PSD Significant Emission Rates (tons/yr)
NOx	-569	40
CO	246	100
PM10	93	15
TSP	138	25

6.1.1 CLASS II NAAQS/PSD Increment Air Dispersion Modeling Analysis

Progress Energy used EPA's Industrial Source Complex Short-Term (ISCST3) model to evaluate impacts from the facility. Model receptors were placed beginning at the source and extended outward for 10 km. In other words, they did not use an inside-the-fenceline exclusion. Five years of NC DAQ approved meteorology (1987-1991) from Raleigh (surface) and Greensboro (upper air), were used with ISCST3. Full terrain elevations were also incorporated into the modeling.

Modeling was conducted with emission rates higher than just for the new project. They used full expected rates for the boiler after the low NOx modifications are made. Maximum impacts were selected for all time periods and both pollutants, and results are displayed in Table 6.2 below. All results were below the Class II Significant Impact Levels (SIL), and thus no further modeling demonstration was required to demonstrate compliance with CLASS II NAAQS and increment standards. The specific, modeled, emission rates for the three loads are provided in Table 5-7 of Progress Energy's PSD application. The hourly rates at 100% load were 150 lb/hr for TSP/PM10, and 156.5 lb/hr for CO.

Table 6.2 Class II Significant Impact Level Results (ug/m^3)

Pollutant	Eval Period	% Load	Max Impact (ug/m^3)	SIL (ug/m^3)
PM10	24-hr	50	3.38	5
PM10	annual	50	0.194	1

CO	1-hr	75	23.70	2,000
CO	8-hr	50	8.21	500

6.2 Non Regulated Pollutant Impact Analysis (North Carolina Toxics)

No increases of toxic pollutants exist with this project. Further, DAQ (reference conversation with Don Van der Vaart, Jan 4, 2005) has determined that the increase of TSP is not significant enough to require additional modeling demonstrations.

6.3 Additional Impact Analysis

6.3.1 Growth Impacts

No additional employees are planned to be hired; thus no negative impacts to the area from growth are anticipated by Progress Energy.

6.3.2 Soils and Vegetation

Impact results from the project were well below Significant Impact Levels, and thus NC DAQ believes the facility project will not cause adverse impacts on soil or vegetation.

6.3.3 Class II Visibility Impairment Analysis

A level 1 screening analysis was conducted, and the threshold distance was determined to be 100km. After review of this radius surrounding the Progress Energy facility, DAQ determined that the area contained no protected sites that would be threatened by this project.

6.4 Class I Increment/Air Quality Related Values (AQRV) Regional Haze Impact Analysis

The Swanquarter National Wildlife Refuge is located about 160 km East of the Progress Energy site. After review of the project, the Federal Land Manager for Swanquarter, Meredith Bond, decided that no Class I modeling was required.

6.5 Non-attainment Analysis

There are no designated non-attainment areas relevant for this project.

6.6 Source Impact Analysis Conclusion

Based on the ambient impact analysis, the proposed project at the Progress Energy facility will not cause or contribute to any violation of: NAAQS, Class II PSD increment standards, Class I PSD increment, NC AAL, or any Federal Land Manager AQRVs.

APPENDIX A

Emission Calculations for PSD Applicability

APPENDIX B

Draft Permit

APPENDIX C

Public Notice

APPENDIX D

RBLC NCDAQ Search Results

APPENDIX E

Application