APPENDIX BD-1
BEST AVAILABLE CONTROL TECHNOLOGY DETERMINATION (BACT)

Marathon Generation Plant Unit No. 9
Florida Keys Electric Cooperative Association
PSD-FL-285 and 0870004-004-AC
Marathon, Monroe County

The Florida Keys Electric Cooperative Association (FKEC) plans to install a new Diesel Engine Generator at its existing Marathon Generation Plant (MGP) in Marathon, Monroe County. The unit is a General Motors Electro-Motive Diesel generator model 20-710G4B with a nominal base load rating of 3.58 megawatts (MW) at 32°C and 718 mm Hg. The facility currently consists of eight (8) diesel engine generators used for peaking power. Units 1 & 2 are each rated at 2.0 MW. Units 3, 4 and 5 are each rated at 3.0 MW, Units 6 & 7 are 2.5 MW each, and Unit 8 is rated at 3.58 MW and is identical to the new Unit 9. Units 1-7 are allowed to burn No. 2 fuel oil with a sulfur content of 0.5 percent or less, by weight. Unit 8 and the new Unit 9 will burn No. 2 low sulfur fuel oil with a sulfur content not to exceed 0.05 percent, by weight, and each will have a fuel oil consumption limit of 2.015 million gallons per year. The facility also has four fuel oil storage tanks and other electrical generating support equipment.

FKEC has indicated that the maximum annual air pollutant emission rates in tons per year for the Unit 9 diesel generator, based on consumption of 2.015 million gallons of No. 2 fuel oil, with a maximum sulfur content of 0.05 percent, by weight, will be:

Pollutant	PSD Significance Levels[1]	Uncontrolled Emissions[2]	Controlled Emissions[3]	Expected Emissions[4]	Subject to PSD Review?[5]
NO_X	40	423	289.5	21.15	Yes
CO	100	23.7		1.73	No
PM	25	9.2	<9.2	0.67	No
PM_{10}	15	7.6	<7.6	0.55	Yes
SO_2	40	7.2		0.53	No
VOC	40	13.2		0.96	No

[1] Table 62-212.400-2, F.A.C.
[2] Based on firing No. 2 fuel oil (0.05% sulfur by weight) at a maximum of 2.015 million gals/yr at full load with no emission controls.
[3] Based on firing No. 2 fuel oil (0.05% sulfur by weight) at a maximum of 2.015 million gals/yr at full load with good combustion control practices and NO_X emissions control of timing retardation and aftercoolers.
[4] Based on FKEC's historical and projected actual operating hours of 640 or less.
[5] Annual PM_{10} emissions from the new Unit 9 will not exceed the PSD Significance Level of 15 tpy. However, when the potential emissions from Unit 9 are combined with potential emissions from the existing major PSD source onsite (Unit 8), total PM_{10} potential emissions from the two units (15.2 tpy) exceed the PM_{10} Significance Level.

The Marathon Generation Power Plant is a major source of air pollution or Title V source. Additionally, since potential emissions are greater than 250 tpy for at least one criteria pollutant (NO_X from Unit 8), the facility is also a Major Facility with respect to Rule 62-212.400, Prevention of Significant Deterioration. Because the project will result in a significant increase in nitrogen oxide and particulate matter (less than or equal to 10 microns) emissions per Table 62-212.400-2, F.A.C., "Regulated Air Pollutants - Significant Emissions Rates," a BACT determination is required pursuant to Rule 62-212.410, F.A.C.

BACT DETERMINATION REQUESTED BY THE APPLICANT:

POLLUTANT	EMISSION LIMIT
Nitrogen Oxides	68 lbs/hr by timing retardation and aftercoolers
Particulate Matter less than or equal to 10 microns	1.73 lbs/hr by low sulfur fuel (less than or equal to 0.05% sulfur, by weight) and good combustion practices

The Applicant proposed the control technology for BACT for the PSD pollutant NO_X to be timing retardation and aftercoolers, with emissions limited to 68 lbs/hr. For the PSD pollutant PM_{10}, the Applicant proposed good combustion practices and the exclusive use of low sulfur fuel (less than or equal to 0.05% sulfur, by weight) to limit emissions to 1.73 lbs/hr.

DATE OF RECEIPT OF COMPLETE BACT APPLICATION:

August 24, 2000

BACT DETERMINATION PROCEDURE:

In accordance with Chapter 62-212, F.A.C., this BACT determination is based on the maximum degree of reduction of each pollutant emitted which the Department of Environmental Protection (Department) determines is achievable through application of production processes and available methods, systems, and techniques. This determination includes consideration of energy, environmental and economic impacts, and other costs. In addition, the regulations state that, in making the BACT determination, the Department shall give consideration to:

> Any Environmental Protection Agency determination of BACT pursuant to Section 169, and any emission limitation contained in 40 CFR Part 60 - Standards of Performance for New Stationary Sources or 40 CFR Part 61 - National Emission Standards for Hazardous Air Pollutants.
>
> All scientific, engineering, and technical material and other information available to the Department.
>
> The emission limiting standards or BACT determination of any other state.
>
> The social and economic impact of the application of such technology.

The EPA currently stresses that BACT should be determined using the "top-down" approach. The first step in this approach is to determine, for the emission unit in question, the most stringent control available for a similar or identical emission unit or emission unit category. If it is shown that this level of control is technically or economically unfeasible for the emission unit in question, then the next most stringent level of control is determined and similarly evaluated. This process continues until the BACT level under consideration cannot be eliminated by any substantial or unique technical, environmental, or economic objections.

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The air pollutant emissions from this facility can be grouped into categories based upon the control equipment and techniques that are available to control emissions from these emission units. Using this approach, the emissions can be classified as follows:

Combustion Products (e.g., SO_2, NO_X, PM). Controlled generally by good combustion of clean fuels, removal in add-on control equipment.

Products of Incomplete Combustion (e.g., CO, VOC). Control is largely achieved by proper combustion techniques.

Grouping the pollutants in this manner facilitates the BACT analysis because it enables the equipment available to control the type or group of pollutants emitted and the corresponding energy, economic, and environmental impacts to be examined on a common basis. Although all of the pollutants addressed in the BACT analysis may be subject to a specific emission limiting standard as a result of PSD review, the control of "non-regulated" air pollutants is considered in imposing a more stringent BACT limit on a "regulated" pollutant (i.e., PM, SO_2, H_2SO_4, fluorides, etc.), if a reduction in "non-regulated" air pollutants can be directly attributed to the control device selected as BACT for the abatement of the "regulated" pollutants.

BACT POLLUTANT ANALYSIS

NITROGEN OXIDES (NO_X)

Oxides of nitrogen (NO_X) are generated during fuel combustion by oxidation of chemically bound nitrogen in the fuel (fuel NO_X) and by thermal fixation of nitrogen in the combustion air (thermal NO_X). As flame temperature increases, the amount of thermally generated NO_X increases. Fuel type affects the quantity and type of NO_X generated. Generally, natural gas is low in nitrogen. However it causes higher flame temperatures and generates more thermal NO_X than oil or coal, which have higher fuel nitrogen content, but exhibit lower flame temperatures.

NO_X emissions represent a significant portion of the total emissions generated by this project, and must be minimized using BACT. For control of NO_X, the Applicant evaluated exhaust control technologies, combustion modifications and combustion practices.

The most stringent NO_X control to be evaluated for the project was Selective Catalytic Reduction (SCR), which is an exhaust control technology. The Applicant determined that SCR was technically infeasible for the new Unit 9 due to engine design, limited guarantees provided by SCR manufacturers, back pressure limitations and limited, if any, operating experience on similar units.

The new Unit 9 is a two-stroke engine that requires injection of lube oil into the unit. Due to the two-stroke design (which includes intake of air and fuel, compression, power and exhaust in two piston strokes and one crankshaft revolution) an additional 'blower' or turbocharger must be included. The turbocharger works to 'pull' the exhaust from the chamber, resulting in lube oil being pulled into the chamber, which is then exhausted. This exhaust would pass through the SCR, thus contaminating and fouling the catalyst.

Siemens Westinghouse was contacted by the Applicant to provide information on the feasibility of installing an SCR catalyst on the project. Due to the typical oil consumption of a two-stroke engine, Siemens Westinghouse would not offer a SCR system because the catalyst would become excessively contaminated.

The Applicant then contacted SCR vendor Johnson Matthey to obtain information about an SCR system for the proposed Project. Although Johnson Matthey did provide cost data for an SCR that could potentially be placed on Unit 9, the guarantees provided for performance are limited. In the information provided, Johnson Matthey did not provide a guarantee for the catalyst life for a two-stroke diesel engine due to the operating conditions found on these engines. Additionally, Johnson Matthey would only provide a performance guarantee for 8,000 hours after exhaust gas initially passes across the catalyst, or one-year after start-up, whichever occurs first.

The Applicant also evaluated the increased exhaust back pressure due to the addition of an SCR system. The maximum allowed back pressure for the 20-710GB unit is 5 inches H_2O. According to calculations done by the engine vendor, the expected exhaust back pressure of the unit to be installed at Marathon will be approximately 4 inches H_2O. Johnson Matthey indicated that they could possibly increase the exhaust ducting size to meet back pressure requirements of the exhaust system. However, Johnson Matthey has not conducted a site visit to determine the feasibility of increasing duct size and the placement of the SCR in relation to the engine and engine building. Due to space constraints, the Applicant has indicated that increased ducting would be difficult, if not infeasible, and as a result installation costs may be significantly higher than those provided by the Vendor.

A review of EPA's BACT/LAER Clearinghouse (BACT Clearinghouse) information by the Applicant indicates that process control and good combustion practices minimize NO_X emissions for most small facilities. Only two facilities (both owned and operated by the same entity) have installed SCR on two-stroke diesel engines. However, both facilities have limited operating experience and one facility had difficulty meeting its NO_X permit limits. Additionally, the SCR at each plant serves seven and ten units, respectively. Four facilities with SCR on small diesel units, listed in the California Air Resources Board's (CARB) database, were also evaluated. Three facilities have four-stoke engines, which cannot be compared to the operating characteristics of a two-stroke engine. The fourth facility's enforceable permit NO_X limit with SCR is similar to the NO_X emission rate for the new Unit 9 with timing retardation and aftercoolers, which are considered more technically feasible controls by the Applicant.

The next most stringent NO_X control evaluated by the Applicant was the modification of the combustion process through a combination of fuel injection timing retardation and cooling of combustion air resulting in exhaust temperature reduction. The design specific to FKEC's 20-710G4B includes a 4° injection timing retardation and a 4-pass aftercooler circuit with the addition of a separately cooled aftercooler circuit. The combination of retarded injection timing and lowered combustion air temperature results in less NO_X formation.

Vendor's data indicate that retarding injection timing will reduce NO_X formation by about 20 percent, but will increase PM emissions by about 10 percent and fuel consumption by 1.5 percent. The 4-pass aftercooler will reduce both NO_X and PM emissions by about 10 percent while reducing fuel consumption by about 0.7 percent. The separately cooled aftercooling circuit will decrease both NO_X and PM by another 10 percent and fuel consumption by 0.5 percent. The net result will be a 30 to 40 percent reduction in NO_X, a 5 percent increase in PM and about 0.3 percent increase in fuel consumption. The use of low sulfur fuel oil will minimize PM emissions thus reducing or eliminating the increase in PM caused by NO_X controls.

PARTICULATE MATTER LESS THAN OR EQUAL TO 10 MICRONS (PM_{10})

Emissions of particulate matter are primarily the result of fuel impurities and byproducts of incomplete combustion. Primary particulate matter control consists of burning clean fuel oil in combination with proper engine design, operation and maintenance. Post-combustion controls for particulate matter include cyclones, electrostatic precipitators, baghouses and scrubbers.

A review of BACT Clearinghouse information indicates that no post-combustion particulate control systems, such as electrostatic precipitators or baghouses, have been employed on diesel engines. The high gas velocities and volumetric flow rates, along with the high combustion efficiency associated with diesel engines, make the application of post-combustion particulate control devices technically infeasible. Rather, particulate emissions from diesel engines are controlled through combustion controls via proper engine design, operation and maintenance. With respect to combustion controls, there are no significant economic, energy or environmental impacts. The combination of good combustion control practices and low sulfur fuel oil (less than or equal to 0.05% sulfur, by weight) results in lower PM_{10} emission rates.

Based on the above information, the Applicant proposes BACT as the combination of NO_X controls (timing retardation and aftercoolers), proper engine design, good combustion practices, and the use of low sulfur fuel, which should provide effective emissions control for the new Unit 9.

BACT DETERMINATION BY DEP:

Based on the information provided by the Applicant and the information searches conducted by the Department, lower emissions limits can be obtained employing the top-down BACT approach for NO_X.

NO_X DETERMINATION

The top-down BACT approach for diesel fired internal combustion engines listed in order from most stringent control to least:

1. Selective Catalytic Reduction (SCR)
2. Combined technologies of injection timing retardation, turbocharger with aftercoolers
3. Good combustion design/practices

The following table summarizes the feasibility of using these control technologies with the EMD 20-710G4B as designed for installation in FKEC's Marathon Generation Plant.

Control Technology	Emission Reduction (%)	Technically Feasible	Cost Effective	Adverse Environ. Impacts	Adverse Energy Impacts
SCR with ammonia	60-90	Yes	No	Yes	Yes
SCR with urea	62.5	Yes	No	No	Yes
Timing retard; turbo charger aftercoolers	30-40	Yes	Yes	No	Yes
Dry/Low NO_X	18	No	N/A	N/A	N/A

SCR has become more widely used in the United States and the technology is being improved such that the hazards and costs have been reduced. It remains, however, a costly technology for small applications and has hazards associated with the use and storage of ammonia. Additionally, SCR is not generally used with diesel engines of this size. The Applicant rejected SCR because it was found to be technically infeasible for the new Unit 9.

The Department's review of the BACT/LAER database lists only two facilities (both owned and operated by the same entity) which use SCR on diesel engines. SCR was selected because a local ordinance mandated strict limits on emissions without regards to cost. Additionally, seven units at one facility exhaust through one SCR, while at the other facility, ten units exhaust through one SCR. Therefore, an SCR is more cost effective for these units on a dollar per kW and dollar per ton basis, when compared to Unit 9, due to the larger total capacity exhausting through each SCR and a greater NO_X reduction based on total emissions passing through the SCR.

The Department understands that SCR systems are normally not installed on small diesel engines and SCR manufacturers may not recommend this type of control equipment with these engines. However, SCR systems have been placed on other similar units, as shown in the BACT/LAER database and in the data provided by SCR manufacturer Johnson Matthey. These examples indicate that SCR on the new unit 9 may not be technically infeasible. Nevertheless, it appears that the costs for SCR to operate properly and efficiently on Unit 9 will outweigh the benefits of the NO_X reduction from this control technology. Based on the limited cost data provided by Johnson Matthey, the cost of NO_X removal may range from $4,000 to $5,000 per ton.

Johnson Matthey provided only limited guarantees: there is no guarantee for catalyst life with a two-stroke diesel engine due to the operating conditions found on these engines and there is a limited performance guarantee of 8,000 hours after exhaust gas initially passes across the catalyst, or one-year after start-up, whichever occurs first. The costs to frequently replace the catalyst and service the engine may be prohibitive. Additionally, the potential back pressure that the SCR would add to the system may exceed the ducting increase expectations of Johnson Matthey, especially when considered in combination with the space constraints at the Marathon Plant. Subsequent to more detailed design, Johnson Matthey may find that increased ducting is infeasible or installation and material costs may significantly increase. The unknown additional costs for installing SCR on Unit 9 and the more cost effective arrangement of the facilities in the BACT/LAER database (many units exhausting through one SCR), indicates that this control technology would be cost prohibitive for Unit 9.

For NO_X emissions, the Department accepts the Applicants proposed use of injection timing retardation and cooling of combustion air as BACT for this project.

PM_{10} DETERMINATION

The Department's review of the BACT/LAER database indicates that no post-combustion particulate control systems have been installed on small diesel engines. Instead, particulate emissions are controlled through good combustion practices.

For PM_{10} emissions, the Department accepts the Applicant's proposed use of good combustion control practices and the exclusive use of low sulfur fuel oil (less than or equal to 0.05% sulfur, by weight).

The BACT emission levels established by the Department are as follows:

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POLLUTANT	EMISSION LIMIT
Nitrogen Oxides (NO_X)	68 lbs/hr (297.8 TPY)
Visible Emissions	20%

COMPLIANCE

Compliance with the visible emission limitations shall be in accordance with the EPA Reference Method 9 as contained in 40 CFR 60, Appendix A.

Compliance with the NO_X limitations shall be in accordance with the EPA Reference Method 7E as contained in 40 CFR 60, Appendix A.

DETAILS OF THE ANALYSIS MAY BE OBTAINED BY CONTACTING:

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11/16/00
Date: