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Prevention of Significant Deterioration Greenhouse Gas Permit Application Matagorda Energy Center, Matagorda County, Texas

Prepared for

APEX Matagorda Energy Center, LLC

Submitted to

U.S. Environmental Protection Agency Region 6

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Executive Summary

APEX Matagorda Energy Center, LLC (APEX) plans to construct the Matagorda Energy Center, a 317-megawatt (MW) Compressed Air Energy Storage (CAES) facility located in Matagorda County, Texas (the Project). CAES is a commercially available, economically attractive form of bulk energy storage for the electricity grid.

The proposed Matagorda Energy Center will produce electricity by compressing air during off-peak demand periods for subsequent use in generating electricity during peak demand periods. This facility has the unique capability of providing bulk energy storage which enhances the performance of both renewable (wind and solar facilities) and conventional fossil fuel energy generation. Worldwide, two CAES plants, the McIntosh plant in Alabama and the Huntorf facility in Germany, have operated successfully for over 20 years.

The CAES technology involves two major processes: (1) air compression and storage and (2) air release for electricity generation. During the air compression and storage process, electric motor-driven compressors are used to inject air into an underground cavern (or other storage media) for storage under high pressure. The storage cavern for the Matagorda Energy Center will be created by leaching a void space in an underground salt formation (the Markham Dome) located directly beneath the plant site. The Matagorda Energy Center storage cavern is expected to operate over a wellhead pressure range of approximately 1,900 to 2,830 pounds per square inch absolute (psia) (static pressure range). Electricity is generated by releasing the high-pressure air, heating the air with natural gas, and expanding it through sequential turbines (expanders), which in turn drive an electrical generator. When full, the inventory of stored air will support approximately 100 hours of generation at full-rated generation output without recharge.

The compression and expansion equipment for the McIntosh Plant was supplied by Dresser-Rand. Notwithstanding the absence of a follow-on CAES project (subsequent to installation of the McIntosh facility), Dresser-Rand has maintained its commercial offering of CAES technology. Today, Dresser-Rand is the only equipment manufacturer offering an integrated CAES design, along with performance guarantees across the compression and generation functions.

The Matagorda Energy Center will include a number of design enhancements in comparison to the McIntosh plant. These enhancements will serve to increase the efficiency of the plant, both with regard to fuel and air use, enhance operating flexibility, and reduce water consumption associated with compressor cooling.

In accordance with the terms of federal Prevention of Significant Deterioration (PSD) regulations, APEX is applying to U.S. Environmental Protection Agency (EPA) Region 6 for a PSD permit to construct the Matagorda Energy Center. The application is limited to requesting a permit for the emissions of greenhouse gases (GHGs) from the Matagorda Energy Center and contains a description of the Project, a review of applicable federal regulations, a listing of the emissions, and a best available control technology analysis. PSD permitting emission thresholds are not exceeded for any pollutant other than GHGs. Consequently, APEX is applying for a Texas Commission on Environmental Quality (TCEQ) Standard Permit for Electric Generating Units (EGU) and TCEQ Permits by Rule for support equipment to authorize emissions of pollutants other than GHGs.

The Matagorda Energy Center will have potential GHG emissions (comprised of carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), and sulfur hexafluoride (SF_6) of 459,131 tons per year (tpy) CO_2-equivalent (CO_2e). Because the emissions of CO_2e exceed 100,000 tpy, this plant will be a major new source subject to the GHG PSD rules.

In accordance with the requirements of the federal PSD program and EPA's PSD permitting guidance for GHGs, a best available control technology (BACT) analysis was performed. The BACT analysis concludes that the APEX Project design represents BACT for GHGs.

US EPA ARCHIVE DOCUMENT

Contents

Section **Page**

Executive Summary ..... **i**

Acronyms and Abbreviations ..... **v**

Introduction **1-1**
1.1 Project Contacts 1-3
1.2 Document Overview 1-3

Project Description **2-1**
2.1 Facility Location and Plot Plan 2-1
2.2 Matagorda Energy Center CAES Operation 2-1
2.2.1 Facility Operation Cycle 2-3
2.2.2 Support of Wind and Power Generation 2-3
2.3 Emission Sources 2-3
2.3.1 Expansion Turbine Generators 2-3
2.3.2 Wet Cooling Towers 2-3
2.3.3 Fugitive Emissions 2-4
2.3.4 Emergency Generator Engine 2-4
2.3.5 Aqueous Ammonia Storage Tank 2-4
2.3.6 Facility Maintenance Activities 2-4
2.4 Non-Emitting Facility Components 2-4
2.4.1 Ancillary Facilities 2-4
2.5 Emission Control Summary 2-5
2.6 Emissions Monitoring 2-5
2.7 Inspection Schedule 2-6
2.8 Operating Schedule 2-6
2.9 Permitting and Construction Schedule 2-6

GHG Emissions Summary **3-1**
3.1 Expansion Turbines 3-1
3.2 Auxiliary Equipment 3-1
3.3 GHG Emission Summary 3-1

Regulatory Review **4-1**
4.1 Federal Regulations 4-1
4.1.1 Greenhouse Gas Tailoring Rule 4-1
4.1.2 Other PSD Requirements 4-2
4.1.3 Federal Implementation Plan for Texas 4-2
4.1.4 New Source Review 4-2

Greenhouse Gas BACT Analysis **5-1**
5.1 Background 5-1
5.1.1 APEX Energy Storage Technology Selection 5-1
5.2 Regulatory Basis 5-1
5.3 Emissions Summary 5-1
5.3.1 GHG BACT Analysis Assumptions 5-2
5.4 Top-Down BACT Process 5-3
5.5 Expansion Turbine BACT for GHGs 5-4
5.5.1 Step 1: Identify All Control Technologies 5-4
5.5.2 Step 2: Eliminate Technically Infeasible Options 5-4
5.5.3 Step 3: Rank Remaining Control Technologies by Control Effectiveness 5-5

US EPA ARCHIVE DOCUMENT

Section **Page**

5.5.4 Step 4: Evaluate Most Effective Controls and Document Results 5-5
5.5.4.1 Facility Information 5-6
5.5.4.2 Cost Analysis 5-6
5.5.4.3 Safety, Operational, and Environmental Impacts of CCS 5-10
5.5.4.4 Energy Efficiency Option 5-11
5.5.5 Step 5: Select BACT 5-12
5.6 Natural Gas Generator BACT for GHGs 5-13
5.6.1 Step 1: Identify All Control Technologies 5-13
5.6.2 Step 2: Eliminate Technically Infeasible Options Effectiveness 5-13
5.6.3 Step 3: Rank Remaining Control Technologies by Control Effectiveness 5-14
5.6.4 Step 4: Evaluate Most Effective Controls and Document Results 5-14
5.6.5 Step 5: Select BACT 5-14
5.7 Fugitive Emissions BACT for GHGs 5-14

References 6-1

Appendixes

A Area Map (Figure A-1), Plot Plan (Figure A-2), and Process Flow Diagram (Figure A-3)
B Greenhouse Gas Supporting Documentation
C Permit Application Forms

Tables

Table 2-1 Permitting and Construction Schedule
Table 3-1 GHG Emission Source Summary
Table 4-1 GHG Pollutants Expected to be Emitted, Annual Emission Rates, Global Warming Potential, and Annual Emissions Rates Adjusted for Global Warming Potential
Table 5-1 Matagorda Energy Center Estimated GHG Emissions by Equipment Category
Table 5-2 CO_2 Quantity and Concentration
Table 5-3 Vendor CCS Information
Table 5-4 Control Costs for Carbon Capture at Matagorda Energy Center
Table 5-5 Comparison of CAES Installations
Table 5-6 Matagorda Energy Center Proposed BACT Limits
Table 5-7 Emergency Generator Efficiency and Design Data Comparison
Table 5-8 Control Cost for LDAR at the Matagorda Energy Center

Figure

Figure 5-1 Existing CO2 Pipelines and Oil Fields in Central Texas

US EPA ARCHIVE DOCUMENT

Acronyms and Abbreviations

APEX	APEX Matagorda Energy Center, LLC
BACT	best available control technology
CAA	Clean Air Act
CAES	Compressed Air Energy Storage
CatOx	catalytic oxidation
CEM	continuous emissions monitor
CFR	Code of Federal Regulations
CH_4	methane
CCN	Certificate of Convenience and Necessity
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
DOE	U.S. Department of Energy
ERCOT	Electric Reliability Council of Texas
°F	degree Fahrenheit
EPA	United States Environmental Protection Agency
FIP	Federal Implementation Plan
FR	*Federal Register*
GHG	greenhouse gas
GWP	global warming potential
HFC	Hydrofluorocarbon
HHV	higher heating value
HP	high-pressure
IPCC	Intergovernmental Panel on Climate Change
kW	kilowatt
kWh	kilowatt-hour
LAER	lowest achievable emission rate
LCRA	Lower Colorado River Authority
lb	Pound
lb/hr	pound per hour
LDAR	leak detection and repair
LHV	lower heating value
LP	low-pressure

US EPA ARCHIVE DOCUMENT

MACT	maximum achievable control technology
MRR	Final Mandatory Reporting of Greenhouse Gases Rule, or Mandatory Reporting Rule
MMBtu	million British thermal units per hour
MW	Megawatt
NAAQS	National Ambient Air Quality Standards
NSR	New Source Review
NO_X	nitrogen oxide
N_2O	nitrous oxide
O_2	oxygen
PFC	Perfluorocarbon
PM_{10}	particulate matter less than 10 microns in diameter
$PM_{2.5}$	particulate matter less than 2.5 microns in diameter
ppm	part per million
PTE	potential to emit
PSD	Prevention of Significant Deterioration
PUC	Public Utility Commission
RACT	Reasonably Available Control Technology
SCGT	Simple Cycle Gas Turbine
SCR	selective catalytic reduction
SF_6	sulfur hexafluoride
SIP	State Implementation Plan
SO_2	sulfur dioxide
TCEQ	Texas Commission on Environmental Quality
TDU	Transmission and Distribution Utility
tpy	ton per year
VOC	volatile organic compound

US EPA ARCHIVE DOCUMENT

SECTION 1.0

Introduction

APEX Matagorda Energy Center, LLC (APEX) plans to construct the Matagorda Energy Center, a 317-megawatt (MW) Compressed Air Energy Storage (CAES) facility located near Clemville, in Matagorda County, Texas (the Project). CAES is a commercially available, economically attractive form of bulk energy storage for the electricity grid.

Recent years have seen a rapid increase in the amount of renewable electric generating resources – especially wind energy. For example, installed wind generation in the Electric Reliability Council of Texas (ERCOT) region has more than doubled over the past five years, to approximately 9,600 MW (nameplate). [Source: ERCOT Capacity/Demand/Reserves Reports, 2007 and May 2012]

This rapid growth in renewable forms of power generation is the result of a number of public policy initiatives encouraging the construction of renewable generation, at both the state and federal level. Addition of a significant amount of renewable generation has created a number of challenges for the grid operator (ERCOT) with regard to managing the overall stability and reliability of the bulk power system, for reasons explained below.

The grid operator must take actions to balance the supply of power against demand on a near instantaneous basis. If demand exceeds supply, the system frequency will begin to decline from the objective of 60 hertz (Hz); conversely, if supply is greater than demand, frequency will begin to increase. Because demand changes continually, grid operation requires a constant series of adjustments in the operation of the on-line generation fleet (as well as use, on a more limited basis, of customer "demand side" response).

Renewable generating resources such as wind and solar can complicate grid operation in a number of ways. First, by definition these resources are intermittent – neither the magnitude of wind velocity nor solar intensity can be controlled. Secondly, because the marginal production cost of these resources is essentially zero, the grid operator will make every effort to accommodate output from these resources, even when demand on the system is very low. In fact, because many renewable resources benefit from a federal production tax credit (approximately $22 per megawatt-hour [MWh]), these resources can remain profitable at power market prices as low as negative $22/MWh.

As the amount of renewable generation has increased, so has the grid operator's need for a greater amount of flexible "stand-by" resources capable of responding quickly to deviations in variations in the output of intermittent resources. Additionally, wind generation, which in West Texas typically peaks during nighttime hours, can act to suppress off-peak prices. For example, in 2011 the ERCOT west zone experienced 349 hours of negative prices, with 993 hours below $10/MWh. [Source: ERCOT Market Information System.]

These circumstances support the economic attractiveness of grid-level energy storage in the ERCOT market. Such resources could provide valuable quick response capability, as well as serving to ameliorate off-peak grid management issues, by time shifting off-peak energy to periods of higher demand.

Only two technologies are commercially available and capable of proving sufficient storage capacity to be of value at the bulk power level – CAES and pumped hydroelectric ("hydro") generation. Both technologies are dependent on suitable geographic/geologic features. Pumped hydro requires a river with substantial elevation change; CAES requires suitable underground storage media. While no practical sites for pumped hydro exist in Texas, the state has numerous underground salt deposits, in the form of salt domes in the eastern and gulf coast regions, and bedded salt in the western regions of the state. Additionally, the natural gas industry has decades of experience with the storage of high-pressure natural gas in underground caverns formed by leaching (dissolving with water) a void space in the salt. Storage of air represents a relatively straightforward extension of underground natural gas storage experience.

CAES technology involves two major processes: (1) air compression and storage and (2) air release for electricity generation. During the air compression and storage process, electric motor driven compressors are used to inject

US EPA ARCHIVE DOCUMENT

air into an underground cavern (or other storage media) for storage under high pressure. Electricity is generated by releasing the high-pressure air, heating the air with natural gas, and expanding it through sequential turbines (expanders), which in turn drive an electrical generator. Worldwide, two CAES plants, the McIntosh plant in Alabama and the Huntorf facility in Germany, have operated successfully for over 20 years.

APEX conducted an evaluation of more than 20 potential sites in west and southeast Texas before selecting the Matagorda Energy Center site. The Matagorda Energy Center site was chosen for development of a CAES facility because of the presence of suitable geologic conditions and an existing adjacent brine production facility with natural gas supply and natural gas liquids storage. Appendix A provides a map showing the location of the Matagorda Energy Center.

The storage cavern for the Matagorda Energy Center will be created by drilling a "cavern well" approximately 3,750 feet into the underground salt deposit. Fresh water withdrawn from local groundwater wells will be pumped down the well to dissolve salt, creating the storage cavern. Salt brine withdrawn from the cavern during this "leaching" process will be used by a commercial brine production facility located on adjacent property. This leaching process, expected to require approximately 555 days, will be carefully controlled to produce a cavern of the desired capacity and shape.

Dresser-Rand, the equipment supplier for the McIntosh CAES installation, has continued to offer CAES technology to the market. Indeed, today Dresser-Rand is the only equipment manufacturer providing both the compression and expansion equipment for CAES, along with performance guarantees. APEX plans to use Dresser-Rand supplied equipment for the Matagorda Energy Center. However, the Matagorda Energy Center will incorporate several design improvements in comparison to the McIntosh plant. One major change is complete separation of the compression and expansion/generation functions. At McIntosh, a single electrical machine functions as a motor when compressing, and as a generator when expanding. This is accomplished by connecting the motor/generator via clutches to the compression train and the expansion train. While this design results in capital cost savings (avoiding the cost of a second electrical machine), it constrains operating flexibility for the expansion and compression activities. APEX will install a dedicated motor for compression, and a dedicated generator for expansion/generation, allowing simultaneous operation of both functions. This added operating flexibility increases the value of the CAES facility to the grid.

Numerous other changes in comparison to McIntosh have the effect of improving the fuel heat rate, reducing specific air consumption (air use per MWh generated), increasing the useful operating range (valuable when providing quick response services to the grid), reducing nitrogen oxide (NO_X) emissions, and reducing water consumption associated with gas cooling during compression. These design changes will be explained more completely in following sections.

The APEX Matagorda Energy Center Project will consist of the following emission sources:

- Two expansion/generation trains capable of generating 158.34 MW of electricity each, with each train consisting of three expansion turbines, operated in series
- Two sets of cooling towers to reject heat produced during the compression process
- One natural gas fired emergency generator engine
- An aqueous ammonia storage and feed system for a Selective Catalytic Reduction (SCR) emission control system for NO_X
- Equipment fugitive emissions from pumps, valves, flanges, etc. (principally associated with the natural gas fuel supply system)
- Facility maintenance activities

In accordance with the federal Prevention of Significant Deterioration (PSD) regulations, APEX is applying to U.S. Environmental Protection Agency (EPA) Region 6 for a permit to construct the Matagorda Energy Center. The application is limited to requesting a permit for the emissions of greenhouse gases (GHGs) from the Matagorda

US EPA ARCHIVE DOCUMENT

Energy Center and contains a description of the project, a review of applicable federal regulations, a listing of the emissions, and a best available control technology analysis. PSD permitting emission thresholds are not exceeded for any other pollutant. Consequently, APEX is applying for a Texas Commission on Environmental Quality (TCEQ) Standard Permit for Electric Generating Units (EGU) to authorize emissions of pollutants other than GHGs.

Construction is planned to start in the fourth quarter of 2013, with the start of operation commencing in the third quarter of 2016.

Section 1.1 provides Project contacts and Section 1.2 provides an overview of the documentation being submitted with the application for a permit to construct the Matagorda Energy Center.

1.1 Project Contacts

The following individuals may be contacted for additional information on this Project:

Applicant	Stephen Naeve Chief Operating Officer APEX Matagorda Energy Center, LLC 3200 Southwest Freeway, Suite 2210 Houston, TX 77027 Phone: (713) 963-8104 email: stephen.naeve@apexcaes.com
Permitting Consultant	Ashley Campsie Senior Project Manager CH2M HILL, Inc. 9193 South Jamaica Street Englewood, CO 80112 Phone: (720) 286-1236 email: ashley.campsie@ch2m.com

1.2 Document Overview

The following is an overview of the information included in this permit application.

- **Section 1.0 – Introduction.** This section provides an overview of the Project and describes the application organization.
- **Section 2.0 – Project Description.** This section includes a general description of the proposed Project including equipment and operations of the Project. Information regarding non-emitting processes and equipment is provided for a general understanding of plant operations.
- **Section 3.0 – Greenhouse Gas Emissions Summary.** This section provides a summary of emissions-related information.
- **Section 4.0 – Greenhouse Gas Regulatory Review.** This section contains a detailed regulatory review of federal GHG air regulations that may affect the permitting, construction, or operation of the proposed Project.
- **Section 5.0 – Best Available Control Technology (BACT) Analysis.** This section includes a BACT analysis for GHG pollutants. This analysis follows the EPA-prescribed five-step, top-down approach. Requested permit limits are also included in this section.

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- **Appendix A – Location Map, Plot Plan, and Process Flow Diagram.** This appendix includes a location map, plot plan, and process flow diagram.
- **Appendix B – Greenhouse Gas Supporting Documentation.** This appendix contains the calculations used to determine the GHG emissions for this permit application as well as maintenance schedules.
- **Appendix C –Permit Application Forms –** This appendix contains permit application forms. Since EPA Region 6 has not developed a specific form for GHG permits, the TCEQ Standard Permit Application form (Form PI-1S) format is provided. In addition, TCEQ Tables 1F and 2F are provided to document the emission increases associated with the Project relative to the PSD permitting thresholds.

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SECTION 2.0

Project Description

APEX proposes to construct and operate the Matagorda Energy Center located in Matagorda County, Texas. The proposed Matagorda Energy Center will consist of two Dresser-Rand expansion turbine/generation (ETG) trains (FINs: TURBTRNA and TURBTRNB; EPNs: TURBASTK and TURBBSTK), each rated at 158.34 MW output at full load. The total generating capacity of the plant will thus be approximately 317 MW. There will be two compression trains installed, each driven by an electrical motor of 150 MW (nominal) power rating. Two sets of cooling towers will be installed to reject heat produced during compression. The proposed Matagorda Energy Center will also have an emergency generator engine fired with natural gas and an aqueous ammonia storage and feed system for the SCR emission control system.

2.1 Facility Location and Plot Plan

Maps showing the facility location (area map) and the planned facility layout (plot plan) are provided in Appendix A. The plot plan identifies the arrangement of key Project components and equipment.

CAES facilities require an underground storage cavern for storage of compressed air. In Texas, salt domes provide the unique geologic conditions necessary for cavern creation but are only present in selected areas within the state. APEX conducted an evaluation of more than twenty potential sites in west and southeast Texas before selecting the Matagorda Energy Center site. The proposed Matagorda Energy Center site was selected for development of this facility because of the presence of suitable geologic conditions and an existing adjacent brine production facility with natural gas supply and natural gas liquids storage. The property is currently undeveloped.

2.2 Matagorda Energy Center CAES Operation

The Matagorda Energy Center will employ two Dresser-Rand CAES compression trains, each consisting of a set of multi-stage compressors driven by a dedicated 150-MW (nominal rating) electric motor. Each compression train will be capable of producing up to 1.4 million pounds per hour of air at a compressor outlet pressure of up to 2,830 pounds per square inch absolute (psia). The expansion/generation component of the plant will consist of two expansion turbine/generator trains, each rated at 158.34 MW. Thus at maximum compression load, the facility will consume up to 300 MW of energy, while at maximum generator output the facility will produce approximately 317 MW.

The cavern for the Matagorda Energy Center will be created by drilling a “cavern well” having a cemented well casing at a terminal depth of approximately 3,750 feet. Fresh water withdrawn from local groundwater wells will be pumped down the well to dissolve salt, creating the storage cavern. Salt brine withdrawn from the cavern during this “leaching” process will be used by a commercial brine production facility located on an adjacent property. This leaching process is carefully controlled to produce a cavern of the desired capacity and shape. The cavern is expected to operate over a wellhead pressure range of approximately 1,900 to 2,830 psia (static pressure range). If full, the cavern will support approximately 100 hours of generation at near full rated output without recharge.

The expansion/generation components of a CAES facility share certain fundamental characteristics with conventional utility scale gas turbines – both technologies use a compressible gas as the working fluid, operating on the same thermodynamic cycle (the Brayton cycle). However, equipment design and configuration are, in certain respects, profoundly different.

A simple cycle gas turbine (SCGT) has a compressor section, followed by an expander section, connected on a common shaft with an electrical generator. Inlet air is compressed (at a compression ratio of approximately 16:1 in a modern utility scale machine), fired with natural gas, and the resulting hot, high-pressure gas is expanded

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through a turbine. The work done in the expansion turbine drives both the compression section and the generator.

While suitable for certain services, the SCGT has significant operational drawbacks; most notably, it has a relatively limited load range. Minimum load for a SCGT is typically 50 to 60 percent of maximum output, and heat rate deteriorates as the machine output is reduced from full load. The SCGT operating range is heavily influenced by operational limits of the compressor section. A compressor simply cannot be designed to operate efficiently over a broad range of flow rate/pressure ratio.

Because CAES expanders are supplied with high-pressure air from the storage cavern, CAES operation is unaffected by turndown limitations of a compressor. Thus the expansion trains at the Matagorda Energy Center will be capable of operating sustainably at an extremely low output (less than 10 percent of maximum rated output), with the ability to ramp to full load in less than five minutes.

This exceptional response rate and broad operating range make CAES ideal for providing grid reliability services such as frequency regulation or standby capacity (commonly called “spinning reserves”). Within ERCOT the wholesale market compensates generators for provision of such grid reliability services (termed “Ancillary Services”).

CAES technology differs from conventional gas turbine technology in other important ways. For example, the Matagorda Energy Center uses three expanders, operating on a single shaft, connected to the generator. High-pressure air from the cavern passes sequentially through the three expanders, performing work (accompanied by a reduction in pressure) as the air flows through each stage of expansion. The lowest stage of expansion operates at an inlet pressure comparable to industrial scale gas turbines, and thus its design resembles a conventional gas turbine. However, the two higher-pressure expanders operate at pressures far in excess of a typical gas turbine. Thus, the design of the higher pressure expanders is derived from Dresser-Rand steam turbine experience. (Utility scale stream turbines commonly operate at pressures in excess of 2000 psia).

A process flow diagram for the Matagorda Energy Center plant is provided in Appendix A. It depicts the compressors, operating at design basis compression, under summer ambient conditions, and further assuming a “near” full cavern. Compression occurs in four stages. Because compression of air results in an increase in temperature, it is necessary to cool the air between the stages. Heated water from this process will be cooled in a conventional mechanical draft cooling tower. Make-up water to the cooling tower will be sourced from commercial brine production facility water wells located on adjacent property or the Lower Colorado River Authority (LCRA). Cooling tower blowdown will be discharged to the Tres Palacios River. Maximum daily water consumption is expected to be approximately 1 million gallons (assuming summer operation, 12 hours of compression at high compressor flow). Annual water requirements are expected to be approximately 400 acre feet.

The process flow diagram in Appendix A also depicts the expansion/generation process. At maximum generator output, approximately 400 lbm/second of air from the cavern header passes through a recuperator, where the air is preheated to a temperature of 600°F (degrees Fahrenheit) before entering the topping turbine, at a turbine inlet pressure of approximately 2,300 psia. Air is expanded in the topping turbine, resulting in a temperature and pressure drop. The air next flows to one of two high-pressure (HP) combustors. Natural gas is burned with the air in the HP combustors, and the resultant heated gases enter the HP expander at approximately 1,000 °F and 800 psia. The gases exit the HP expander, flowing to the low-pressure (LP) combustors, where additional natural gas is burned to increase the gas temperature for further expansion in the LP expander. Gases exiting the LP expander flow through the recuperator, preheating the air from the cavern, and exhaust to the stack.

The addition of a topping turbine is a design feature unique to the Matagorda Energy Center. This addition is made possible by the fact that the cavern pressure at Matagorda (which has been optimized on the basis of numerous site specific geological and economic parameters, including ERCOT power market considerations) is much higher than at McIntosh (or at other sites which have been studied for CAES installation).

A natural gas fired reciprocating engine will power an emergency electric generator rated at 740 electric kilowatt (ekW), necessary to support starting the plant when power from the grid is unavailable (“black start”).

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2.2.1 Facility Operation Cycle

Economic modeling of the Matagorda Energy Center predicts that the system will operate in generation service at a relatively low load (on the order of 10 to 20 percent of maximum output) much of the time, ready to respond to ERCOT instructions to quickly ramp up in order to provide Ancillary Services. At other hours of the year, the plant is expected to operate at or near full load. APEX is electing to limit the Project fuel usage in order to stay below PSD significant levels for criteria pollutants. The emissions presented in this permit application are based on this fuel use limit.

2.2.2 Support of Wind and Power Generation

The proposed Matagorda Energy Center will produce electricity by compressing air during off-peak demand periods for subsequent use in generating electricity during peak demand periods. This facility has the unique capability of providing bulk storage of energy generated by wind and solar energy facilities during periods of low electrical demand. Installed wind capacity within ERCOT has increased from 863 MW in 2002 to 9,609 MW at year end 2011, representing an eleven-fold increase. [Source: ERCOT Capacity/Demand/Reserves Report, 2002 and December 2011.]

In numerous reports, the United States Department of Energy (DOE) has addressed the role storage can play in accommodating intermittent renewable generation resources:

- "Energy storage can further enhance the potential of renewable energy by providing load shifting, peak shaving, dispatchability, and a means to bring stranded renewable energy into the grid" (DOE, 2012).
- "In grids with a significant share of wind generation, intermittency and variability in wind generation output due to sudden shifts in wind patterns can lead to significant imbalances between generation and load that in turn result in shifts in grid frequency. Such imbalances are usually handled by spinning reserve at the transmission level, but energy storage can provide prompt response to such imbalances without the emissions related to most conventional solutions" (DOE, 2008a).
- "Energy storage technologies are not an alternative to any particular resource decision; rather, they are a valuable adjunct to all resources, and they will allow increased capacity to be derived from any given quantity of physical resources" (DOE, 2008b).

The Matagorda Energy Center enhances the integration of wind (and other intermittent generating resources, such as solar power) within the ERCOT market.

2.3 Emission Sources

2.3.1 Expansion Turbine Generators

The electric generation process will consist of two 158.34-MW expansion turbine trains. Electricity generation will involve passing compressed air through the topping, HP and LP expansion turbines and heating the air with natural gas in advance of the HP and LP expansion turbine stages. In addition, the air is preheated before entering the first stage of expansion in a recuperator, capturing exhaust heat from the expanders.

2.3.2 Wet Cooling Towers

Two sets of wet cooling towers will be installed to provide cooling for the air between stages of compression. Since this source does not emit GHG emissions, it is not included in the GHG BACT analysis.

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2.3.3 Fugitive Emissions

Process fugitive emissions consist of hydrocarbon emissions and ammonia emissions from potential equipment leak points, and sulfur hexafluoride (SF_6) leaks from circuit breakers. APEX is proposing a comprehensive equipment maintenance program that will include periodic inspections for leaks and subsequent repair.

2.3.4 Emergency Generator Engine

One natural gas fired emergency generator engine will be used to provide emergency power for the facility. This engine will typically operate only during testing, anticipated to occur approximately once per month for 30 minutes per testing event. For permitting purposes, the total operating hours for the emergency generator are assumed to be 50 hours per year or less. A 740 ekW Caterpillar G3516 SITA model engine is proposed for the facility.

2.3.5 Aqueous Ammonia Storage Tank

An aqueous ammonia storage tank will be installed to provide ammonia for the SCR emission control system employed to reduce NO_X emissions from the turbine trains. This storage tank will not emit GHGs and is therefore not included in the emission inventory or BACT analysis.

2.3.6 Facility Maintenance Activities

Facility maintenance activities may also generate insignificant emissions from time to time, during the process of purging equipment prior to inspection and repair. These emissions will consist primarily of methane and small amounts of VOC from the pipeline supply.

2.4 Non-Emitting Facility Components

2.4.1 Ancillary Facilities

Other facilities used to support power generation at the Matagorda Energy Center will include the following:

- Water treatment system to remove solids and hardness from plant makeup water
- Wastewater treatment system to allow recycle of cooling tower blow-down and other plant wastewater
- Plant and instrument air compressors (electric-driven) and auxiliary equipment
- Plant sumps and sump pumps
- An electrically driven fire pump
- Miscellaneous fire protection equipment
- A pipeline and pump for conveyance of cooling water blowdown to the existing adjacent brine production facility
- Septic system for sanitary waste
- Process/potable water wells
- Stormwater detention basins
- Administration and warehouse/maintenance buildings
- Air storage cavern
- Electrical substation
- Natural gas compression station driven by an electric motor

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Electrical transmission will also be required for the facility development. Within ERCOT, the transmission lines are independently sited and operated by a Transmission and Distribution Utility (TDU), not the generator. The TDU, not APEX, will evaluate the alternative routes and present its case to the Texas Public Utility Commission (PUC) in accordance with the PUC's rules and procedures for granting of a Certificate of Convenience and Necessity (CCN) for new transmission line construction or upgrading. Under this law and by PUC practice, comprehensive evaluation of environmental impacts of proposed lines is required as a component of the CCN approval process. Once a route for any new construction (as well as plans for any necessary network upgrades) is approved, the TDU will design, build, own, and operate the interconnection facilities. Texas law and PUC rules entitle generators to interconnection with costs (other than the step-up transformers and related protection at the plant site) being borne by the broad market.

2.5 Emission Control Summary

The Matagorda Energy Center will include the following air emission controls:

- Low NO_X burners with water injection on the expander combustors and a SCR system to reduce NO_X emissions from the expansion turbine train
- An oxidation catalyst to reduce carbon monoxide (CO) and volatile organic compound (VOC) emissions from the expander combustors
- Good combustion design and operation to reduce emissions of particulate matter of 10 microns in diameter (PM_{10}) and 2.5 microns in diameter ($PM_{2.5}$) from the expander combustors
- Use of pipeline-quality natural gas to minimize sulfur dioxide (SO_2) emissions from the expander turbine trains
- High-efficiency drift eliminators on the cooling towers to reduce PM_{10} and $PM_{2.5}$ emissions in the cooling tower drift
- NSCR system controlling NO_X, CO, and VOC emissions from the emergency generator engine

2.6 Emissions Monitoring

APEX is proposing to monitor the quantity of fuel combusted by the turbines in order to calculate carbon dioxide (CO_2) emissions, net heat rate (BTU/kWh) in conjunction with kWh produced, and lb CO_2 per MWh on a rolling 365 day period. This represents direct demonstration of compliance with the BACT limitations and therefore monitoring of other operating parameters is not needed to demonstrate compliance. The facility will also analyze the natural gas fuel quality as required by the Acid Rain Program to determine the HHV of the fuel (or Carbon Based Fc-Factor as presented in 40 Code of Federal Regulations [CFR] Part 75). This approach will be consistent with Acid Rain Program in 40 CFR Part 76, GHG Mandatory Reporting Rules in 40 CFR Part 98, Subpart D, and the proposed NSPS Subpart TTTT rule.

The emissions inventory in Appendix B shows air and fuel flow rates at various points in the turbo expander load range. At 100 percent load, the quantity of air represents approximately 2.77 times the stoichiometric requirements. Air-fuel ratio of the turbo-expanders will be controlled by monitoring the turbine inlet temperature at the combustor exit. A secondary measurement will be based on the apparent fuel-air ratio based on the inlet air mass flowmeter, and the HP and LP fuel gas flowmeters. Both means of determining and controlling the fuel-air ratio will be in continuous operation while the turbo-expanders are in operation.

For the HP combustors, the exit temperature is measured at the combustor exit, just ahead of the stage 1 turbine nozzles. Temperatures are monitored in four locations around the arc of admission, averaged to determine the overall inlet temperature, and compared to the inlet air temperature to calculate the fuel-air ratio. These

US EPA ARCHIVE DOCUMENT

temperatures are monitored continuously, and their output is fed back to the fuel controls to maintain a constant 540°C turbine inlet temperature.

For the LP combustors, the turbine inlet temperature is too high at 1600°F (872°C) for reliable direct temperature measurement. The turbine inlet temperature is therefore determined by measuring the exhaust temperature at nine locations around the exhaust diffuser exit. The turbine flowpath delta T is a known function of mass air flow and pressure ratio, which is then added to the averaged exhaust temperature to obtain turbine inlet temperature. The turbine inlet temperature is compared to the HP expander exhaust temperature to determine temperature rise and air-fuel ratio in the LP combustors.

In addition to the direct temperature measurements, mass airflow and mass fuel flows to both sets of combustors are measured and monitored by the plant control and data logging systems. An alert is triggered when the difference between fuel-air ratios based on the temperature measurements and those based on air and fuel mass flow measurements are out of range.

2.7 Inspection Schedule

The burners for the APEX Matagorda Energy Center will operate at a pressure of approximately 800 psia for the HP combustors, and 265 psia for the LP combustors (at maximum rated output). Under these circumstances, inspection of the burners while in service is impractical and unsafe.

The burner maintenance and inspection schedule found in Appendix B was provided by Dresser-Rand (Table 1 and Table 1A). APEX will follow the Dresser-Rand maintenance schedule, for the combustors, burners and turbo expanders. This schedule is subject for revision by Dresser-Rand.

To demonstrate performance of the recuperator, air and exhaust gas temperatures will be measured upstream and downstream of the recuperator. Temperatures found to be outside the desired range will trigger an alert to operators.

2.8 Operating Schedule

The annual operating schedule of the Matagorda Energy Center will be dependent on the demand for electric power within the ERCOT system. Thus, the exact operating schedule cannot be precisely predicted at this time.

The permit limits requested in this application, and the resulting assumptions used in the GHG emission calculations and BACT analysis, are as follows:

- Up to 7,807,409 MMBtu per year of operation (including normal operation, startups, and shutdowns) for both turbine trains combined at various loads (100 percent load or at any lesser load rate), based on HHV of the natural gas fuel
- Up to 365 startups and 365 shutdowns for each turbine train per year
- Up to 50 hours per year operation of the emergency generator engine

The expansion turbine fuel usage is based on continuous operation. In other words, the facility could operate up to 8,760 hours per year (counting startup and shutdown episodes) and could operate 24 hours per day, 7 days per week, and 365 days per year.

2.9 Permitting and Construction Schedule

The planned permitting and construction timeline is shown in Table 2-1.

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TABLE 2-1
Permitting and Construction Schedule

Event	Date
Air Permit Application Filed with EPA	November 20, 2012
Air Permit Application Filed with TCEQ	November 20, 2012
Air Permits Issued by EPA and TCEQ	November 20, 2013
Start of Construction	4th Quarter 2013
Commercial Operation	3rd Quarter 2016

US EPA ARCHIVE DOCUMENT

SECTION 3.0

GHG Emissions Summary

GHG emission estimates were prepared for all emissions sources from the Matagorda Energy Center, including the turbines and auxiliary equipment. Detailed GHG emission calculations are provided in Appendix B.

3.1 Expansion Turbines

The APEX Project consists of two nominal 158.34-MW expansion turbine generators. Each expansion turbine train has a separate stack. GHG emissions for the expansion turbine trains were calculated for normal operating mode, as well as startup and shutdown events, using emission factors obtained from the federal Mandatory GHG Reporting Rule, 40 CFR Part 98. The design maximum natural gas fuel usage rates utilized in the calculations were increased by three percent to account for equipment degradation between overhauls. The annual carbon dioxide equivalent (CO_2e) emissions from the turbine trains were estimated based on a maximum fuel usage of 7,807,409 MMBtu of natural gas usage for both turbine trains combined (including startup and shutdowns).

3.2 Auxiliary Equipment

In addition to the two expansion turbine trains planned for the Matagorda Energy Center, there are fugitive emissions from equipment leaks and an emergency generator that will emit GHGs. Facility maintenance may also emit GHGs during equipment purging prior to inspection and repairs. Estimated GHG emissions from the auxiliary equipment and maintenance activities are:

- Fugitives with estimated emissions of 254 CO_2e tons/year
- One natural gas-fired emergency generator (nominal 1,053-BHP engine with estimated emissions of 23 CO_2e tons/year)
- Facility maintenance activities with estimated emissions of 85 CO_2e tons/year

3.3 GHG Emission Summary

The GHG emission sources for the Project are shown in Table 3-1, along with estimated annual CO_2e emissions.

TABLE 3-1
GHG Emission Source Summary

Emission Point Number	Emission Point	Estimated Annual CO_2e Emissions (tpy)
TURBASTK, TURBBSTK, TURBASTK(SS), TURBBSTK(SS)	Two (2) Nominal 158.34-MW Expansion Turbines (including normal emissions and startup/shutdown emissions)	458,769
FUG1	Fugitives	254
GENENG1	One (1) Natural Gas-fired Emergency Generator	23
MAINT1	Facility Maintenance Activities	85
TOTAL		459,131

US EPA ARCHIVE DOCUMENT

SECTION 4.0

Regulatory Review

This section provides a regulatory review of the applicability of federal air quality permitting requirements for GHGs and GHG air pollution control regulations for the Matagorda Energy Center Project. The purpose of this section is to provide appropriate explanation and rationale regarding the applicability of these regulations to the Matagorda Energy Center. The review is limited to federal regulations for GHG because no State of Texas regulations for GHG apply to the permitting of Matagorda Energy Center. TCEQ has not adopted regulations under the Tailoring Rule. Therefore, TCEQ is the permitting authority for the Matagorda Energy Center non-GHG pollutants (other regulated New Source Review [NSR] pollutants), while EPA Region 6 is the permitting authority for the Matagorda Energy Center GHG pollutants.

4.1 Federal Regulations

The proposed Project was evaluated to determine compliance with applicable federal GHG air quality regulations. Potentially applicable federal GHG regulations include the following:

- Final Prevention of Significant Deterioration and Title V Greenhouse Gas Tailoring Rule (Tailoring Rule) – 40 CFR 51.166, 52.21, as published in the *Federal Register* (FR) June 3, 2010 (75 FR 31514)
- Federal Implementation Plan (FIP) for State of Texas GHG – 40 CFR 52.37, as published in the *Federal Register*: 75 FR 82246 (December 30, 2010)) (interim rule); 76 Fed. Reg. 25178 (May 3, 2011) (final rule).
- New Source Review (NSR) – 40 CFR 51 and 52

On April 2, 2007, the U.S. Supreme Court found that GHGs are air pollutants under Clean Air Act (CAA) Section 302(g) (*Massachusetts* v. *EPA,* 549 U.S. 497 [2007]). GHG includes the six gases of CO_2, nitrous oxide (N_2O), methane (CH_4), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and SF_6. Of these, the first three and SF_6 will be emitted from the Matagorda Energy Center. These gases have different potential to affect global warming, termed the global warming potential (GWP). The GWP of the four emitted gases are: CO_2 (1), N_2O (310), CH_4 (21), and SF_6 (23,900).

Based on the series of legal and regulatory actions that culminated in the Tailoring Rule, regulation of major increases of GHG emissions through the Prevention of Significant Deterioration (PSD) permit program is required. EPA recognized that application of the major source threshold levels for the criteria pollutants for PSD pollutants of 100 or 250 tons per year (tpy) to GHG emissions would make virtually every new project a major source. Accordingly, in June 2010, EPA adopted the Tailoring Rule to establish a major source threshold for GHG of 100,000 tons of GHG per year.

The State of Texas has an approved State Implementation Plan (SIP) based program for the criteria pollutants for the PSD permitting of new major sources. However, Texas has decided not to include GHG in the state PSD permitting program. Accordingly, the GHG PSD program is being implemented by the EPA for major sources of GHG within the State of Texas through the federally approved FIP.

4.1.1 Greenhouse Gas Tailoring Rule

On June 3, 2010, EPA issued the final Tailoring Rule (75 FR 31514), which allowed the phasing in of the PSD permitting process for new major sources of GHGs such as the Matagorda Energy Center. Step 2 of the Tailoring Rule requires that beginning July 1, 2011, all new sources with the potential to emit (PTE) greater than 100,000 tpy of CO_2e (including the statutory threshold of 100 or 250 tons on a mass basis) comply with PSD and Title V requirements. All references to “tons” are provided in terms of short tons (2,000 pounds/ton) instead of metric tonnes, in accordance with EPA GHG PSD permitting guidance.

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As shown in Table 4-1, under the Tailoring Rule, the Matagorda Energy Center will be a major source subject for PSD permitting because the total emissions of CO_2e exceed 100,000 tpy. The APEX Project will result in CO_2e emissions of 459,125 tpy. Therefore, the Project is classified as a major source for PSD applicability determination.

TABLE 4-1
GHG Pollutants Expected to be Emitted, Annual Emission Rates, Global Warming Potential, and Annual Emissions Rates Adjusted for Global Warming Potential

Pollutant	Proposed Facility GHG Emissions (tpy)	Global Warming Potential (GWP)	CO_2e GHG Emissions Adjusted for GWP (tpy)
Carbon Dioxide (CO_2)	456,319	1	456,319
Nitrous Oxide (N_2O)	7.12	310	2,208
Methane (CH_4)	22.5	21	473
Sulfur hexafluoride (SF_6)	0.005	23,900	131
Total GHG as CO_2e	----	----	459,131

4.1.2 Other PSD Requirements

In accordance with EPA's March 2011 PSD and Title V Permitting Guidance for GHGs, the following elements of PSD review are not required for GHG pollutants and therefore have not been included in this application: an impacts analysis; PSD additional impacts analysis; and GHG preconstruction monitoring analysis.

4.1.3 Federal Implementation Plan for Texas

EPA has determined that the Texas SIP is deficient for purposes of the PSD permitting of GHG. Accordingly, EPA adopted a FIP in which it retains the authority to issue a PSD permit for GHG. Thus, this application is being filed with EPA Region 6 for the sole purpose of obtaining a PSD permit for the emissions of GHG from the Matagorda Energy Center. A permit for the emissions of the criteria and hazardous air pollutants from Matagorda Energy Center will be obtained from the State of Texas.

EPA has not adopted ambient air quality standards or finalized new source performance standards for GHG. Accordingly, this application only contains a BACT analysis for GHG.

4.1.4 New Source Review

PSD is the portion of NSR that applies to pollutants that are in attainment of National Ambient Air Quality Standards (NAAQS). Since there are no ambient air quality standards for GHG, major new or modified air emission sources are potentially subject to PSD review rather than non-attainment NSR review for GHG pollutants.

The first step in PSD review is determining whether the proposed facility is a major PSD source. As noted above, the Matagorda Energy Center will be a major source. Therefore, Matagorda Energy Center is subject to PSD review for GHG. The primary PSD requirement is application of BACT to emissions of GHG.

US EPA ARCHIVE DOCUMENT

SECTION 5.0

Greenhouse Gas BACT Analysis

5.1 Background

APEX plans to build a compressed air energy storage plant in Matagorda County, Texas (the Project). The Matagorda Energy Center will consist of a total of two natural gas-fired expansion turbine generators sized at a nominal 158.34-MW capacity each and will be equipped with low NO_X burners with water injection and SCR for NO_X control and Catalytic Oxidation for CO and VOC control. Matagorda Energy Center auxiliary equipment includes two sets of mechanical draft wet cooling towers, one natural gas fired emergency generator engine, and an aqueous ammonia storage tank.

5.1.1 APEX Energy Storage Technology Selection

APEXs has determined that the proposed Dresser-Rand CAES technology is the only alternative that meets all of the Matagorda Energy Center requirements for economic and reliable power 24 hours per day and in all weather conditions. APEX reached this determination on the basis of extensive economic analysis of all generating technology alternatives available for installation at a site within the ERCOT market.

5.2 Regulatory Basis

GHGs have become subject to emission permitting through PSD and Title V programs. On June 3, 2010, EPA issued the final Tailoring Rule (75 FR 31514), which allowed phasing in the PSD permitting process for new sources of GHGs such as the Matagorda Energy Center. Step 2 of the Tailoring Rule requires that beginning July 1, 2011, all new sources with PTE greater than 100,000 tpy of GHGs on a CO_2e basis, and with a GHG PTE of 100 or 250 tpy, depending on source type, on a mass basis will become subject to PSD and Title V requirements. All references to tons within the table and in this BACT analysis are provided in terms of short tons (2,000 pounds/ton) instead of metric tonnes, in accordance with EPA GHG PSD permitting guidance.

The Matagorda Energy Center will be a new source with a GHG PTE of greater than 100,000 tpy CO_2e. Because the TCEQ has a SIP-approved PSD program for all criteria pollutants but has not adopted regulations under the Tailoring Rule, TCEQ is the permitting authority for the Matagorda Energy Center non-GHG pollutants (other regulated NSR pollutants), while EPA Region 6 is the permitting authority for the Matagorda Energy Center GHG pollutants. Therefore, this GHG BACT analysis is presented EPA Region 6 as part of the Matagorda Energy Center permit application process.

5.3 Emissions Summary

Per EPA Tailoring Rule definitions, GHGs consist of the following gases:

- Carbon Dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)
- Sulfur hexafluoride (SF_6)

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To determine CO_2e emissions, mass flows of each individual gas emitted are multiplied by the appropriate Global Warming Potential (GWP) as referenced to the Intergovernmental Panel on Climate Change (IPCC) Second Assessment Report, and the results are summed.

The expansion turbine combustors will be fired with pipeline-quality natural gas, and complete combustion will result in water and CO_2 byproducts. However, incomplete combustion will result in some unburned natural gas CH_4 emissions. Additionally, because of the presence of nitrogen in the combustion air, some small quantities of N_2O will also be emitted.

The standby generator engine will be fired with natural gas, again resulting in CO_2 emissions from oxidation of the fuel, minor quantities of CH_4 emissions resulting from incomplete combustion, and N_2O emissions from conversion of nitrogen from the atmosphere and fuel.

Fugitive emissions from equipment leaks consist of hydrocarbons, including CH_4, CO_2, and SF_6, which may be used as an insulating gas for high-voltage equipment and circuit breakers.

In addition, equipment maintenance activities may emit GHGs during equipment purging prior to inspection and repairs. These emissions will consist primarily of CH_4 and other hydrocarbons.

Table 5-1 represents potential sources and estimated quantities of GHG emissions from the Matagorda Energy Center equipment.

TABLE 5-1
Matagorda Energy Center Estimated GHG Emissions by Equipment Category

Equipment/Activity	Description	Total CO_2e Emissions (tpy)
Two (2) Expansion Turbine Trains	Maximum Heat Input Each 695.1 MMBtu/hr Higher Heating Value (HHV)**	**458,769** (including normal, startup, and shutdown operating conditions)
Fugitive Equipment Leaks	Weight percent of methane in gas stream 90.7 percent	**254**
One (1) Natural Gas-Fired Emergency Generator	Maximum Heat Input 7.78 MMBtu/hr	**23**
Facility Maintenance Activities	Emissions during purging of equipment prior to maintenance	**85**
Total		**459,131**

*** Design maximum heat input to turbines was adjusted upward by 3% to account for equipment degradation between overhauls.*

5.3.1 GHG BACT Analysis Assumptions

During the completion of GHG BACT analysis, the following assumptions were made:

1. Table 5-1 presents the estimated Matagorda Energy Center GHG emissions in terms of CO_2e emissions, and only includes emissions of CO_2, CH_4, N_2O, and SF_6. The Matagorda Energy Center is not expected to emit HFCs or PFCs because these manufactured gases are primarily used as cooling, cleaning, or propellant agents.
2. From the GHG emissions inventory presented in Appendix B, the relative quantities of CH_4, N_2O, and SF_6 total only approximately 2812 tpy of CO_2e, or approximately 0.61 percent of total CO_2e emissions. Due to the extremely small contribution of these three constituents to the total GHG emissions, the Matagorda Energy Center GHG BACT analysis only included the five-step process for CO_2 emissions.
3. Installation of low NO_X burners with water injection and an SCR system for NO_X emissions reduction, and an oxidation catalyst for control of CO and VOCs for each expansion turbine train will be required to meet the

US EPA ARCHIVE DOCUMENT

requirements of the TCEQ Standard Permit for EGUs and result in emissions below criteria pollutant PSD permitting thresholds.

4. During actual expansion turbine operation, the oxidation catalyst may result in minimal increases in CO_2 from the oxidation of any CO and CH_4 in the flue gas. However, the EPA Final Mandatory Reporting of Greenhouse Gases Rule (Mandatory Reporting Rule or MRR) (40 CFR 98) factors for estimating CO_2e emissions from the combustion of natural gas assume complete combustion of the fuel. While the oxidation catalyst has the potential of incrementally increasing CO_2 emissions, these emissions are already accounted for in the MRR factors and included in the CO_2e totals.

5. Similarly, the SCR catalyst may result in an increase in N_2O emissions. Although quantifying the increase is difficult, it is generally estimated to be very small or negligible. From the GHG emissions inventory, the estimated N_2O emissions from all combustion turbines total only 7.12 tpy. Therefore, even if there were an order of magnitude increase in N_2O because of the SCR, the impact to total CO_2e emissions would be insignificant.

Use of the SCR and oxidation catalyst slightly decreases the Project thermal efficiency due to backpressure on the expansion turbines (these impacts are already included in the emission inventory) and, as noted above, may create a marginal but unquantifiable increase to N_2O emissions. The expansion turbine SCR systems will be designed to reduce NO_X from the expander low-NO_X burners (LNBs) with water injection. Similarly, the oxidation catalyst systems have the benefit of reducing CO and VOC emissions.

While elimination of the NO_X and CO/VOC controls could conceivably be considered as an option within the GHG BACT, the environmental benefits of the NO_X, CO, and VOC control are assumed to outweigh the marginal increase to GHG emissions. Thus, even if carried forward through the GHG BACT analysis, they would be eliminated in Step 4 because of other environmental impacts. *See* EPA's *PSD and Title V Permitting Guidance for Greenhouse Gases* (EPA, 2011). Therefore, we have not considered omission of these controls within the BACT analysis.

5.4 Top-Down BACT Process

The EPA has developed a recommended process for conducting BACT analyses, referred to as the "top-down" method. The following steps to conduct a top-down analysis are listed in the EPA's *New Source Review Workshop Manual* (EPA, 1990):

- Step 1: Identify all control technologies
- Step 2: Eliminate technically infeasible options
- Step 3: Rank remaining control technologies by control effectiveness
- Step 4: Evaluate most effective controls and document results
- Step 5: Select BACT

Each of these steps, described in the following sections, has been conducted for GHG emissions for the Matagorda Energy Center. The following top-down BACT analysis for CO_2e has been prepared in accordance with the EPA's *New Source Review Workshop Manual* (EPA, 1990) and *PSD and Title V Permitting Guidance for Greenhouse Gases* (EPA, 2011). A top-down BACT analysis takes into account energy, environmental, economic, and other costs associated with each alternative technology.

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5.5 Expansion Turbine BACT for GHGs

5.5.1 Step 1: Identify All Control Technologies

The expansion turbine generators will be nominal 158.34 MW machines that utilize the latest emissions control technology. There are two basic alternatives identified to limit the GHG emissions of the Project. These options include:

- Carbon Capture and Storage (CCS)
- Electrical Generation Conversion Efficiency (Energy Efficiency)

APEX has determined that the proposed Dresser-Rand CAES technology is the only alternative that meets all of the Matagorda Energy Center requirements for economic operation within the ERCOT market. As such, other generation technologies such as coal, conventional gas-turbine based generation, reciprocating engines, wind, and solar were not evaluated in this BACT analysis. This is consistent with EPA's March 2011 *PSD and Title V Permitting Guidance for Greenhouse Gases,* which states, "EPA has recognized that a Step 1 list of options need not necessarily include inherently lower polluting processes that would fundamentally redefine the nature of the source proposed by the permit applicant…", and "…the permitting authority should keep in mind that BACT, in most cases, should not regulate the applicant's purpose or objective for the proposed facility…" (p. 26). Nonetheless, it should be noted that the Matagorda Energy Center is intended to provide secure, reliable capacity to the grid, assisting the grid operator in coping with the intermittent nature of solar and wind generation, and renewable generation is not an effective supplement and backup for other renewable generation.

The only identified alternatives are post-combustion CCS and energy efficiency of the proposed generation facility.

5.5.2 Step 2: Eliminate Technically Infeasible Options

Carbon Capture and Storage Systems

CCS systems involve use of adsorption or absorption processes to remove CO_2 from flue gas, with subsequent desorption to produce a concentrated CO_2 stream. The concentrated CO_2 is then compressed to "supercritical" temperature and pressure, a state in which CO_2 exists neither as a liquid nor a gas, but instead has physical properties of both liquids and gases. The supercritical CO_2 would then be transported to an appropriate location for underground injection into a suitable geological storage reservoir, such as a deep saline aquifer or depleted coal seam, or used in crude oil production for enhanced oil recovery.

The concentration of CO_2 is required because injection of exhaust streams containing high levels of nitrogen, oxygen and dilute CO_2 is not technically feasible. Research into technically and economically feasible capture systems is ongoing and is the focus of many large-scale grants from the DOE. Adequate techniques for compression of CO_2 exist, but such compression systems require large amounts of energy. Furthermore, the capture process is energy intensive. It is estimated that a significant portion of power plant output would be required for CO_2 capture and subsequent compression. As an example, as stated in the August 2010 *Report of the Interagency Task Force on Carbon Capture and Storage*, "For a [550 MWe net output] natural gas combined cycle (NGCC) plant, the capital cost would increase by $340 million and an energy penalty of 15 percent would result from the inclusion of CO_2 capture."

Research into geologic storage requirements is also ongoing. DOE research programs are investigating the reliability, permanence, risks, required monitoring, verification, and other issues to be addressed before geologic storage can proceed on a large commercial scale. Many regulatory issues remain to be resolved, such as pore space ownership, financial responsibility requirements, long-term risk following closure of the sequestration site, and issues regarding CO_2 purity and potential contamination of aquifers.

CCS systems are not currently available on a commercial basis. Large-scale demonstration projects are currently being planned or are in early stages of development, but no company or vendor currently offers a commercially available turn-key, integrated CCS system.

US EPA ARCHIVE DOCUMENT

The Interagency Task Force on Carbon Capture and Storage consists of 14 executive departments and federal agencies, co-chaired by the DOE and EPA. As detailed in its August 2010 report, one goal of the task force is to bring five to 10 commercial demonstration projects online by 2016. With demonstration projects still years away, clearly the technology is not currently commercially available.

In the EPA PSD GHG permitting guidance, it is acknowledged that, "A number of ongoing research, development, and demonstration projects may make CCS technologies more widely applicable *in the future*" (italics added). "While CCS is a promising technology, EPA does not believe that at this time CCS will be a technically feasible BACT option in certain cases." As noted above, to establish that an option is technically infeasible, the permitting record should show that an available control option neither has been demonstrated in practice nor is available and applicable to the source type under review. EPA recognizes the significant logistical hurdles that the installation and operation of a CCS system presents, clearly distinguishing CCS from add-on control technologies that are typically used to reduce emissions of other regulated pollutants. Logistical hurdles for CCS may include obtaining contracts for offsite land acquisition (including the availability of land), the need for funding (including, for example, government subsidies), timing of available transportation infrastructure, and developing a site for secure long-term storage. Not every proposed project will have the resources to overcome the offsite logistical barriers necessary to apply CCS technology to its operations, and smaller sources will likely be especially constrained in this regard.

The Interagency Task Force report notes the lack of demonstration in practice: "Current technologies could be used to capture CO_2 from new and existing fossil energy power plants; however, they are not ready for widespread implementation primarily because they have not been demonstrated at the scale necessary to establish confidence for power plant application. Since the CO_2 capture capacities used in current industrial processes are generally much smaller than the capacity required for the purposes of GHG emissions mitigation at a typical power plant, there is considerable uncertainty associated with capacities at volumes necessary for commercial deployment."

Therefore, the CCS alternative is not considered technically feasible for the Matagorda Energy Center and is eliminated from further consideration. While it is being eliminated based on technical feasibility in Step 2, it should be acknowledged that even if carried forward for further analysis, it would undoubtedly be eliminated in Step 4 based on cost effectiveness. A qualitative cost analysis has been included in Step 4 to demonstrate the economic infeasibility.

EPA's *PSD and Title V Permitting Guidance for Greenhouse Gases* (EPA, 2011) identifies three categories of control alternatives (p. 25):

1. Inherently lower-emitting processes/practices/designs
2. Add-on controls
3. Combinations of lower-emitting process/practices/designs and add-on controls

Because there are no demonstrated add-on controls, only those processes, practices, and designs that result in lower GHG emissions are applicable for this BACT analysis.

5.5.3 Step 3: Rank Remaining Control Technologies by Control Effectiveness

Since CCS is eliminated in Step 2 as a technically infeasible control technology, the only remaining technology identified in Step 1 is energy efficiency. Since only one control technology remains at this step of the BACT analysis, ranking of numerous control technology options is not applicable.

5.5.4 Step 4: Evaluate Most Effective Controls and Document Results

As demonstrated in Step 2, CCS is not a technically feasible alternative for the Matagorda Energy Center. Although not required, a site specific analysis is presented below to demonstrate that even if CCS were technically feasible it would not be economically feasible.

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5.5.4.1 Facility Information

The Table below shows site specific Matagorda Energy Center information to comprehensively evaluate the cost of CCS as a CO_2 reduction technology for the Matagorda Energy Center. Table 5-2 below provides an estimate of CO_2 quantity and concentration in the Matagorda Energy Center flue gas over the rated load range for each combustion turbine.

TABLE 5-2
CO_2 Quantity and Concentration

Load	Stack Flowrate (acfm)	Concentration CO_2 (%)	Quantity CO_2 (lb/sec)
100% of Rated Output	452,569	3.5	1,351
75 % of Rated Output	344,042	3.4	985
50% of Rated Output	232,590	3.2	607
25% of Rated Output	167,291	2.8	389
11% of Rated Output	98,650	1.7	141

5.5.4.2 Cost Analysis

Estimates for the Matagorda Energy Center CCS were prepared utilizing two primary sources: 1) vendor information, and 2) published cost estimating information.

Carbon Capture Cost Estimate

Information was requested from a major carbon capture system vendor to include carbon capture system preliminary design, budgetary pricing, and operational details for the Matagorda Energy Center. The following flue gas information was utilized as a basis of design over the anticipated operating range:

Flow rate: ~ 99,000 to 453,000 actual cubic feet per minute per unit (40 MMSCF/hr maximum instantaneous total for both units)
Temperature: 210 to 230 degrees F
CO_2 concentration: 1.7 to 3.5%
CO_2 target removal rate: 90%

The estimated annual CO_2 emissions at maximum yearly fuel usage for both trains at the Matagorda Energy Center are 445,104 tons CO_2 per year (excluding startup and shutdown operating conditions) based on a federally enforceable combined fuel limit. With an estimated 90 percent reduction from the carbon capture system, the total captured CO_2 will be a maximum of approximately 400,594 tons per year.

The vendor response included information for a post combustion amine scrubbing system. The design flue gas flow rate was based on 40 MMSCF/hr, which is based on the maximum total flue gas flow rate from two units. The scrubber system design is capable of recovering approximately 69.9 tons of CO_2 per hour (609,550 tpy) at maximum capacity, but will be effectively limited to the 400,594 tons CO_2 per year, based on federally enforceable fuel limits.

Vendor Information

The following information is summarized from the vendor response for a carbon capture amine scrubber system.

Major Equipment List

There are three major categories of equipment included with the scrubber system: 1) flue gas pretreatment, 2) CO_2 absorption, and 3) solvent regeneration.

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Flue gas pretreatment - Because the flue gas temperature from the combustion turbine is too high to be fed directly into the CO_2 absorber; the flue gas must first be cooled through the use of a heat exchanger.

CO_2 Absorption - The CO_2 absorber is a packed column where the flue gas is first treated in the CO_2 absorption section in the lower absorber section, and treated flue gas then passes through a water wash located in the upper section before exiting the absorber and being exhausted to atmosphere. The CO_2-rich solvent from the absorber is pumped to the regenerator.

Solvent Regeneration - The regenerator is also a packed column where the CO_2 is removed from the rich solvent with the use of steam. The rich solvent is stripped of CO_2, regenerated to a lean solvent, and returned to the CO_2 absorber. The CO_2 product gas stream is available for recovery or compression required for transport.

CO_2 Compression - In preparation for transport either to storage or enhanced oil recovery (EOR) applications, the CO_2 must be dehydrated and compressed to a supercritical phase which corresponds to a pressure of up to approximately 2,200 psi. This compression is required to minimize transport pipe diameter and avoid two-phase flow in the pipe.

Cost Estimate

The carbon capture vendor provided a budgetary installed cost estimate for the CO_2 capture equipment plus the CO_2 compression and dehydration equipment, which was $230 million.

Parasitic Power Estimate and Heat Rate Impact

The vendor also provided the following indicative estimates for equipment power consumption:

- CO_2 capture and recovery equipment: 4.85 MW
- CO_2 compression and dehydration equipment: 6.40 MW

Utility Requirements

- Nominal process steam requirement: 180,000 lb/hr @ 50 psig and 360 °F
- Process cooling water requirement: 975 gpm makeup

Approximately 200 MMBtu/hr of steam energy will be required, which would require the installation of an on-site auxiliary boiler to provide the steam. Assuming a 70 percent boiler conversion efficiency, an approximate 300 MMBtu/hr auxiliary boiler would be required.

The current Matagorda Energy Center net heat rate is 4,390 Btu/kWh higher heating value (HHV) at maximum load. Allowing for the impact of the power and steam requirements for the carbon capture, compression, and dehydration equipment, the resultant Matagorda Energy Center net heat rate would be increased by approximately 26 percent to 5,534 Btu/kWh (HHV).

New Heat Rate Adjustment = (Original Heat Input +Additional Heat Input)/ (Original net power output-Reduction in net power output)

(1,390 MMBtu/hr + 300 MMBtu/hr)/(316,676 kW -11,250kW) = 5,534 Btu/kWh

Carbon Transport and Storage

Estimates for the Matagorda Energy Center carbon transport and storage were primarily derived from the referenced information below.

Transport Piping Size

Table 1 in the *Carbon Management GIS: CO_2 Pipeline Transport Cost Estimation* (MIT, 2009) provides an estimated pipeline size based on CO_2 flow rate. With the calculated maximum CO_2 flow rate of approximately 400,594 tons CO_2 per year, the estimated pipeline diameter is 6 inches.

CO_2 Transport Pipeline Boosting Compression Cost Estimate

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In the *CO_2 Transportation Cost Calculations* (CCPC, 2011), estimated capital cost of boosting compression can range from $3.5 to $6 million per MW of booster compression power installed which includes capital and power costs over the lifetime of the installation. This boosting compression is to overcome pipeline pressure drop associated with the CO_2 mass flow, and is in addition to the compression required to change the captured CO_2 to a "supercritical" temperature and pressure in preparation for transport. However, since the estimated length of transport pipeline is assumed to be less than 40 miles, no boosting compression costs are anticipated for the Matagorda Energy Center.

Any cooling water or associated equipment required for CO_2 compression process has not been included in the cost and therefore would be additive to the values presented below.

Transport Piping Cost Estimate

Also from Reference 1, 2007 CO_2 pipeline construction cost is estimated by the equation below;

LCC = a * D * L * (2007 Index)

LCC = Land Construction Cost
a = $33,853
D = pipeline diameter in inches (estimated 6 inches for Matagorda Energy Center)
L = pipeline length in miles

Calculations result in approximately $200,000 per mile for a 6-inch pipeline in 2007 dollars.

This equation can be utilized to estimate the Matagorda Energy Center transport piping cost by comparing to the 232-mile Greencore CO_2 pipeline project from Wyoming to Montana. The Greencore project consists of a 20-inch pipeline, and is estimated to cost $275 to $325 million to complete (Reference 8) or approximately $1.2 to $1.4 million per mile in 2012 dollars. Using the LCC equation above and scaling the 20-inch Greencore project cost per mile to the Matagorda Energy Center 6-inch pipeline, the result is $420K per mile.

Using Table 3.1 from the *Carbon Management GIS: CO_2 Pipeline Transport Cost Estimation*, construction conditions can significantly impact overall pipeline costs; with highway or railroad crossing costs resulting in 3 times base case cost, and populated areas having a 15 times base case cost effect. The Greencore project is being installed in relatively open terrain in Wyoming and Montana, and also includes a long distance economy of scale. The Matagorda Energy Center project is located in a higher population density area with greater infrastructure. Therefore, utilizing a conservatively low 2 X base cost adjustment, installed pipeline costs for the Matagorda Energy Center is estimated at $800,000 per mile.

In summary, the transport piping construction is estimated at approximately $800,000 per mile for a 6-inch pipeline.

From Figure 5-1 below, the Matagorda Energy Center is located in proximity of several oil fields which are potential sites for CO_2 EOR projects. Making the assumption that these oil fields are suitable for injection, and further assuming the Matagorda Energy Center can negotiate supply contracts with oil producers, transport piping costs were calculated using the distance from the Matagorda Energy Center to the closest oil field. The approximate distance from the Matagorda Energy Center to the closest site is approximately 12 miles. Using the calculated cost per mile estimate from above, the piping cost for the Matagorda Energy Center to the potential EOR sites would be approximately $9.6 million.

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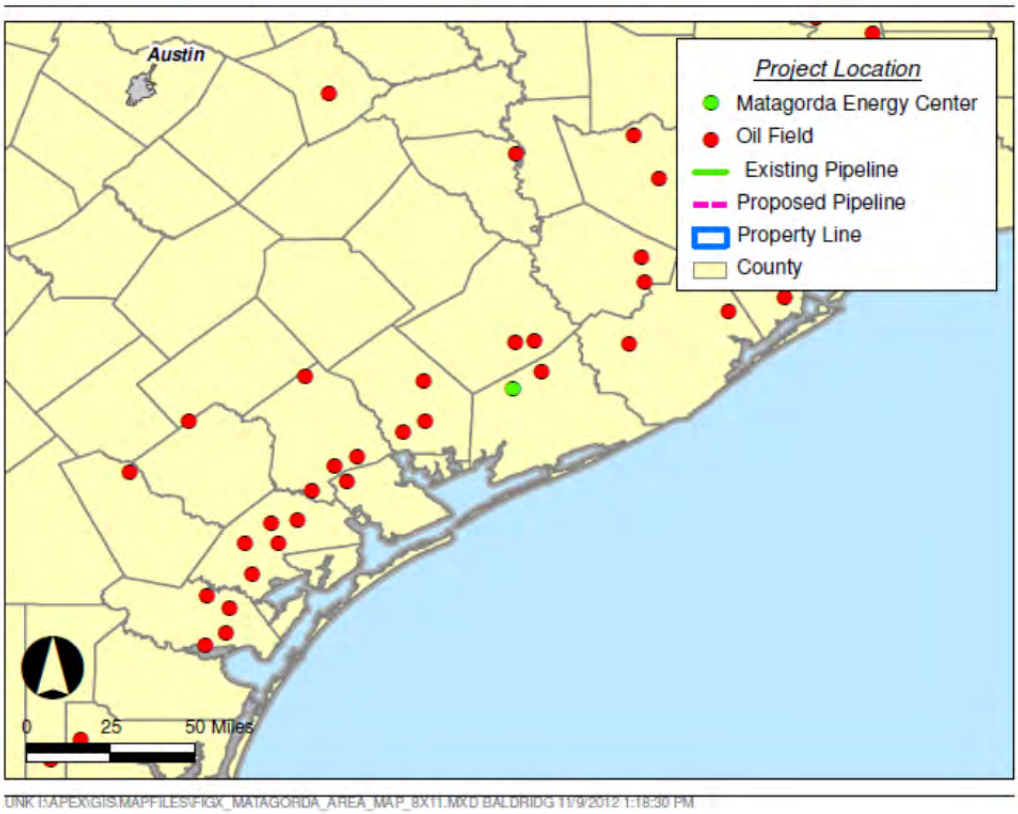
FIGURE 5-1
Existing CO_2 Pipelines and Oil Fields In Central Texas



Reference: Basin Oriented Strategies for CO_2 Enhanced Oil Recovery: East and Central Texas, U.S. DOE, February 2006

TABLE 5-3
Vendor CCS Information

Parameter	Carbon Capture Vendor	Source
Installed Capital Cost	$230 million	Vendor
Parasitic Power Consumption (Scrubber + compression/dehydration)	11.25 MW	Vendor
Annual Scrubber O&M Costs	$12 million	Estimated at 4% of capital cost (Ref.6)
Pipeline Installed Cost	$9.6 million	Estimate Above (12 miles at $800K/mile)
Pipeline O&M Costs	$1.6 million	Estimated at 5% of capital cost (Ref. 2)
Booster Compression Lifetime Costs	0	Assumed No Booster Compression Required
Net Matagorda Energy Center Heat Rate Impact	Increased by 26 % to 5,534 Btu/kWhr	Calculation

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The following control cost table presents the calculation of the annual cost of CCS for the Matagorda Energy Center utilizing a Capital Cost Recovery Factor of 0.1205, which is based on a weighted cost of capital of 11.6 percent. The cost of capital is derived assuming a cost of equity of 20 percent interest and cost of debt of 6 percent interest, with a 40/60 equity to debt ratio. The equipment life was assumed to be 30 years.

TABLE 5-4
Control Costs for Carbon Capture at Matagorda Energy Center

Capital Cost Recovery Factor=0.1205

11.6% Pre-tax Cost of Capital, 30-year equipment life

Carbon Capture	
Installed Capital Cost	$230,000,000
Annual Scrubber O&M Costs	$9,200,000
Pipeline Installed Cost	$9,600,000
Pipeline O&M Costs	$480,000
Subtotal Annual Equipment Cost	$38,551,800
Annual Cost of Lost Generation (@0.05 $/kwh)	$4,927,500
Annual Cost of Process Steam (@ $10/1000 lb)	$15,768,000
Total Annual Cost	**$59,247,300**

5.5.4.3 Safety, Operational, and Environmental Impacts of CCS

Safety and Environmental Impacts

Implementing CCS systems may cause several health and safety concerns (AMA, 2010). Some of the associated risks are listed below:

- CO_2 capture and transport system leaks resulting in concentrations of greater than 7-10 percent may cause threat to human and animal life.
- Inadvertent leaks from EOR applications or underground storage caverns can accumulate and pose risk of asphyxiation to humans and animals. When released in significant quantities, CO_2 can accumulate in low areas and closed spaces since it is heavier than air.
- Injection of CO_2 in underground storage formations which are close to aquifers can lead to water contamination because of the formation of carbonic acid.
- Production of amine is energy intensive and can leak from the scrubber system (IEA, 2004).
- Long term effects of underground storage are unknown.

While not specifically a safety or environmental issue there are several other issues of concern. The transport and storage of CO_2 raises questions of changes of ownership. These issues can also involve accounting and liability issues between both public and private sector entities. While this analysis assumes that the captured CO_2 will be utilized for EOR operations, similar ownership concerns would apply for all underground storage options.

Impact on Net GHG Emissions

While a carbon capture system such as the amine scrubber reviewed above claims CO_2 removal efficiency of 90 percent, there are significant parasitic power requirements associated with operation of the scrubber system. For the Matagorda Energy Center, the heat rate is increased by approximately 26 percent, because of the net power output being diminished by 11.25 MW of parasitic load and the significant process steam requirements. Because less power is being generated by the Matagorda Energy Center, this power must be replaced with purchases from other generation facilities. Assuming the secondary generation facility CO_2 emission rate meets the new NSPS

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requirement of 1,000 lb CO_2/MWh, the additional GHG produced to replace the CCS lost generation is approximately 30,797 tpy CO_2 based on an 62.5 percent capacity factor.

The steam requirement necessitates the installation of a nominal 300 MMBtu/hr auxiliary boiler. Given this heat input for natural gas, and a 62.5 percent capacity factor, the calculated CO_2 emissions resulting from steam generation is 95,995 tpy. The cost of an auxiliary boiler was not included in this analysis, and it was assumed that the cost of on-site steam generation would be $10/1,000 lb of steam (see Table 5-5).

In order to calculate the net CO_2 reduction from carbon capture system, the following equation was used:

Net CO_2 reduction = Captured CO_2 – Energy penalty-related CO_2 emissions (IEA, 2004)

Net CO_2 reduction = 400,594 tpy – (30,797 tpy + 95,995 tpy)

Net CO2 reduction = 273,802 tpy

Estimated Matagorda Energy Center CCS Cost

The cost per net ton of CO_2 removed is:

Annual Cost/Net CO_2 Reduction = $59,247,300 /273,802tpy = 216 $/ton of CO_2 removed

This cost is significantly higher than other GHG mitigation options and is economically infeasible for the following reasons.

- The estimated CCS capital cost of $230MM would increase the total project capital costs by nearly 70 percent from $350MM to $580MM and make the project economically infeasible.

The estimated annual cost of $216/ton removed is 10 times higher than the ADAGE projected 2020 allowance trading value of $22/ton.

Since CCS is clearly not economically feasible or technically feasible at this time, an evaluation of the remaining control technology under consideration, energy efficiency, is provided.

5.5.4.4 Energy Efficiency Option

The Matagorda Energy Center as proposed will utilize high-efficiency, state-of-the-art, CAES expansion turbines and associated combustors. Operation will use good combustion practices and good operating and maintenance practices to ensure complete combustion of the natural gas fuel. Additionally, insulation materials will be applied to minimize heat loss from the expanders, combustors, ducts, and the recuperator. Heat loss from the expanders and combustors will be further mitigated by the fact that these components will be housed within a building – i.e. not exposed to the elements.

Energy efficiency is normally expressed in terms of net heat rate. The Matagorda turbine trains have an estimated net heat rate of 4,390 Btu/kWh at maximum load and 4,773 Btu/kWh at low load (HHV basis). The heat rates have been adjusted to reflect 3 percent degradation between system overhauls (per Dresser-Rand guidance). Performance figures for the Matagorda Energy Center reflect Matagorda Energy Center site conditions at 60°F.

As discussed earlier, for numerous reasons CAES expansion turbine technology is unique – and thus the assessment of BACT for GHG's for the Matagorda Energy Center must be based on a comparison to the limited population of CAES installations. There are two CAES facilities in operation worldwide – McIntosh, in Alabama, and the Huntorf facility in Germany. Huntorf, completed in 1978, is a 290 MW facility designed and built by Brown Boveri Corporation (now a component of Asea Brown Boveri (ABB)). Huntorf was originally built to provide peaking power service, as well as black start capability for nuclear power units in the region. Today the plant has increasingly seen use to help balance wind generation in North Germany. Huntorf was constructed without a recuperator in order to minimize system start-up time.

McIntosh was placed in commercial operation in 1991 as a single train CAES facility, rated at 110-MW output. As discussed earlier, McIntosh used a novel "motor/generator", whereby a single electrical machine fulfilled dual roles as a motor for compressing, and as a generator when operating in the expansion mode. As with the Matagorda Energy Center, the compression/expansion equipment at McIntosh was supplied by Dresser-Rand.

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With regard to expander train design features, the HP and LP expanders and associated combustors at Matagorda Energy Center are very similar to the McIntosh equipment. The Matagorda Energy Center HP expander will operate at a higher full load inlet pressure than McIntosh (800 psia at Matagorda vs. 630 psia at McIntosh). Additionally, the Matagorda Energy Center combustors will use water injection for NO_X control, whereas McIntosh does not use water injection. Finally, the recuperator at McIntosh was designed for an effectiveness of 75 percent compared to a design effectiveness of 90 percent for Matagorda Energy Center.

The application of a third expansion turbine at Matagorda Energy Center (the topping turbine) is an innovation driven by the much higher operating pressures of the cavern.

As shown in Table 5-2, the heat rate for the Matagorda Energy Center represents a 31 percent improvement in comparison to Huntorf, and a 6 percent improvement in comparison to McIntosh. The design heat rate for Matagorda Energy Center (not adjusted for equipment degradation) was used for this computation, to be consistent with data available for the other two CAES installations.

The most important contributor to this heat rate improvement is the improved recuperator efficiency at Matagorda Energy Center. Other design changes have a meaningful impact on output (and hence capital cost on a $/kW basis) and specific air consumption, but they do not affect heat rate materially.

TABLE 5-5
Comparison of CAES Installations

	Output	Recuperator Efficiency	Heat Rate (at max load)	Number of Expanders	Cavern Operating Pressure Range	Hours of Storage (Full Load, No Recharge)
Huntorf**	290 MW	none installed	6,175 Btu/kWh (HHV)	2	700 – 970 psia	approximately 3
McIntosh**	110 MW (single CAES train installation)	75 percent	4,555 Btu/kWh (HHV)	2	660 – 1,087 psia	approximately 25
Matagorda Energy Center	317 MW (158.34 MW per train)	90 percent	4,262 Btu/kWh (HHV basis, prior to degradation)	3	1,900 -- 2,830 psia	approximately 100

*** Data Source: Princeton University (April 2008).*

The heat rate advantage of the Matagorda Energy Center documented in Table 5-5 above supports a determination that the Matagorda Energy Center will have an energy conversion efficiency higher than CAES units currently in existence.

5.5.5 Step 5: Select BACT

The only technically feasible GHG control technology for the Matagorda Energy Center is energy efficiency. Furthermore, the comparison provided in Section 5.5.4 demonstrates that the Matagorda Energy Center will have a higher energy conversion efficiency than comparable CAES facilities. Consequently, the Matagorda Energy Center as designed complies with GHG BACT requirements.

EPA's PSD permitting guidance for GHGs suggests use of output-based BACT emission limits and longer-term averaging periods for determining ongoing compliance. Based on APEXs' analysis of conservative operating scenarios, partial load operation, and turbine performance degradation, proposed BACT permit limits are provided in Table 5-6.

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TABLE 5-6
Matagorda Energy Center Proposed BACT Limits

BACT Basis	Net Heat Rate (HHV) (Btu/kWh)*	Lb CO_2/MW-hr*
Electrical Generation Efficiency*	4,773	558

* At Matagorda Energy Center site conditions, taking into account load fluctuations and performance degradation between overhauls

The calculation of the lb CO_2/MWh limit is provided in Appendix B and is based on the indicated estimated maximum heat rate, the load condition resulting in the highest CO_2 emissions per MW output, and an assumed 3 percent performance degradation between major equipment overhauls. The proposed averaging time for the compliance demonstration is a rolling 365 day period, consistent with other recently permitted power plants located in Texas.

5.6 Natural Gas Generator BACT for GHGs

In addition to the two combustion turbine trains planned for the Matagorda Energy Center, one natural gas-fired emergency generator (nominal 1,053-BHP engine with estimated emissions of 23 CO_2e tpy) will operate at the plant. The GHG calculation for this source is located in Appendix B.

5.6.1 Step 1: Identify All Control Technologies

The available control technologies for the natural gas generator are identical to those identified for the combustion turbines. These options include

- Carbon Capture and Storage Systems (CCS)
- Generator Engine Efficiency
- Energy Efficiency
- Use of Clean Fuel

5.6.2 Step 2: Eliminate Technically Infeasible Options Effectiveness

Carbon Capture and Storage Systems

As discussed above, CCS for GHG control is not considered a technically feasible control option, because of CCS systems not currently being available on a commercial basis, logistical hurdles, lack of demonstration in practice, and cost of implementation. Therefore, CCS is eliminated from further consideration for natural gas generator engine GHG reduction.

Generator Engine Efficiency

The natural gas generator engine for the Matagorda Energy Center will incorporate a high-efficiency design.

TABLE 5-7
Emergency Generator Efficiency and Design Data Comparison

	Selected Generator Caterpillar G3516SITA	Similar Generator Waukesha VHP7100G
kW (bhp)	740(1053)	725(1025)
Btu/bhp-hr	7391	7223
Fuel use (scf/hr)	8600	8181

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Table 5-7 above provides a comparison of similar sized gas fired units from different manufacturers. The annual CO_2e emissions difference between the two units is approximately 1.1 tons per year. The Caterpillar unit selected by APEX Matagorda Energy Center, prior to add-on non-selective catalytic reduction (NSCR) controls, provides lower NO_x and VOC emissions than the Waukesha counterpart. With the addition of NSCR controls, the NO_x, VOC, and CO emissions are substantially lower. Thus, the criteria pollutant emissions reductions were determined to be an acceptable trade-off, with more overall benefit to the environment, than a slightly better efficiency (Btu/bhp-hr) with the Waukesha unit.

Efficient Use of Energy

The natural gas generator engine will not be operated continuously, but only during maintenance testing and during emergencies for backup power generation. Therefore, energy will be utilized in an efficient manner.

Use of Clean Fuel

The generator will use natural gas for fuel instead of diesel. The use of natural gas yields the lowest emissions of GHG.

5.6.3 Step 3: Rank Remaining Control Technologies by Control Effectiveness

The remaining technically feasible GHG control technologies for the Matagorda Energy Center are “Generator Efficiency”, “Efficient Use of Energy” and “Use of Clean Fuel.” These technologies are equally important toward minimizing GHG emissions.

5.6.4 Step 4: Evaluate Most Effective Controls and Document Results

The remaining technically feasible GHG control technologies for the Matagorda Energy Center are “Generator Efficiency”, “Efficient Use of Energy” and “Use of Clean Fuel.” All three technologies will be implemented for the generator engine.

5.6.5 Step 5: Select BACT

GHG BACT for the Matagorda Energy Center natural gas generator is “Generator Efficiency”, “Efficient Use of Energy” and “Use of Clean Fuel.” The generator engine will be selected with consideration for high design efficiency, and will be operated in an efficient manner using natural gas fuel. Due to the estimated minor CO_2e emissions contribution from the engine (only 0.005 percent of total GHG emissions), no BACT permit limit is recommended for the Matagorda Energy Center natural gas generator.

5.7 Fugitive Emissions BACT for GHGs

In addition to the combustion sources planned for the Matagorda Energy Center, there are hydrocarbon emissions from leaking piping components, which include methane emissions and sulfur hexafluoride (SF_6) leaks from circuit breakers. Although this is a small source with an estimated 248 tpy CO_2e or 0.05 percent of the total site emissions, for completeness, fugitive emissions are addressed in this BACT analysis. The GHG calculations for this source are located in Appendix B.

Step 1: Identify All Control Technologies

The available control technologies for process fugitive emissions are as follows

- Use of a Leak Detection and Repair (LDAR) Program using traditional FID or newer IR camera technology
- A Comprehensive Equipment Maintenance Program
- Installing leakless technology components to eliminate fugitive emission sources
- Designing and constructing facilities with high quality components and materials of construction
- Using a lower leak detection level for components

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Step 2: Eliminate Technically Infeasible Options Effectiveness

Use of LDAR

LDAR programs are a technically feasible option for controlling process fugitive GHG emissions from components in natural gas service. The traditional LDAR program using an FID will not detect SF_6. An IR camera can detect leaks of SF_6 if calibrated for SF_6; therefore, a LDAR program using IR camera technology is a technically feasible option for SF_6 leaks.

Use of a Maintenance Program

A comprehensive equipment maintenance program is a technically feasible option for controlling process fugitive GHG emissions from components in natural gas service.

Installing Leakless Technology

Matagorda Energy Center will be using welded piping where possible. Other components such as flanges and valves inherently cannot be leakless. Since the facility cannot be constructed, operated or maintained without the use of flanges and valves, installing leakless technology is technically infeasible for controlling process fugitive GHG emissions.

Designing and Constructing with High Quality Components

Designing and constructing with high quality components is technically feasible for controlling process fugitive emissions from components in natural gas service and SF_6.

Lower Detection Levels

Using lower detection levels for components is technically feasible for controlling process fugitive emissions from components in natural gas service and SF_6 in conjunction with a LDAR program.

Step 3: Rank Remaining Control Technologies by Control Effectiveness

The remaining technically feasible GHG control technologies for the Matagorda Energy Center are “LDAR”, “Maintenance Program”, “High Quality Components” and “Lower Detection Levels”.

Step 4: Evaluate most effective controls and document results

LDAR

There are varied levels of stringency in LDAR programs for controlling volatile organic compound (VOC) emissions. However, because of the extremely small amount of GHG emissions from the fugitive sources, an LDAR program would not be considered for control of GHG emissions alone but in conjunction with an already existing LDAR program. This evaluation does not compare the effectiveness of different levels of LDAR programs.

Although technically feasible, the use of an LDAR program to control the small amount of GHG emissions from the fugitive sources at the Matagorda Energy Center is not cost effective.

Based on an estimate from an LDAR company, assuming that this site would be similar to a smaller gas plant subject to 40 CFR Part 60, Subpart KKK with around 600 quarterly components to monitor the cost would be as follows:

- $16,000 for the first year, which includes tagging and initial monitoring
- $12,000 for annual monitoring

Control costs are evaluated based on cost effectiveness calculated as annual cost per ton of pollutant removed. Additional costs would be incurred for multiple calibrations of the IR camera if used to also detect leaks of SF_6 which have not been included. Based on this cost estimate, APEX believes the use of an LDAR or LDAR like program would not be cost effective for the Matagorda Energy Center. The comprehensive equipment maintenance program will have similar reduction percentages and costs can be rolled into normal operations without additional capital. APEX suggests the comprehensive equipment maintenance program will be more cost effective. Therefore, an LDAR program can be eliminated based on economic feasibility.

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TABLE 5-8

Control Cost for LDAR at the Matagorda Energy Center

Capital Cost Recovery Factor	0.1205 (annual 11.6% pre-tax cost of capital, equipment life 30 years)
Total Capital Cost	$16,000
Total Annual Operating Cost	$12,000
Annualized Equipment Cost	$1,928
Total Annual Cost	$13,928
PTE CO_2e (ton/yr)	254.0
CO_2e Removal (ton/yr)	77.4
Cost per ton of CO_2e removed ($/ton)	$179.95

Maintenance Program

Due to LDAR being cost prohibitive, a more reasonable choice for size and equipment at the Matagorda Energy Center would be to apply a comprehensive equipment maintenance program. The cost of this program would be rolled into the normal operation and maintenance of the facility.

The comprehensive maintenance program will include periodic inspections for leaks using auditory, visual and olfactory (AVO) methods to find leaks. Elements of the program include at a minimum the following:

- Monthly walkthroughs using AVO to identify leaks
- First attempt to repair within 5 days and repair or replace within 15 days
- Exceptions for components that require a process unit shut down or waiting on parts to repair or replace
- Records of leaks and repairs shall be kept and made available upon request

High Quality Components

APEX will use high quality components and materials for design and construction of the Matagorda Energy Center. The cost of implementing this will be included in the cost of construction.

Lower Detection Levels

Lower detection levels are associated with an LDAR program with a leak definition. The comprehensive maintenance program detailed above does not have a leak definition and the LDAR program has been removed as not cost effective. Therefore, this approach is cost prohibitive as part of an LDAR program.

Step 5: Select BACT

Based on the above analysis, BACT is determined to be a comprehensive equipment maintenance program using AVO and the installation of high quality components.

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SECTION 6.0

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Appendix A
Area Map, Plot Plan, and Process Flow Diagram

Figure A-1: APEX Matagorda Energy Center Site-Area Map
Figure A-2: APEX Matagorda Energy Center Site-Plot Plan
Figure A-3: APEX Matagorda Energy Center Process Flow Diagram

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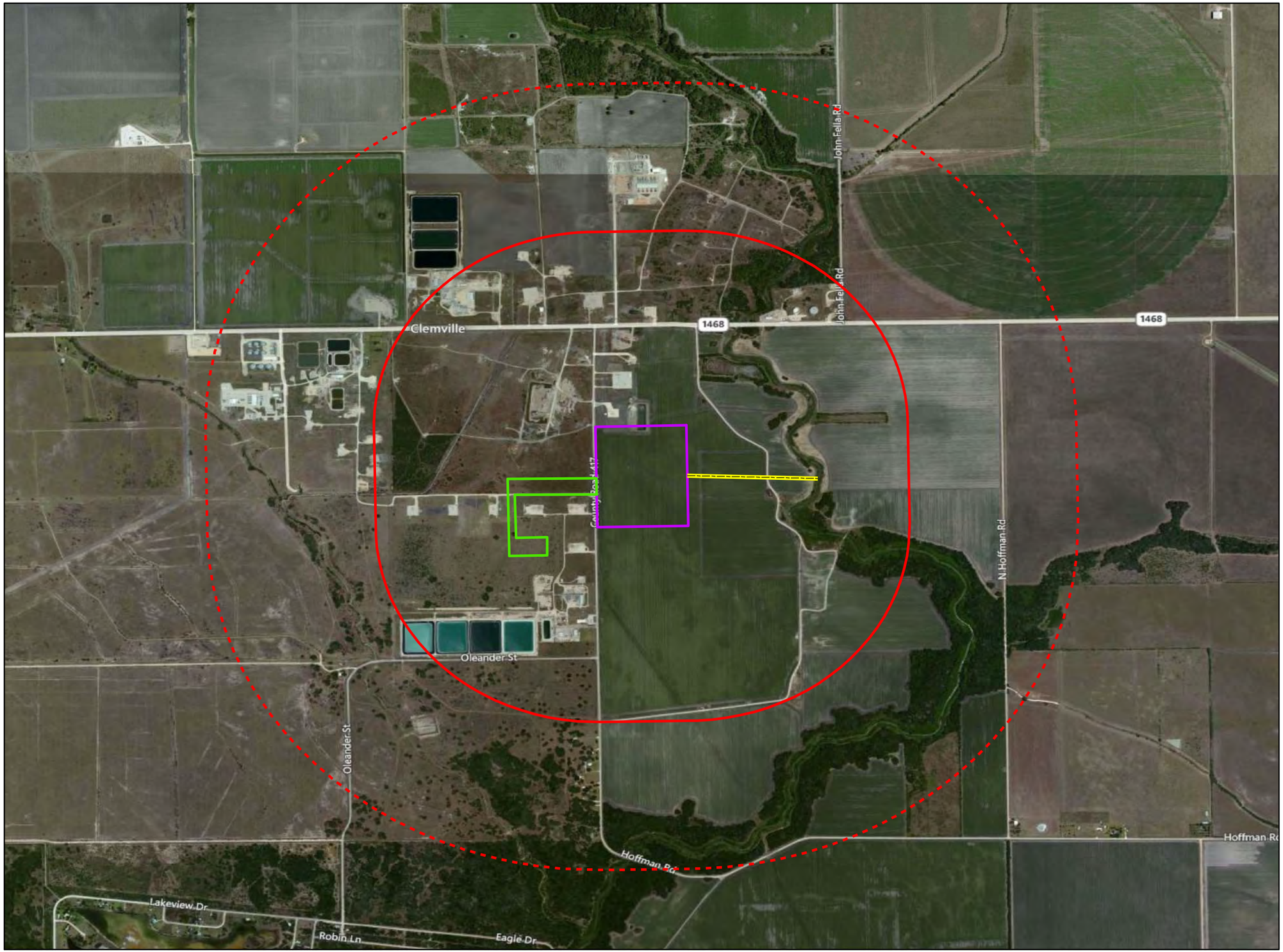
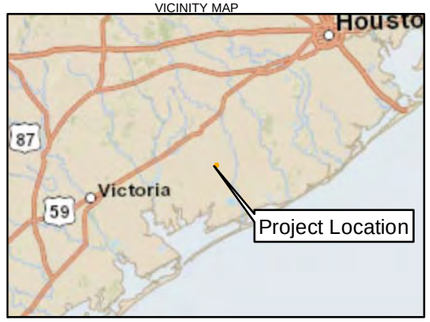


VICINITY MAP



LEGEND

- Proposed Wastewater Pipeline Corridor
- Proposed Air Pipeline Corridor
- Proposed Site
- 3,000-Foot Radius
- One-Mile Radius

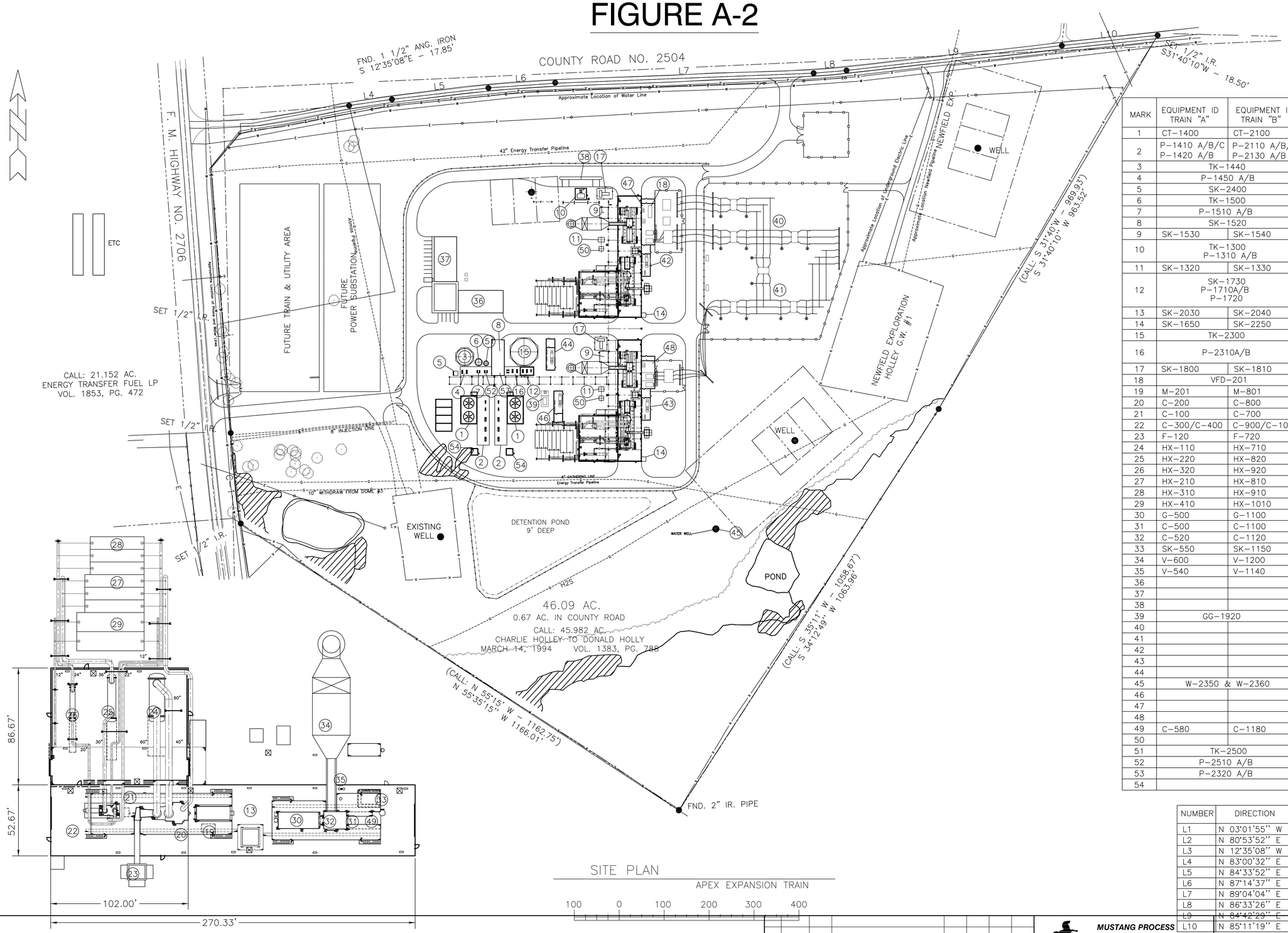
Imagery Source: National Agriculture Imagery Program (NAIP), 2010.

N

0 500 1,000 2,000
Feet

Figure A-1
APEX Matagorda Site - Area Map
Matagorda County, Texas

FIGURE A-2



SITE PLAN

APEX EXPANSION TRAIN

100 0 100 200 300 400

LARGE SCALE TRAIN

0 25 50 75 100

CURVE #1

CENTRAL ANGLE – 3°05'46"
RADIUS – 3769.72'
LENGTH – 203.70'
CHORD – N 4°34'47"W – 203.68'

MARK	EQUIPMENT ID TRAIN "A"	EQUIPMENT ID TRAIN "B"	DESCRIPTION
1	CT–1400	CT–2100	COOLING TOWERS (CT)
2	P–1410 A/B/C P–1420 A/B	P–2110 A/B/C P–2130 A/B	COOLING TOWER PUMPS
3	TK–1440		CT BLOW DOWN TANK
4	P–1450 A/B		CT BLOW DOWN PUMPS
5	SK–2400		WASTE WATER TREATMENT
6	TK–1500		DEMIN WATER FEED STORAGE TANK
7	P–1510 A/B		DEMIN WATER FEED TRANSFER PUMPS
8	SK–1520		DEMIN WATER PURIFICATION
9	SK–1530	SK–1540	DEMIN WATER INJECTION SKID
10	TK–1300 P–1310 A/B		AMMONIA STORAGE AMMONIA TRANSFER PUMPS
11	SK–1320	SK–1330	AMMONIA INJECTION SKID
12	SK–1730 P–1710A/B P–1720		FIRE WATER PUMP SKID
13	SK–2030	SK–2040	LUBE OIL SKID
14	SK–1650	SK–2250	INSTRUMENT AIR SKID
15	TK–2300		WELL/FIRE WATER STORAGE TANK
16	P–2310A/B		COOLING TOWER/WELL WATER MAKE–UP PUMPS
17	SK–1800	SK–1810	FUEL GAS FILTER SKID
18	VFD–201		M–201/M–801 MOTOR VFD
19	M–201	M–801	MOTOR
20	C–200	C–800	MEDIUM PRESSURE COMP.
21	C–100	C–700	LOW PRESSURE COMP.
22	C–300/C–400	C–900/C–1000	(HP1/2) HIGH PRESSURE COMP.
23	F–120	F–720	AIR INTAKE FILTER
24	HX–110	HX–710	WATER COOLER
25	HX–220	HX–820	WATER COOLER
26	HX–320	HX–920	WATER COOLER
27	HX–210	HX–810	AIR COOLER
28	HX–310	HX–910	AIR COOLER
29	HX–410	HX–1010	AIR COOLER
30	G–500	G–1100	POWER GENERATOR
31	C–500	C–1100	HI PRESSURE EXPANDER
32	C–520	C–1120	LO PRESSURE EXPANDER
33	SK–550	SK–1150	ELECTRO HYDRAULIC SKID
34	V–600	V–1200	RECUPERATOR
35	V–540	V–1140	MOTIVE AIR ACCUMULATOR
36			MAINTENANCE SHOP
37			CONTROL ROOM & OFFICE BLDG
38			AMMONIA TRUCK UNLOADING AREA
39	GG–1920		FUEL GAS GENERATOR (EMRGY)
40			POWER SUBSTATION TRAIN "A"
41			POWER SUBSTATION TRAIN "B"
42			TRAIN A ELECTRICAL SWGR/MCC
43			TRAIN B ELECTRICAL SWGR/MCC
44			UTILITIES ELE. SWGR/MCC TRAIN "A"
45	W–2350 & W–2360		WATER WELL LOCATION(S)
46			UTILITIES ELE. SWGR/MCC TRAIN "B"
47			SUBSTATION ELEC ROOM TRAIN "A"
48			SUBSTATION ELEC ROOM TRAIN "B"
49	C–580	C–1180	TOPPING TURBINE
50			FIRE WATER VALVE HOUSE
51	TK–2500		POTABLE WATER STORAGE TANK
52	P–2510 A/B		POTABLE WATER PUMPS
53	P–2320 A/B		DEMIN/POTABLE WATER SUPPLY PUMPS
54			COOLING TOWER CHEMICAL STORAGE BLDG

NUMBER	DIRECTION	DISTANCE	RECORD CALL
L1	N 03°01'55" W	244.80'	N 2°50'47"W – 441.89'
L2	N 80°53'52" E	390.68'	N81°05'E – 390.39'
L3	N 12°35'08" W	426.31'	N 12°24'W – 428.90'
L4	N 83°00'32" E	96.36'	N 85°31'E – 472.7'
L5	N 84°33'52" E	216.05'	
L6	N 87°14'37" E	147.56'	
L7	N 89°04'04" E	577.09'	N89°33'E – 394.57'
L8	N 86°33'26" E	73.48'	N89°07'E – 205.31'
L9	N 84°42'29" E	482.40'	N85°00'E – 734.63'
L10	N 85°11'19" E	74.34'	

REV	DATE	BY	DESCRIPTION	CHK	ENGR	APPR	CLIENT
G	21AUG2012	DPC	REISSUE FOR PERMITTING	BAL	BAL	JMN	
F	20JUL2012	DPC	REISSUE FOR ESTIMATE	BAL	BAL	JMN	
E	2JUL2012	DPC	ISSUE FOR ESTIMATE	BAL	BAL	JMN	
D	06/01/12	DPC	ISSUE FOR PERMITTING	DPC	BL	JMN	
C	04/26/12	DPC	ISSUE FOR PERMITTING	DPC	BL	JMN	
B	04/16/12	DPC	ISSUE FOR INFORMATION	DPC	BL	JMN	
A	03/26/12	MEJ	ISSUE FOR INFORMATION	MEJ	BL	JMN	

MUSTANG PROCESS AND INDUSTRIAL, INC.

Apex CAES

PROJECT NO:	20406N	
DESIGNED BY:	CARL SEGAN	
DRAWN BY:	CARL SEGAN	26JAN2012
CHECKED BY:	MARK JERNIGAN	
APPROVED BY:	JOHN NEFF	27MAR2012
SCALE:	1"=100'	DATE

BETHEL ENERGY CENTER, LLC

CIVIL
PRELIMINARY SITE PLAN

DRAWING NO: C–1 REV: G

BASED ON DWG–ENG–1104 REV 2

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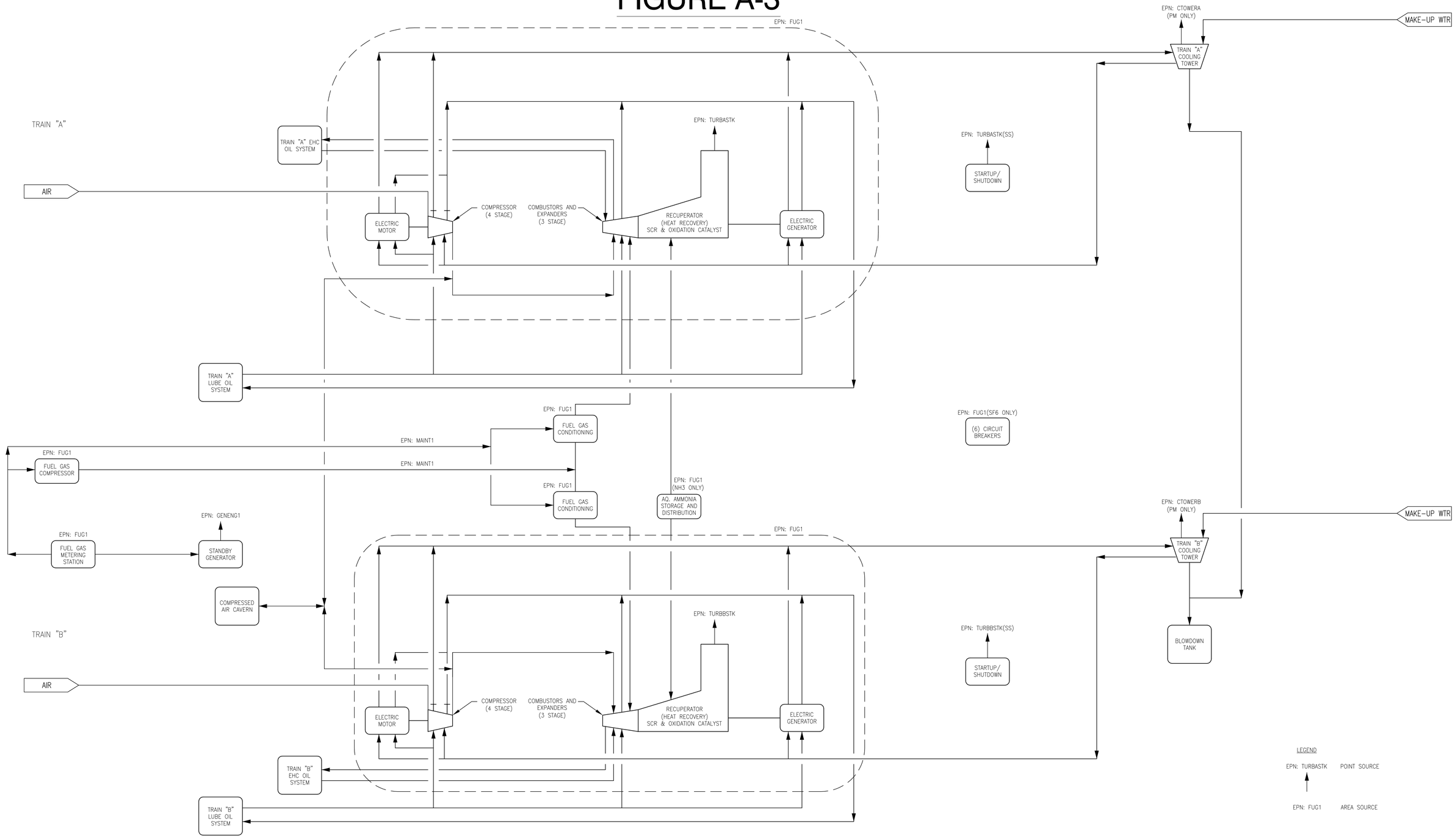
FIGURE A-3



REV	DATE	BY	DESCRIPTION	CHK	ENGR	APPR	CLIENT
A	11/01/12	MBM	ISSUE FOR PERMIT APPLICATION	MEJ	MEJ	JMN	

MUSTANG PROCESS AND INDUSTRIAL, INC.

Apex-CAES

PROJECT NO: 20406N		COMPRESSED AIR ENERGY STORAGE (CAES)
DESIGNED BY:		CAES OVERALL PROCESS FLOW DIAGRAM
DRAWN BY: MBM	01NOV2012	
CHECKED BY:		
APPROVED BY:		
SCALE: NTS	DATE	DRAWING NO: PFD-002 REV: A

BASED ON DWG-ENG-1104 REV 2

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Appendix B
Greenhouse Gas Supporting Documentation

APEX Matagorda Energy Center Greenhouse Gas Potential to Emit Emission Calculations
Turbo-expander Operating Parameters Across Operating Range
Table 1 and 1a: Dresser-Rand Maintenance Schedule
Heat Rate Comparison McIntosh CAES Plant & APEX Matagorda Energy Center

US EPA ARCHIVE DOCUMENT

APEX Matagorda Energy Center
Greenhouse Gas Potential to Emit Emissions Summary

APEX Matagorda Energy Center Potential To Emit Greenhouse Gases												
			CO_2		CH_4		N_2O		SF_6		CO_2e	
	EPN	FIN	lb/hr	(English) tons/yr	lb/hr	(English) tons/yr	lb/hr	(English) tons/yr	lb/hr	(English) tons/yr	lb/hr	(English) tons/yr
Maximum Operating Scenario with Federally Enforceable Limits:												
CAES Train A (1)	TURBASTK	TURBTRNA	---	222,552	---	4.2	---	0.42	---	---	---	222,770
CAES Train B (1)	TURBBSTK	TURBTRNB	---	222,552	---	4.2	---	0.42	---	---	---	222,770
Standby generator	GENENG1	GENENG1	455	23	0.01	0.000	0.001	0.0000	---	---	455	23
Cooling Tower A	CTOWERA	CTOWERA	---	---	---	---	---	---	---	---	---	---
Cooling Tower B	CTOWERB	CTOWERB	---	---	---	---	---	---	---	---	---	---
CAES Train A Startup and Shutdown (2)	TURBASTK (SS)	TURBSUA TURBSDA	30,663	5,596	11.68	2.132	17.21	3.1407	---	---	36,243	6,614
CAES Train B Startup and Shutdown (2)	TURBBSTK (SS)	TURBSUB TURBSDB	30,663	5,596	11.68	2.132	17.21	3.1407	---	---	36,243	6,614
Fugitives	FUG1	FUG1	---	0.1906	---	5.87	---	---	---	0.005	---	254
Maintenance	MAINT1	MAINT1	---	0.13	---	4.02	---	---	---	---	---	85
Site-wide PTE with Federally Enforceable Limits (3):				**456,319**		**22.5**		**7.12**		**0.005**		**459,131**

Assumptions:

(1) CAES Train natural gas usage and air emissions presented above are distributed equally between the two trains. However, the distribution of natural gas may vary across the two trains but will not exceed the federally enforceable limit of 7,807,409 MMBtu/yr for both trains. The annual hours of operation exclude 365 startups per year per train at 30 minutes each, which equals 183 hours per year. Therefore, it is assumed there are 8577 hours of normal operation per year.

(2) Turbine startup/shutdown assumes 365 startups for 30 minutes per train and 365 shutdowns for 3 minutes each per train

(3) Federally enforceable limit of 7,807,409 MMBtu/yr of combined natural gas usage at both CAES trains, 50 hours per year of emergency generator usage, 730 startups and 730 shutdowns per year for both CAES trains combined.

US EPA ARCHIVE DOCUMENT

APEX Matagorda Energy Center
GHG Emission Calculations for Expansion Turbines under Normal Operating Conditions

Natural Gas GHG Emissions, Maximum for One Train (FIN/EPN: TURBTRNA/TURBASTK or TURBTRNB/TURBBSTK)

Pollutant	Conversion Factor (kg to english tons)	Maximum Natural Gas Usage at 100% Load, One Train (MMBtu/yr)	Emission Factor (kg/MMBtu)	Emissions (english tons/year)	Global Warming Potential	ONE TRAIN CO_2e (english tons/year)
CO_2	0.0011023	6,088,721	53.02	355,849	1	355,849
CH_4	0.0011023	6,088,721	0.001	6.71	21	140.94
N_2O	0.0011023	6,088,721	0.0001	0.67	310	208.06
					Maximum TOTAL for One Train at 100% Load, 8760 hours/yr	356,198

Natural Gas GHG Emissions, Maximum for Both Trains Combined (FIN/EPN: TURBTRNA/TURBASTK and TURBTRNB/TURBBSTK)

Pollutant	Conversion Factor (kg to english tons)	Maximum Combined Annual Fuel Usage For Both Trains Under Normal Conditions (MMBtu/yr) (1)	Emission Factor (kg/MMBtu)	Emissions (english tons/year)	Global Warming Potential	TWO TRAINS CO_2e (english tons/year)
CO_2	0.0011023	7,615,912	53.02	445,104	1	445,104
CH_4	0.0011023	7,615,912	0.001	8.40	21	176.30
N_2O	0.0011023	7,615,912	0.0001	0.84	310	260.25
					Maximum Operating Scenario at Federally Enforceable Combined Fuel Limit, Both Trains	**445,540**

GHG PSD Threshold = 100,000 tpy CO2-e

Maximum Combined Annual Fuel Usage For Both Trains Under Normal Conditions = 7,615,912 MMBtu/yr

Maximum Annual Fuel Usage For Both Trains Under Startup/Shutdown Conditions = 191,497 MMBtu/yr

TOTAL, Federally Enforceable Combined CAES Train Fuel Usage Limit (1) = 7,807,409 MMBtu/yr

Proposed BACT Limit in Units of lbs CO2/MW-hr (3) = 558 lbs CO2/MW-hr

Proposed BACT Limit **11% Load =** **15.033** **MW**

Pollutant	Conversion Factor (kg to english tons)	11% load 8760 Fuel Use (MMBtu/yr) (2)	Emission Factor (kg/MMBtu)	Emissions (metric tons/year)	Global Warming Potential	ONE TRAIN CO2e (english tons/year)	BACT(3) (lbs CO2/MWhr)
CO2	0.0011023	628,494	53.02	36,732	1	36,732	558
CH4	0.0011023	628,494	0.001	0.69	21	15	0.2
N2O	0.0011023	628,494	0.0001	0.07	310	21	0.3
					TOTAL	36,768	558

Assumptions:

Each train contains (1) 158.34 MW rated generator consuming natural gas

Equations and Example Calculations:

(1) Federally enforceable combined natural gas usage limit of 7,807,409 MMBtu/yr for both CAES trains.

((158,338 kW at 100% load x 4390 btu/kWhr at 100% load x 4889 hours/year) + (24,529 kW at 15% load x 4531 btu/kWhr at 15% load x 3688 hours/year)) x 1 mmbtu/1000000 btu x 2 trains + Startup Fuel Usage + Shutdown Fuel Usage = 7,807,409 MMBtu/yr

(2) 15033 kw output per train at 11% load fuel rate x 4773 btu/kwhr x 1 mmbtu/1000000 btu x 8760 hr/yr = 628,494 mmbtu/yr

(3) Proposed BACT limit (worst case lb CO2/MWhr rate at 11% load) = 36,732 english tons CO2/year x 1 year/8760 hours x 1/15.033 MW = 558 lbs CO2/MW-hr

References:

Heat rates (btu/kWhr) provided by manufacturer.

Emission factors obtained from EPA Mandatory GHG Reporting Rule, 40 CFR 98, Tables C-1 and C-2.

US EPA ARCHIVE DOCUMENT

APEX Matagorda Energy Center
GHG Emissions Calculations for Standby Emergency Generator Engine

Standby Emergency Engine GHG Emissions Calculations - Startup, Maintenance, and Emergency Conditions (FIN/EPN: GENENG1)

FIN/EPN	Rating (ekW)	Rating at Maximum Load (bhp)	Annual 30-Min Events (Events/yr)	Annual Operation (1) (hr/yr)
GENENG1	740	1,053	100	50
One (1) Standby Generator Set; Caterpillar G3516-SITA-130, 1200 rpm, 4-cycle, rich burn Natural gas fired				
Constituents	**Emission Factor**		**Hourly Emissions 30-min duration (lb/hr)**	**Annual Emissions (ton/yr)**
	Factor	**Units**		
Criteria Pollutants				
CO2	53.02	kg/MMBtu	454.87	22.74
CH4	0.001	kg/MMBtu	0.01	0.0004
N2O	0.0001	kg/MMBtu	0.001	0.0000
CO2e			455.32	22.77

Assumptions:

(1) Annual operation based on 50 hours per year which includes
- Monthly maintenance checks of 30 minutes duration = 6 hours per year
- Emergency operation

Hourly emissions are based on 30 minutes of emissions in one hour block of time.
Emissions are based on the operating load of the generator

Brake horsepower (bhp) is the power delivered directly to and measured at the engine's crankshaft; hp is the power delivered to and measured at the output shaft. The mechanical losses are accounted for in the % efficiency.

Engine uses NSCR to control NOx, CO, and VOC

Constants:

7391	btu/bhp-hr Brake Specific Fuel Consumption (BSFC) per Caterpillar spec sheet (8600 scf/hr fuel gas flow/1053 bhp x 905 btu/scf fuel heat value at the specified rating)
2.20462	lb/kg
1	Global Warming Potential for CO2
21	Global Warming Potential for CH4
310	Global Warming Potential for N2O

Equations and Example Calculations:

CO2 Hourly Emissions (lb/hr) = Engine Rating (bhp) x BSFC (btu/bhp-hr) x CO2 EF (kg/mmbtu) x Conversion (2.20462 lb/1 kg) x Operating Time (0.5 hr/hr) = CO2 (lb/hr)
CO2 Hourly Emissions (lb/hr) = 1053 (bhp) x 7391 (btu/bhp-hr) x 53.02 (kg/mmbtu) x Conversion (2.20462 lb/1 kg) x Operating Time (0.5 hr/hr) = 454.87 (lb/hr)
CO2 Annual Emissions(tpy) = CO2 Emissions (lb/hr) x Maximum Hours of Operation (hr/yr) x Conversion (1 ton/2000 lb) = CO2 (tpy)
CO2 Annual Emissions(tpy) = 454.87 (lb/hr) x 50 (hr/yr) x Conversion (1 ton/2000 lb) = 22.74 (tpy)
CO2e Hourly Emissions (lb/hr) = CO2 Hourly Emissions (lb/hr) x GWP CO2 (lb CO2e/ lb CO2) + CH4 Hourly Emissions (lb/hr) x GWP CH4 (lb CO2e/lb CH4) + N2O Hourly Emissions (lb/hr) x GWP N2O (lb CO2e/lb N2O) = CO2e lb/hr

References:

CO2 based on	Emission factors as per 40 CFR Part 98, Table C-1
CH_4 based on	Emission factors as per 40 CFR Part 98, Table C-2
N_2O based on	Emission factors as per 40 CFR Part 98, Table C-2
CO2e based on	CO2 equivalent (CO2e) Emission factors as per 40 CFR Part 98, Tables C-1 and C-2 which are based on the summation of CO2, CH4, and N2O emissions

US EPA ARCHIVE DOCUMENT

APEX Matagorda Energy Center
GHG Emissions Calculations for Turbine Startup Events

Turbine Startup (SU) Events GHG Emissions Calculations (FIN: TURBSUA and TURBSUB; EPN: TURBASTK (SS) and TURBBSTK (SS))

Data provided per train unless stated otherwise

EPN	NG Fuel Flowrate at 50% Load Per Train (mmbtu/hr)	Duration of Time at 50% Load (minutes per hour)	NG Fuel Flowrate at 100% Load Per Train (mmbtu/hr)	Duration of Time at 100% Load (minutes per hour)	Annual Operation For Both Trains (events/yr)	Annual NG Usage for Startups MMBtu/yr
TURBASTK (SS) TURBBSTK (SS)	312.04	15	695.06	15	730	183,796

One train includes natural gas demand for HP combustor, LP combustor, and topping turbine
Natural gas fired

Constituents	Emission Factor		Hourly Emissions (lb/event)	Annual Emissions (ton/yr)
	Factor	Units		
CO2	53.02	kg/mmbtu	29,430	10,742
CH4	0.001	kg/mmbtu	11.66	4.25
N2O	0.0001	kg/mmbtu	17.21	6.28
CO2e			35,009	12,778

Assumptions:
Calculations based on start to full load in 30 minutes
Assumes 365 startups per year for each train.

Constants:

21496	Btu/lb LHV per Dresser-Rand
23839	Btu/lb HHV per Dresser-Rand
1044	btu/scf at HHV per Dresser-Rand
2.20462	lb/kg
1	Global Warming Potential for CO2
21	Global Warming Potential for CH4
310	Global Warming Potential for N2O

Equations and Example Calculations:
CO2 Hourly Emissions (lb/event) = NG Fuel Flowrate at 50% Load Per Train (mmbtu/hr) x CO2 EF (kg/mmbtu) x Conversion (2.20462 lb/1 kg) x duration of event (15 min/event) x Conversion (1hr/60min) + NG Fuel Flowrate at 100% Load Per Train (mmbtu/hr) x CO2 EF (kg/mmbtu) x Conversion (2.20462 lb/1 kg) x duration of event (15 min/event) x Conversion (1hr/60min) = CO2 (lb/event)
CO2 Annual Emissions (tpy) = CO2 Hourly Emissions per Event (lb/event) x Events Per year (count) x Conversion (1 ton/2000 lb) = CO2 tpy
CO2e Hourly Emissions (lb/hr) = CO2 Hourly Emissions (lb/hr) x GWP CO2 (lb CO2e/ lb CO2) + CH4 Hourly Emissions (lb/hr) x GWP CH4 (lb CO2e/lb CH4) + N2O Hourly Emissions (lb/hr) x GWP N2O (lb CO2e/lb N2O) = CO2e lb/hr

References:

CO2 based on	Emission factors as per 40 CFR Part 98, Table C-1
CH_4 based on	Emission factors as per 40 CFR Part 98, Table C-2
N_2O based on	Emission factors as per 40 CFR Part 98, Table C-2
CO2e based on	CO2 equivalent (CO2e) Emission factors per 40 CFR Part 98, Tables C-1 and C-2 which are based on the sum of CO2, CH4, and N2O emissions

US EPA ARCHIVE DOCUMENT

APEX Matagorda Energy Center
GHG Emissions Calculations for Turbine Shutdown Events

Turbine Shutdown (SD) Events GHG Emissions Calculations (FIN: TURBSDA and TURBSDB; EPN: TURBASTK (SS) and TURBBSTK (SS))

Data provided per train unless stated otherwise

Name of Unit	Number of Trains	NG Fuel Flowrate at 25% Load Per Train (mmbtu/hr)	Duration of Time in 1-hr minutes per hour	Annual Operation For Both Trains (events/yr)	Annual NG Usage for Shutdowns MMBtu/yr
TURBASTK (SS) TURBBSTK (SS)	2	191.81	3.3	730	7,701

Constituents	Emission Factor		Hourly Emissions (lb/event)	Annual Emissions (ton/yr)
	Factor	Units		
CO2	53.02	kg/mmbtu	1233.12	450.09
CH4	0.001	kg/mmbtu	0.02	0.0085
N2O	0.0001	kg/mmbtu	0.002	0.00085
CO2e			1234.33	450.53

Assumptions:

Assumes 365 shutdowns per year for each train.
Assumes 25% Load during the duration of the shutdown.

Constants:

21496	Btu/lb LHV per Dresser-Rand
23839	Btu/lb HHV per Dresser-Rand
1044	btu/scf at HHV per Dresser-Rand
2.20462	lb/kg
1	Global Warming Potential for CO2
21	Global Warming Potential for CH4
310	Global Warming Potential for N2O

Equations and Example Calculations:

CO2 Hourly Emissions (lb/event) = NG Fuel Flowrate at 25% Load Per Train (mmbtu/hr) x CO2 EF (kg/mmbtu) x Conversion (2.20462 lb/1 kg) x duration of event (3.3 min/event) x Conversion (1hr/60min) = CO2 (lb/event)

CO2 Annual Emissions (tpy) = CO2 Hourly Emissions per Event (lb/event) x Events Per year (count) x Conversion (1 ton/2000 lb) = CO2 tpy
CO2e Hourly Emissions (lb/hr) = CO2 Hourly Emissions (lb/hr) x GWP CO2 (lb CO2e/ lb CO2) + CH4 Hourly Emissions (lb/hr) x GWP CH4 (lb CO2e/lb CH4) + N2O Hourly Emissions (lb/hr) x GWP N2O (lb CO2e/lb N2O) = CO2e lb/hr

References:

CO2 based on	Emission factors as per 40 CFR Part 98, Table C-1
CH_4 based on	Emission factors as per 40 CFR Part 98, Table C-2
N_2O based on	Emission factors as per 40 CFR Part 98, Table C-2
CO2e based on	CO2 equivalent (CO2e) Emission factors as per 40 CFR Part 98, Tables C-1 and C-2 which are based on the summation of CO2, CH4, and N2O emissions

APEX Matagorda Energy Center
GHG Emissions Calculations for Equipment Leak Fugitives

Fugitives Emissions Calculations (FIN/EPN: FUG1)

Fugitive Emissions	lbs/hr	TPY
CO2	0.044	0.191
CH4	1.339	5.866
CO2e	28.170	123.384

Emissions Source	Emission Factor [1]	Units	Number	Emissions, lb/hr	Emissions, TPY	% CO2 [2]	CO2, lb/hr	CO2, TPY	% CH4 [2]	CH4, lb/hr	CH4, TPY	CO2e, lb/hr	CO2e, TPY
Valves													
Gas	0.00992	lb/hr/component	105	1.04	4.56	2.931%	0.0305	0.134	90.216%	0.94	4.12	19.76	86.566
Heavy Oil	0.0000185	lb/hr/component	0	--	--	--	--	--	--	--	--	--	--
Light Oil	0.0055	lb/hr/component	0	--	--	--	--	--	--	--	--	--	--
Aqueous Ammonia/Water/Light Oil	0.000216	lb/hr/component	37	0.008	0.035	100% NH3	--	--	100% NH3	--	--	--	--
Pumps													
Gas	0.00529	lb/hr/component	0	--	--	--	--	--	--	--	--	--	--
Heavy Oil	0.00113	lb/hr/component	0	--	--	--	--	--	--	--	--	--	--
Light Oil	0.02866	lb/hr/component	0	--	--	--	--	--	--	--	--	--	--
Aqueous Ammonia/Water/Light Oil	0.0000529	lb/hr/component	2	0.0001	0.0005	100% NH3	--	--	100% NH3	--	--	--	--
Flanges													
Gas	0.00086	lb/hr/component	470	0.4042	1.7704	2.931%	0.0118	0.0519	90.216%	0.36	1.60	7.67	33.59265
Heavy Oil	0.00000086	lb/hr/component	0	--	--	--	--	--	--	--	--	--	--
Light Oil	0.000243	lb/hr/component	0	--	--	--	--	--	--	--	--	--	--
Aqueous Ammonia/Water/Light Oil	0.00000617	lb/hr/component	150	--	--	--	--	--	--	--	--	--	--
Connectors													
Gas	0.00044	lb/hr/component	0	0.00	0.00	2.931%	0.0000	0.00E+00	90.216%	0.000	0.000	0.00	0.000000
Heavy Oil	0.0000165	lb/hr/component	0	--	--	--	--	--	--	--	--	--	--
Light Oil	0.000463	lb/hr/component	0	--	--	--	--	--	--	--	--	--	--
Aqueous Ammonia/Water/Light Oil	0.000243	lb/hr/component	2	0.0005	0.0021	100% NH3	--	--	100% NH3	--	--	--	--
Open-Ended Lines													
Gas	0.00441	lb/hr/component	0	--	--	--	--	--	--	--	--	--	--
Heavy Oil	0.000309	lb/hr/component	0	--	--	--	--	--	--	--	--	--	--
Light Oil	0.00309	lb/hr/component	0	--	--	--	--	--	--	--	--	--	--
Aqueous Ammonia/Water/Light Oil	0.0006	lb/hr/component	0	--	--	--	--	--	--	--	--	--	--
Other/Compressors/Relief Valves/Process Drains													
Gas	0.0194	lb/hr/component	2	0.04	0.17	2.931%	0.0011	4.98E-03	90.216%	0.04	0.15	0.74	3.22E+00
Heavy Oil	0.0000683	lb/hr/component	0	--	--	--	--	--	--	--	--	--	--
Light Oil	0.0165	lb/hr/component	2	0.033	0.145	100% VOC	--	--	100% VOC	--	--	--	--
Aqueous Ammonia/Water/Light Oil	0.0309	lb/hr/component	0	0	0								
TOTAL				**1.52**	**6.6**		**0.044**	**0.191**		**1.339**	**5.866**	**28.17**	**123.38**

Gas Analysis	MW	Mole %	Equivalent Weight	Weight %
Nitrogen	28.0134	0.216%	0.061	0.36%
Carbon dioxide	44.01	1.129%	0.50	2.9%
Hydrogen sulfide	34.08	0%	0	0%
Methane	16.043	95.337%	15.3	90.2%
Ethane	30.07	2.942%	0.88	5.22%
Propane	44.097	0.195%	0.086	0.507%
Isobutane	58.1222	0.044%	0.026	0.151%
n-Butane	58.1222	0.034%	0.020	0.117%
Isopentane	72.1488	0.015%	0.011	0.064%
n-Pentane	72.1488	0.008%	0.006	0.034%
Cyclopentane	70.1329	0.000%	0.000	0.000%
n-Hexane	86.1754	0.000%	0.000	0.000%
Cyclohexane	84.1595	0.000%	0.000	0.000%
Other C6's	86	0.080%	0.069	0.406%
Heptanes	100.2019	0.000%	0.000	0.000%
Methylcyclohexane	98.1861	0.000%	0.000	0.000%
Benzene	78.1118	0.000%	0.000	0.000%
Toluene	92.1384	0.000%	0.000	0.000%
Ethylbenzene	106.165	0.000%	0.000	0.000%
Xylenes	106.165	0.000%	0.000	0.000%
Octanes Plus	114.23	0.000%	0.000	0.000%
VOC		0.38%		1.28%
HAPs		0.00%		0.00%
TOTAL		100%	17.0	100%

Assumptions:
Fuel speciation provided by gas analysis on 7/26/2012 at Analyzer Mainline C/S #3 Port Lavaca No. B20731-090927, Florida Gas Transmission
Florida Gas Transmission estimates 16 valves and 104 flanges (52 pairs) at the gas metering stations
Per Mustang Engineering preliminary design estimates on the natural gas supply line, there are approximately 105 valves, 235 sets (pairs) of flanges, and two PSVs

Constants:
1 Global Warming Potential for CO2
21 Global Warming Potential for CH4

Equations and Example Calculations:
CO2 Hourly Emissions (lb/hr) = Number of Components x Component Emission Factor (lb/hr/component) x VOC Weight Percent (wt. %) = CO2 lb/hr
CO2 Annual Emissions Per Train (tpy) = CO2 Emissions (lb/hr) x Conversion (1 ton/2000 lb) x Annual Operation (8760 hr/yr) = CO2 (tpy)
CO2e Hourly Emissions (lb/hr) = CO2 Hourly Emissions (lb/hr) x GWP CO2 (lb CO2e/ lb CO2) + CH4 Hourly Emissions (lb/hr) x GWP CH4 (lb CO2e/lb CH4) = CO2e lb/hr
CO2e Annual Emissions Per Train (tpy) = CO2e Emissions (lb/hr) x Conversion (1 ton/2000 lb) x Annual Operation (8760 hr/yr) = CO2e (tpy)

References:
(1) TCEQ. January 2008. *Emissions Factors for Equipment Leak Fugitive Components Addendum to RG-360A*, Table 4 for Oil and Gas Production Operations.
(2) From gas analysis

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APEX Matagorda Energy Center
GHG Emissions Calculations for Circuit Breakers

Circuit Breaker Fugitive Emissions Calculations (FIN/EPN: FUG1)

Emissions	lbs/hr	TPY
SF6	0.001	0.01
CO2e	29.88	130.85

	Value	Units
345 kV, 2000A, 1300 BIL Breaker		
lb SF6 per breaker	365	
Number of breakers	6	
Leak Rate, % by weight	0.5	
Global Warming Potential (1)	23900	
SF6 emission rate	10.95	lb/yr
	0.00125	lb/hr
	0.0055	ton/yr
CO2e emission rate	261,705	lb/yr
	29.88	lb/hr
	130.85	ton/yr

1. Global Warming Potential factors based on Table A-1 of 40 CFR 98 Mandatory Greenhouse Gas Reporting.

Assumptions:
365 pounds of SF6 for each 345 kV circuit breaker

Equations and Example Calculations:
SF6 annual emissions (lb/yr) = lb SF6 per breaker (lb/breaker) x Number of breakers (count) x Leak Rate (wt%/yr) x Conversion (1/100%) = SF6 lb/yr
SF6 annual emissions (lb/yr) = 365 (lb/breaker) x 6 (count) x 0.5 (wt%/yr) x Conversion (1/100%) = 10.95 SF6 lb/yr
SF6 hourly emissions (lb/hr) = SF6 annual emissions (lb/yr) x Conversion (yr/8760hr) = SF6 lb/hr
SF6 hourly emissions (lb/hr) = 10.95 (lb/yr) x Conversion (yr/8760hr) = 0.00125 lb/hr
SF6 annual emissions (ton/yr) = 10.95 (lb/yr) x Conversion (ton/2000 lb) = 0.0055 ton/yr
CO2e annual emissions (ton/yr) = SF6 annual emissions (ton/yr) x GWP (ton CO2e/ton SF6) = CO2e ton/yr
CO2e annual emissions (ton/yr) = 0.0055 (ton/yr) x 23900 (ton CO2e/ton SF6) = 130.85 ton/yr

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APEX Matagorda Energy Center
GHG Emissions Calculations from Facility Maintenance Activities

Maintenance Emissions Calculations (FIN/EPN: MAINT1)

Emission Unit Data	Value	Units	Source
Maximum Vent Rate	113	cf/hr	Depressurizing of NG supply line from metering station to CAES train as worst case at 1100 PSIG and 25C.
Maximum Vent Rate	8,435	scf/hr	Conversion to Std. Conditions (68F, 14.7 psia)
Average Maintenance Event Frequency	1	vent/month	Estimate per train
Conversion Factor	385	dscf/lbmole	Std. Conditions (68F, 14.7 psia)
Number of Trains at the Site	2		

Planned maintenance activities involve depressurizing and breaking lines to access instrumentation and ancillary equipment for periodic planned maintenance. Therefore, the majority of emissions are a result of venting the pressurized line to atmosphere. The length of line to depressurize is minimized by valving off the section needed for access.

Gas Analysis	MW	Mole %	Equivalent Weight	Weight %
Nitrogen	28.0134	0.216%	0.061	0.36%
Carbon dioxide	44.01	1.129%	0.50	2.93%
Hydrogen sulfide	34.08	0%	0	0.00%
Methane	16.043	95.337%	15.3	90.22%
Ethane	30.07	2.942%	0.88	5.22%
Propane	44.097	0.195%	0.086	0.51%
Isobutane	58.1222	0.044%	0.026	0.15%
n-Butane	58.1222	0.034%	0.020	0.12%
Isopentane	72.1488	0.015%	0.011	0.06%
n-Pentane	72.1488	0.008%	0.006	0.03%
Cyclopentane	70.1329	0.000%	0.000	0.00%
n-Hexane	86.1754	0.000%	0.000	0.00%
Cyclohexane	84.1595	0.000%	0.000	0.00%
Other C6's	86	0.080%	0.069	0.41%
Heptanes	100.2019	0.000%	0.000	0.00%
Methylcyclohexane	98.1861	0.000%	0.000	0.00%
Benzene	78.1118	0.000%	0.000	0.00%
Toluene	92.1384	0.000%	0.000	0.00%
Ethylbenzene	106.165	0.000%	0.000	0.00%
Xylenes	106.165	0.000%	0.000	0.00%
Octanes Plus	114.23	0.000%	0.000	0.00%
VOC	58	0.38%		1.28%
HAPs		0.00%		0.00%
Total		100.00%	17.0	100%

Emissions For Both Trains	lb/hr	TPY
CO2	10.89	0.13
CH4	335.09	4.02
CO2e	7047.71	84.57

Assumptions:

Fuel speciation provided by gas analysis on 7/26/2012 at Analyzer Mainline C/S #3 Port Lavaca No. B20731-090927, Florida Gas Transmission
The maximum vent rate is based upon depressurizing the natural gas supply line from the Florida Gas Transmission metering station tie-point to the CAES Train HP/LP expanders.

Assumes the NG supply pipe is six inches in diameter (Schedule 80 pipe ID 5.761 inches, area 0.181 ft2) and 625 feet long to provide a volume of 113.1 ft3 at 1100 PSIG and 25C. Converting this to Standard Conditions (68 F and 14.696 PSIA) yields a result of 8435 scf/hr.

Assumes vent occurs within a one-hour period.

Constants:

0.585 SG of natural gas per Dresser-Rand
21496 Btu/lb LHV per Dresser-Rand
23839 Btu/lb HHV per Dresser-Rand
1 Global Warming Potential for CO2
21 Global Warming Potential for CH4

Equations and Example Calculations:

CO2 Hourly Emissions for One Train (lb/hr) = Maximum Vent Rate (scf/hr) x Conversion Factor (lbmol/dscf) x CO2 mole % in Vent (mole %) x MW of CO2 (lb/lbmole) = CO2 lb/hr

CO2 Annual Emissions For Both Trains (tpy) = CO2 Emissions (lb/hr) x Conversion (1 ton/2000 lb) x Annual Operation (1 event/month) x Conversion (12 month/1 yr) x Number of Trains at Site = CO2 (tpy)

CO2e Hourly Emissions (lb/hr) = CO2 Hourly Emissions (lb/hr) x GWP CO2 (lb CO2e/ lb CO2) + CH4 Hourly Emissions (lb/hr) x GWP CH4 (lb CO2e/lb CH4) = CO2e lb/hr

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Turbo-expander Operating Parameters Across Operating Range

	11% Load	15% Load	25% Load. No	25% Load. Not	50% Load	75% Load	100% Load
Air Flow Per Train (lb/sec)	88	100	145	145	200	300	400
Gas Flow Per Train(lb/sec)	0.836	1.295	2.235	2.324	3.636	5.905	8.099
Water Inj Per Train (lb/sec)	0	0	0	0.930	1.454	2.362	3.240
Exhaust Flow (lb/sec)	88.836	101.295	147.235	148.253	205.090	308.267	411.388
Output Per Train (KW)	15,033	24,529	43,071	43,369	69,351	114,516	158,338
Heat Rate (BTU/kWhr)	4773	4531	4453	4599	4499	4425	4390

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Table 1. Dresser-Rand Model EA-418 Turbo-Expander Maintenance Schedule

Component	Dresser Rand Recommended Maintenance Activity				Component Replacement			
	Estimated Repair Turn-Around[1]	Borescope Inspect	Hot Gas Path Inspect-Repair Interval[2]		Replacement Lead Time	Repair/Replacement Interval[4]		
	Weeks	Starts	Starts	EOH (Hours)[3]	Weeks	Minor Repair	Major Repair	Retire
Combustion Liners	6	750	1500	24000	18	72000	na	144000
Transition Pieces	12	750	1500	24000	26	72000	na	144000
Fuel Nozzles	6	750	1500	24000	18	72000	na	144000
Stage 1 Nozzles	26	750	1500	24000	80	48000	96000	144000
Stage 2 Nozzles	26	750	1500	24000	80	72000	na	144000
Stage 3 Nozzles	26	750	1500	24000	80	96000	na	na
Stage 4 Nozzles	26	750	1500	24000	80	96000	na	na
Stage 1 Buckets	20	750	1500	24000[5]	80	72000	na	144000
Stage 2 Buckets	20	750	1500	24000[5]	80	72000	na	144000
Stage 3 Buckets	20	750	1500	24000	80	72000	na	144000
Stage 4 Buckets	20	750	1500	24000	80	72000	na	144000

Notes:

(1) Dependent on the type of repair; time given is guideline only. (Based on most complex repair option)

(2) Whichever comes first.

(3) EOH Calculation:

Starts -	Emergency Start (<10 Min)	50 EOH
	Fast Start (=10 < 15 Min)	25 EOH
	Normal Start(>15 Min)	15 EOH
Operating Hours -	1600°F TIT	EOH = 1 X actual fired hours
	1550°F TIT	EOH = .75 X actual fired hours
	</=1500°F TIT	EOH = .5 X actual fired hours
	Part load hours	EOH = 1 X (actual output/rated output)

(4) Replacement Intervals are guideline only. Individual part replacement intervals depend on HGPI & repair history. Consult D-R Engineering

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Table 1A. Dresser-Rand Model 6T CAES High Pressure Turbo-Expander Maintenance Schedule

Component	Dresser Rand Recommended Maintenance Activity				Component Replacement	
	Estimated Repair Turn-Around(1)	Borescope Inspect	Gas Path Inspect-Repair Interval(2)		Replacement Lead Time	Replacement Interval(4)
	Weeks	Starts	Starts	EOH(3) (hrs)	Weeks	Starts/EOH
Combustion Liners	6	750	1500	24000	18	4500/72000
Fuel Nozzles	6	750	1500	24000	18	4500/72000
Stage 1 Nozzles	26	750	1500	24000	30	9000/144000
Stage 2 - 6 Nozzles	26	NA	1500	24000	30	9000/144000
Stage 1 Buckets	12	750	1500	24000	30	9000/144000
Stage 2 - 6 Buckets	12	NA	1500	24000	30	9000/144000
Rotor	20	NA	1500	24000	60	9000/144000(5)

Notes:

(1) Dependent on the type of repair; time given is guideline only. (Based on most complex repair option)

(2) Whichever comes first.

(3) EOH Calculation Starts: 15 hours/start (power-gen or compressor start using expanders)

Operating Hours: ≥ 1000oF TIT EOH = 1.0 X actual hours

<1000°F TIT EOH = .75 X actual hours

(4) Intervals are guideline only. Actual intervals depend on results of GPI & repair history.

(5) Rotor may be debladed, and rebladed for continued service, dependent on inspection results. Consult D-R Engineering.

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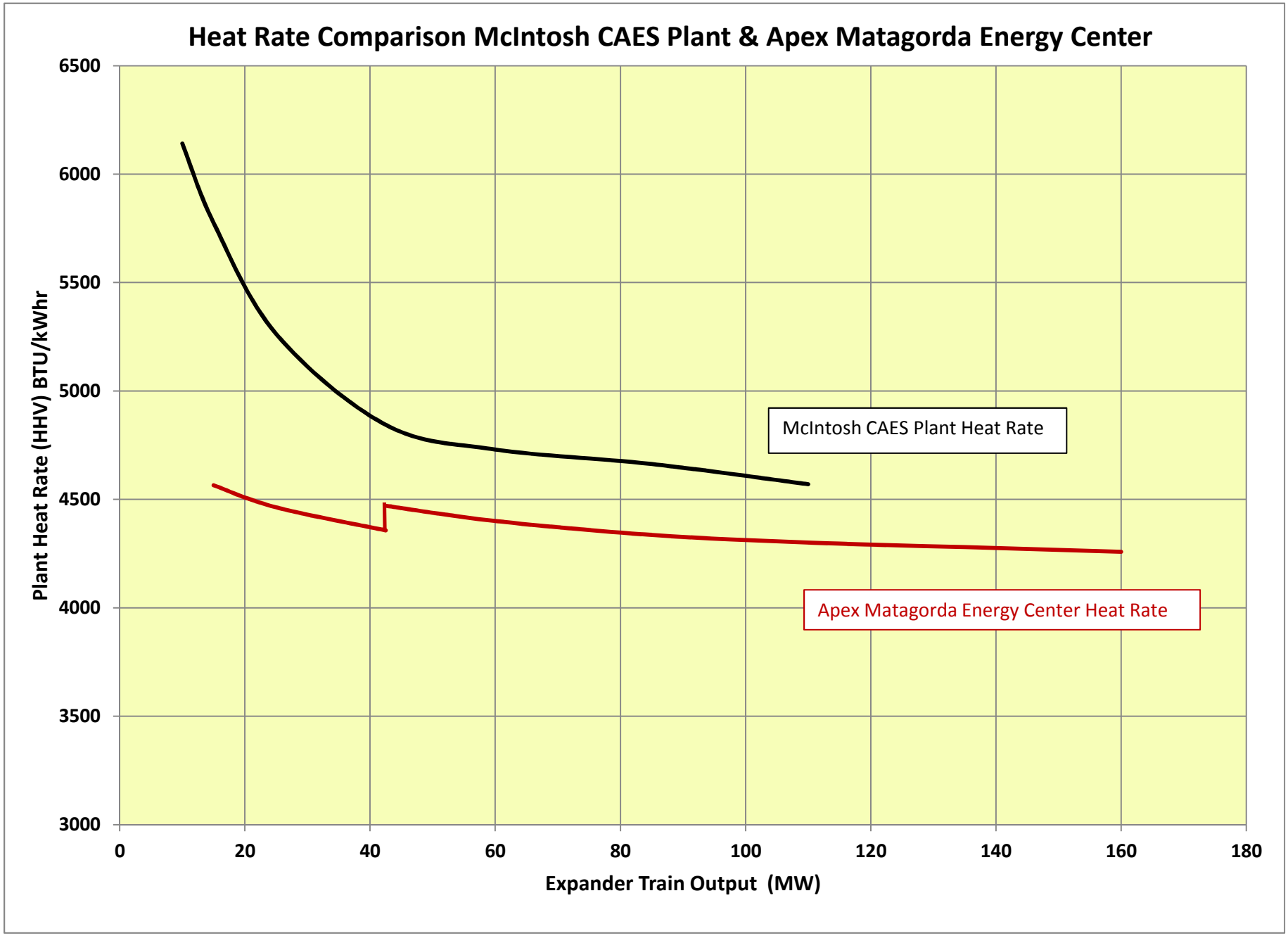

*Both heat rates depicted above do not include the 3% degradation as described in the Matagorda Energy Center application

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Appendix C
Permit Application Forms

Form PI-1S
Table 1F
Table 2F

Texas Commission on Environmental Quality
Form PI-1S
Registrations for Air Standard Permit
(Page 1)

I. Registrant Information			
A. Is a TCEQ Core Data Form (TCEQ Form No. 10400) attached? **Core Data Form required for Standard Permits 6004, 6006, 6007, 6008, and 6013.**			☐ YES ☒ NO
Customer Reference Number (CN): Not yet assigned.			
Regulated Entity Number (RN): Not yet assigned.			
B. Company or Other Legal Customer Name (must be same as Core Data "Customer"): APEX Matagorda Energy Center, LLC			
Company Official Contact Name: Stephen Naeve			
Title: Chief Operating Officer			
Mailing Address: 3200 Southwest Freeway, Suite 2210			
City: Houston	**State:** TX		**ZIP Code:** 77027
Phone No.: (713) 963-8104	**Fax No.:** (832) 553-1874	**E-mail Address:** Stephen.naeve@apexcaes.com	
C. Technical Contact Name: Ashley Campsie/ CH2M HILL			
Title: Environmental Engineer			
Mailing Address: 9191 South Jamaica Street			
City: Englewood	**State:** CO		**ZIP Code:** 80112
Phone No.: (720) 286-1236	**Fax No.:** (720) 286-8187	**E-mail Address:** Ashley.Campsie@ch2m.com	
D. Facility Location Information (Street Address):			
If no street address, provide clear driving directions to the site in writing:			
County Road 417, approximately 0.3 miles south of the intersection of County Road 417 and FM 1468			
City: Clemville	**County:** Matagorda		**ZIP Code:** 77414
Latitude (nearest second): 28°59'14"		**Longitude (nearest second):** -96°08'20"	
II. Facility and Site Information			
A. Name and Type of Facility: APEX Matagorda Energy Center			☒ Permanent ☐ Portable
B. Type of Action:	☒ Initial Application	☐ Renewal	☐ Change to Registration
	Registration No.:		☐ Expiration Date:
C. List the Standard Permit Claimed:			
Description: Electric Generating Unit (EGU) Standard Permit			
D. Concrete Batch Plant Standard Permit *(Check one)* N/A			
☐ Central Mix ☐ Ready Mix ☐ Specialty Mix ☐ Enhanced Controls for Concrete Batch Plants			

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II. Facility and Site Information *(continued)*		
E. Proposed Start of Construction: 4th Q 2013	**Length of Time at the Site:** New Site	
Customer Reference No.: TBD	**Regulated Entity No.:** TBD	
F. Is there a previous Standard Exemption or Permit by Rule for the facilities in this registration? *(Attach details regarding changes)*		☐ YES ☒ NO
If "YES," list Permit No.:		
G. Are there any other facilities at this site which are authorized by an air Standard Permit?		☐ YES ☒ NO
If "YES," list Permit No.:		
H. Are there any other air preconstruction permits at this site?		☒ YES ☐ NO
If "YES," list Permit No.: GHG PSD Permit, to be issued by EPA Region 6		
Are there any other air preconstruction permits at this site that would be directly associated with this project?		☒ YES ☐ NO
If "YES," list Permit No.: GHG PSD Permit, to be issued by EPA Region 6		
I. TCEQ Account Identification Number (if known): TBD		
J. Is this facility located at a site which is required to obtain a federal operating permit pursuant to 30 TAC Chapter 122?		☐ YES ☐ NO ☒ To Be Determined
K. Identify the requirements of 30 TAC Chapter 122 that will be triggered if this Form PI-1S application is approved.		
☐ Application for an FOP	☐ FOP Significant Revision	☐ FOP Minor
☐ Operational Flexibility/Off-Permit Notification	☐ Streamlined Revision for GOP	
☒ To Be Determined	☐ None	
L. Identify the type(s) issued and/or FOP application(s) submitted/pending for the site. *(check all that apply)*		
☐ SOP ☐ GOP	☐ GOP Application/Revision Application: Submitted or Under APD Review	
☐ SOP Application Review Application: Submitted or Under APD Review		☒ N/A
III. Fee Information		
Check/Money Order/Transaction Number: TBD		
Company name on Check: APEX Matagorda Energy Center, LLC		
Fee Amount: $900.00		

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IV.	**Public Notice *(If* Applicable)** ***(public notice is not a requirement of the EGU Standard Permit)***		
A.	Is the plant located at a site contiguous or adjacent to the public works project?		☐ YES ☐ NO
B.	Name of Public Place:		
Physical Address:			
City:		County:	
C.	Small Business Classification:		☐ YES ☐ NO
D.	Concrete batch plants with enhanced controls, permanent rock crushers, and animal carcass incinerators shall place a copy of the technically complete application at the appropriate TCEQ regional office only.		
E.	Please furnish the names of the state legislators who represent the area where the facility site is located:		
State Senator:			
State Representative:			
F.	For Concrete Batch Plants, name of the County Judge for this facility site**:**		
County Judge:			
Mailing Address:			
City:	State:	ZIP Code:	
G.	For Concrete Batch Plants, is the facility located in a municipality and/or extraterritorial jurisdiction of a municipality?		☐ YES ☐ NO
If "YES," list the name(s) of the Presiding Officer(s) for the municipality and/or extraterritorial jurisdiction:			
Title:			
Mailing Address:			
City:	State:	ZIP Code:	
V.	**Technical Information Including State and Federal Regulatory Requirements** ***Registrants must be in compliance with all applicable state and federal regulations and standards to claim a Standard Permit.***		
A.	Is confidential information submitted and properly marked with this registration?		☐ YES ☒ NO
B.	Is a process flow diagram and a process description attached?		☒ YES ☐ NO
C.	Is a plot plan attached?		☒ YES ☐ NO
D.	Are emissions data and calculations for this claim attached?		☒ YES ☐ NO
E.	Is information attached showing how the general requirements and applicability (30 TAC § 116.610 and 116.615) are met?		☒ YES ☐ NO
F.	Is information attached showing how the specific requirements are met?		☒ YES ☐ NO

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VI. Signature Requirements
The signature below indicates that I have knowledge of the facts herein set forth and that the same are true and correct to the best of my knowledge and belief. I further state that to the best of my knowledge and belief, the project for which application is made will not in any way violate any provision of the Texas Water Code (TWC), Chapter 7, Texas Clean Air Act (TCAA), as amended, or any of the air quality rules and regulations of the Texas Commission on Environmental Quality or any local governmental ordinance or resolution enacted pursuant to the TCAA. I further state that I have read and understand TWC §§ 7.177 7.183, which defines ***Criminal Offenses*** for certain violations, including intentionally or knowingly making or causing to be made false material statements or representations in this application, and TWC §§ 7.187, pertaining to ***Criminal Penalties***.
Name: Stephen Naeve *Print Full Name*
Signature: *Original Signature Required*
Date:

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TABLE 1F
AIR QUALITY APPLICATION SUPPLEMENT

Permit No.: TBD	**Application Submittal Date:**
Company: APEX Matagorda Energy Center, LLC	
RN: TBD	**Facility Location:** County Road 417, approximately 0.3 miles south of the intersection of County Road 417 and FM 1468
City: Clemville	**County:** Matagorda
Permit Unit I.D.:	**Permit Name:** GHG PSD Permit
Permit Activity: ☒ New Source ☐ Modification	
Project or Process Description: Compressed Air Energy Storage Facility	

Complete for all Pollutants with a Project Emission Increase.	POLLUTANTS						
	Ozone		CO	PM_{10}	NO_X	SO_2	Other[1]
	VOC	NO_X					(GHG)
Nonattainment? (yes or no)	NO	NO	NO	NO	NO	NO	NO
Existing site PTE (tpy)?	0	0	0	0	0	0	0
Proposed project emission increases (tpy from 2F)[3]	8.0	39.9	47.0	9.8	39.9	3.7	459131
Is the existing site a major source? **[2]If not, is the project a major source by itself? (yes or no)**	NO	NO	NO	NO	NO	NO	YES
If site is major, is project increase significant?	NO	NO	NO	NO	NO	NO	YES
If netting required, estimated start of construction? Grass roots facility - netting is not required.							
Five years prior to start of construction: grass roots facility - netting is not required. **Contemporaneous**							
Estimated start of operation: Grass roots facility, netting is not required. **Period**							
Net contemporaneous change, including proposed project, from Table 3F. (tpy)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
FNSR APPLICABLE? (yes or no)	NO	NO	NO	NO	NO	NO	YES

1 Other PSD pollutants.
2 Nonattainment major source is defined in Table 1 in 30 TAC 116.12(11) by pollutant and county. PSD thresholds are found in 40 CFR § 51.166(b)(1).
3 Sum of proposed emissions minus baseline emissions, increases only. Nonattainment thresholds are found in Table 1 in 30 TAC 116.12(11) and PSD thresholds in 40 CFR § 51.166(b)(23).

The representations made above and on the accompanying tables are true and correct to the best of my knowledge.

Signature Title Date

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TABLE 2F
PROJECT EMISSION INCREASE

Pollutant[1]: GHG (CO2e)	**Permit:** TBD
Baseline Period: N/A	**to** N/A

Affected or Modified Facilities[2] FIN	EPN		Permit No.	Actual Emissions[3]	A Baseline Emissions[4]	B Proposed Emissions [5]	Projected Actual Emissions	Difference (B-A)[6]	Correction[7]	Project Increase[8]
1	TURBTRNA	TURBASTK	TBD	0	0	222,770		222,770		222,770
2	TURBTRNB	TURBBSTK	TBD	0	0	222,770		222,770		222,770
3	GENENG1	GENENG1	TBD	0	0	23		23		23
4	TURBSUA/ TURBSDA	TURBASTK (SS)	TBD	0	0	6,614		6,614		6,614
5	TURBSUB/ TURBSDB	TURBBSTK (SS)	TBD	0	0	6,614		6,614		6,614
8	FUG1	FUG1	TBD	0	0	254		254		254
9	MAINT1	MAINT1	TBD	0	0	85		85		85
10										
11										
12										
13										
14										
15										
								Page Subtotal[9]		459,131