

**San Joaquin Valley  
Unified Air Pollution Control District**

**Draft Best Performance Standard (BPS) x.x.xx**

Date: April 15, 2010

Class and Category	<p style="text-align: center;">Cogeneration – Topping Cycle Plants <u>Subcategories:</u></p> <ol style="list-style-type: none"> <li>1. Natural Gas-Fired IC Engines</li> <li>2. Natural Gas-Fired Turbines (not including oilfield cogeneration units)</li> <li>3. Oilfield Natural Gas-Fired Turbines</li> </ol>
Best Performance Standard	<ol style="list-style-type: none"> <li>1. <u>Natural Gas-Fired IC Engines</u> Emissions Performance Standard of 700 lb-CO<sub>2</sub>e per MWh of Useful Energy</li> <li>2. <u>Natural Gas-Fired Turbines (not including oilfield cogeneration units)</u> Emissions Performance Standard of 800 lb-CO<sub>2</sub>e per MWh of Useful Energy</li> <li>3. <u>Oilfield Natural Gas-fired Turbines</u> Emissions Performance Standard of 800 lb-CO<sub>2</sub>e per MWh of Useful Energy</li> </ol>
Percentage Achieved GHG Emission Reduction Relative to Baseline Emissions	<ol style="list-style-type: none"> <li>1. <u>Natural Gas-Fired IC Engines:</u>                      36.4%</li> <li>2. <u>Natural Gas-Fired Turbines (not including oilfield cogeneration units):</u>                      27.3%</li> <li>3. <u>Oilfield Natural Gas-Fired Turbines:</u>                      27.3%</li> </ol>

District Project Number	C1100393
Evaluating Engineer	James Harader
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Initial Public Notice Date	April 15, 2010
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## **I. Best Performance Standard (BPS) Determination Introduction**

### **A. Purpose**

To assist permit applicants, project proponents, and interested parties in assessing and reducing the impacts of project specific greenhouse gas emissions (GHG) on global climate change from stationary source projects, the San Joaquin Valley Air Pollution Control District (District) has adopted the policy: *District Policy – Addressing GHG Emission Impacts for Stationary Source Projects Under CEQA When Serving as the Lead Agency*. This policy applies to projects for which the District has discretionary approval authority over the project and the District serves as the lead agency for CEQA purposes. Nonetheless, land use agencies can refer to it as guidance for projects that include stationary sources of emissions. The policy relies on the use of performance-based standards, otherwise known as Best Performance Standards (BPS) to assess significance of project specific greenhouse gas emissions on global climate change during the environmental review process, as required by CEQA. Use of BPS is a method of streamlining the CEQA process of determining significance and is not a required emission reduction measure. Projects implementing BPS would be determined to have a less than cumulatively significant impact. Otherwise, demonstration of a 29 percent reduction in GHG emissions, from business-as-usual, is required to determine that a project would have a less than cumulatively significant impact.

### **B. Definitions**

Best Performance Standard for Stationary Source Projects for a specific Class and Category is the most effective, District approved, Achieved-in-Practice means of reducing or limiting GHG emissions from a GHG emissions source, which is also economically feasible per the definition of Achieved-in-Practice. BPS includes equipment type, equipment design, and operational and maintenance practices for the identified service, operation, or emissions unit class and category.

Business-as-Usual is the emissions for a type of equipment or operation within an identified class and category projected for the year 2020, assuming no change in GHG emissions per unit of activity as established for the baseline period, 2002-2004. To relate BAU to an emissions generating activity, the District proposes to establish emission factors per unit of activity, for each class and category, using the 2002-2004 baseline period as the reference.

Category is a District approved subdivision within a “class” as identified by unique operational or technical aspects.

Class is the broadest District approved division of stationary GHG sources based on fundamental type of equipment or industrial classification of the source operation.

### **C. Determining Project Significance Using BPS**

Use of BPS is a method of determining significance of project specific GHG emission impacts using established specifications. BPS is not a required mitigation of project related impacts. Use of BPS would streamline the significance determination process by pre-quantifying the emission reductions that would be achieved by a specific GHG emission reduction measure and pre-approving the use of such a measure to reduce project-related GHG emissions.

GHG emissions can be directly emitted from stationary sources of air pollution requiring operating permits from the District, or they may be emitted indirectly, as a result of increased electrical power usage, for instance. For traditional stationary source projects, BPS includes equipment type, equipment design, and operational and maintenance practices for the identified service, operation, or emissions unit class and category.

## **II. Summary of BPS Determination Phases**

The District has established Topping Cycle Cogeneration as a separate class and category that requires implementation of a Best Performance Standard (BPS) pursuant to the District's Climate Change Action Plan (CCAP). The District's determination of the BPS for this class and category has been made using the phased BPS development process established in the District's Final Staff Report, Addressing Greenhouse Gas Emissions under the California Environmental Quality Act. A summary of the specific implementation of the phased BPS development process for this specific determination is as follows:

<b>BPS Development Process Phases for Topping Cycle Cogeneration</b>			
<b>Phase</b>	<b>Description</b>	<b>Date</b>	<b>Comments</b>
1	Initial Public Process	2/09/10	The District's intent notice is attached as Appendix I.
2	BPS Development	4/15/10	See Section IV of this evaluation document.
3	Public Review	4/15/2010	The District's BPS determination notice and a list of individuals receiving notification are attached as Appendix II.
4	Public Comments	5/10/2010	The public comment period ended on the date given. All public comments received and the District's responses are attached as Appendix III.

### **III. Class and Category**

The District has established cogeneration as a separate class and category of source that requires implementation of a Best Performance Standard (BPS) pursuant to the District's Climate Change Action Plan (CCAP). Cogeneration, also referred to as Combined Heat and Power (CHP), is the generation of electricity and useful thermal energy or mechanical work from a single fuel source.

Cogeneration units are typically categorized as either topping cycle systems or bottoming cycle systems. A topping cycle cogeneration system is a cogeneration system that uses input energy (usually fuel) to first produce electricity, with a portion or all of the reject heat then used as useful thermal energy or as useful mechanical energy. Conversely, a bottom cycle cogeneration system uses the input energy (usually fuel) to first produce useful thermal energy for a process, with the residual thermal energy used for electricity production. Most of the cogeneration units located within the San Joaquin Valley Air Pollution Control District can be categorized as topping cycle units; therefore, this BPS determination will be limited to topping cycle cogeneration units.

Topping cycle cogeneration units can be further divided into subcategories based on the type of combustion unit used in the cogeneration operation. This BPS evaluation will be limited to the two most commonly permitted topping cycle cogeneration systems, natural gas-fired turbines and natural gas-fired IC engines. Finally, oilfield cogeneration facilities that are associated with enhanced oil recovery (EOR) are distinctly different than other cogeneration facilities. EOR cogeneration facilities are typically “once through” devices that generally do not include condensers or cooling towers, as well as have other features that distinguish them from other cogeneration facilities. Therefore, the turbine category will be further subdivided into non-oilfield and oilfield subcategories.

In summary, the final cogeneration subcategories that will be addressed by this analysis are:

1. Natural Gas-Fired Internal Combustion Engines
2. Natural Gas-Fired Turbines (not including oilfield cogeneration units)
3. Oilfield Natural Gas-Fired Turbines

## **IV. BPS Development**

### **STEP 1. Establish Baseline Emissions Factor for Class and Category**

The Baseline Emission Factor (BEF) is defined as the three-year average (2002-2004) of GHG emissions for a particular class and category of equipment, expressed as annual GHG emissions per unit of activity. The term CO<sub>2</sub>e, used throughout this document, refers to carbon dioxide equivalent emissions. Carbon dioxide equivalent is a measure for describing how much global warming a given type or amount of greenhouse gas may cause, using the functionally equivalent amount or concentration of carbon dioxide (CO<sub>2</sub>) as the reference.

#### **A. Representative Baseline Operation**

For cogeneration operations, the representative baseline operation for 2004/2005 has already been evaluated and established by the California Public Utilities Commission (CPUC) as part of their 2007 greenhouse gas emission standard<sup>1</sup>. The baseline emissions factor for cogeneration units will be based on the previous work completed by the CPUC.

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<sup>1</sup> See [http://docs.cpuc.ca.gov/PUBLISHED/FINAL\\_DECISION/64072.htm](http://docs.cpuc.ca.gov/PUBLISHED/FINAL_DECISION/64072.htm)

## B. Basis and Assumptions

- The 2004/2005 baseline emissions reported by the California Public Utilities Commission is representative of the 2002 and 2003 baseline years.
- GHG emissions are stated as “CO<sub>2</sub> equivalents” (CO<sub>2</sub>e) which includes the global warming potential of methane and nitrous oxide emissions associated with gaseous fuel combustion.

## C. Unit of Activity

To relate Business-as-Usual to an emissions generating activity, it is necessary to establish an emission factor per unit of activity, for the established class and category. Cogeneration operations can generate useful electricity, useful thermal energy, and/or useful mechanical energy. Therefore, the chosen unit of activity should account for all three possible types of energy output.

California Assembly Bill 1613 and Assembly Bill 2791 directed the California Energy Commission, Public Utilities Commission (CPUC), and the Air Resources Board (ARB) to implement the Waste Heat and Carbon Emissions Reduction Act. As required by the Assembly Bills, the California Energy Commission published “Guidelines for Certification of Combined Heat and Power Systems Pursuant to the Waste Heat and Carbon Emissions Reduction ACT, Public Utilities Code, Section 2840 ET SEQ.”, modified in January 2010.

In their guidelines, the California Energy Commission utilized MWh useful energy output as the unit of activity for cogeneration units. To be consistent with the CEC guideline, the emissions factor per unit of activity chosen for cogeneration operations will be expressed as lb-CO<sub>2</sub>e/useful energy output (MWh).

The unit of activity, represented in equation form, is shown below:

$$\text{Unit of Activity} = \frac{\text{lb} - \text{CO}_2\text{e}}{\text{Useful Energy Output (MWh)}}$$

The useful energy output is the sum of the useful electrical energy, useful thermal energy, and useful mechanical energy generated by a cogeneration plant, each expressed in units of MWh. Useful thermal energy and useful mechanical energy are typically not measured in units of MWh. The following conversion factors are used to convert useful thermal energy and useful mechanical energy into MWh.

Useful Thermal Energy Conversion Factor: 1 MWh / 3.412 MMBtu

Useful Mechanical Energy Conversion Factor: 1 MWh / 1,341 hp-hr

#### D. Baseline Emission Factor Determination

Pursuant to SB 1368, in 2007 the California Public Utilities Commission adopted an interim greenhouse gas Emissions Performance Standard (EPS)<sup>2</sup> of 1,100 pounds of carbon dioxide equivalent (CO<sub>2</sub>e) per megawatt hour of useful energy. Pursuant to the rulemaking document,

*“Based on the record in this proceeding, we find that this level reflects the intent of the Legislator to base the EPS on representative combined cycle gas turbine emission rates. As discussed in this decision, a 1,100 lb-CO<sub>2</sub>e/MWh standard reasonable accounts for potential CCGT plant “outliers” from the average data on CCGT emission rates to accommodate those units that utilize dry cooling technologies, are smaller-sized facilities, or are located in the desert or at high altitudes. At the same time, our adopted level avoids establishing a performance standard that is representative of the most inefficient, older CCGT power plants currently in operation...”*

In other words, CPUC determined that the 1,100 lb-CO<sub>2</sub>e/MWh standard was representative of the baseline emissions level for the time period they evaluated. Further investigation of the CPUC’s rulemaking shows that the 1,100 lb-CO<sub>2</sub>e/MWh emission standard adopted by the California Public Utilities Commission was based on 2004/2005 baseline data and is applicable to cogeneration plants. Since the population of cogeneration plants does not change significantly from year to year, it is assumed that the 2004/2005 baseline data would closely resemble the 2002 – 2004 baseline data, and the 1,100 lb-CO<sub>2</sub>e/MWh value is an appropriate baseline emissions factor. It should be noted that other GHG emissions from cogeneration systems, such as N<sub>2</sub>O and CH<sub>4</sub>, were determined by PUC to be insignificant compared to the greenhouse gas contribution of CO<sub>2</sub> emissions.

Additionally, the California Energy Commission (CEC) has developed certification guidelines for combined heat and power (CHP) systems. Pursuant to their draft modified “Guidelines for Certification of Combined Heat and Power Systems Pursuant to the Waste Heat and Carbon Emissions Reduction Act, Public Utilities Code, Section 2840 ET SEQ.” (January 2010)<sup>3</sup>, the greenhouse emissions standard for certification of a CHP system is 1,100 lb-CO<sub>2</sub>e/MWh.

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<sup>2</sup> See [http://docs.cpuc.ca.gov/PUBLISHED/FINAL\\_DECISION/64072.htm](http://docs.cpuc.ca.gov/PUBLISHED/FINAL_DECISION/64072.htm)

<sup>3</sup> <http://energy.ca.gov/2009publications/CEC-200-2009-016/CEC-200-2009-016-CMF-REV1.PDF>

Based on the CPUC and CEC determinations, the baseline emissions factor for this cogeneration BPS is determined to be 1,100 lb-CO<sub>2</sub>e/MWh of useful energy. Note, this baseline emissions factor will be applied to all of the topping cycle cogeneration subcategories covered by this BPS (natural gas-fired IC engines, natural gas-fired turbines, and oilfield natural gas-fired turbines).

## **STEP 2. List Technologically Feasible GHG Emission Control Measures**

The following findings or considerations are applicable to topping cycle cogeneration systems:

Two methods of determining the applicable GHG emissions Best Performance Standard for cogeneration units were examined. The first method considered is to perform a detailed analysis to determine the possible GHG control measures for each possible cogeneration system component. While this method could result in the most efficient cogeneration system possible, pinning down specific performance parameters would be very difficult since cogeneration systems often include custom components that are specifically tailored to meet the unique heat and power generation demands of each installation.

The second method considered is to evaluate each entire cogeneration system and determine the lb-CO<sub>2</sub>e/MWh rating for each whole system. This approach would result in the development of a single BPS emissions standard for a cogeneration system, rather than specifying efficiency requirements for individual cogeneration system components. This second method has been chosen for development of the cogeneration BPS for the following reasons:

1. This method is consistent with the approach used by the California Public Utilities Commission to adopt their interim GHG emissions performance standard.
2. This approach is consistent with that used to develop the certification requirements for combined heat and power systems that have been adopted by the California Energy Commission.
3. CPUC and CEC have already developed a framework for determining and enforcing an overall GHG emissions performance standard.
4. This approach allows for flexibility in the design of custom cogeneration components.

The following GHG Control Measures, or in this case potential emission standards, have been identified for each subcategory of the topping-cycle cogeneration system class of emission unit.

Natural Gas-Fired IC Engines

Based on a review of available technology and with consideration of data supplied from industry, manufacturers, and other members of the public, the following is determined to be the technologically feasible GHG emission reduction measures for the topping cycle cogeneration class and category, Natural Gas-Fired IC Engines subcategory:

<b>Technologically Feasible GHG Control Measures for a Topping-Cycle Cogeneration Plant – Natural Gas-Fired IC Engine</b>	
<b>Control Measure</b>	<b>Qualifications</b>
Emissions Performance Standard of 1,100 lb-CO <sub>2</sub> e per MWh of Useful Energy	This proposed emissions level is identical to the emissions performance standard adopted by the CPUC for cogeneration units and identical to the emissions performance standard for certification of a combined heat and power system with the CEC.
Emissions Performance Standard of 700 lb-CO <sub>2</sub> e per MWh of Useful Energy	This proposed emissions level is based on the results of the District's survey of existing natural gas-fired IC engine cogeneration plants located within the SJVAPCD, allowing for some variation of GHG emissions between cogeneration plant designs and utilization. For a copy of the survey results, please refer to Appendix IV.

None of the identified GHG emission standards listed above is expected to result in an increase in emissions of criteria pollutants.

Natural Gas-Fired Turbines

Based on a review of available technology and with consideration of data supplied from industry, manufacturers, and other members of the public, the following is determined to be the technologically feasible GHG emission reduction measures for the topping cycle cogeneration class and category, Natural Gas-Fired Turbines category, not including oilfield cogeneration turbines:

<b>Technologically Feasible GHG Control Measures for a Topping-Cycle Cogeneration Plant – Natural Gas-Fired Turbine (not including oilfield cogeneration turbines)</b>	
<b>Control Measure</b>	<b>Qualifications</b>
Emissions Performance Standard of 1,100 lb-CO <sub>2</sub> e per MWh of Useful Energy	This proposed emissions level is identical to the emissions performance standard adopted by the CPUC for cogeneration units and identical to the emissions performance standard for certification of a combined heat and power system with the CEC.
Emissions Performance Standard of 800 lb-CO <sub>2</sub> e per MWh of Useful Energy	This proposed emissions level is based on the results of the District’s survey of existing turbine cogeneration plants (not including oilfield cogeneration) located within the SJVAPCD, allowing for some variation of GHG emissions between cogeneration plants. For a copy of the survey results, see Appendix V.

None of the identified GHG emission standards listed above is expected to result in an increase in emissions of criteria pollutants.

Oilfield Natural Gas-Fired Turbines

Based on a review of available technology and with consideration of data supplied from industry, manufacturers, and other members of the public, the following is determined to be the technologically feasible GHG emission reduction measures for the topping cycle cogeneration class and category, Natural Gas-Fired Turbines (oilfield cogeneration units) category:

<b>Technologically Feasible GHG Control Measures for a Topping-Cycle Cogeneration Plant – Oilfield Natural Gas-Fired Turbine</b>	
<b>Control Measure</b>	<b>Qualifications</b>
Emissions Performance Standard of 1,100 lb-CO <sub>2</sub> e per MWh of Useful Energy	This proposed emissions level is identical to the emissions performance standard adopted by the CPUC for cogeneration units and identical to the emissions performance standard for certification of a combined heat and power system with the CEC.
Emissions Performance Standard of 800 lb-CO <sub>2</sub> e per MWh of Useful Energy	This proposed emissions level is based on the results of the District’s survey of existing oilfield turbine cogeneration plants located within the SJVAPCD, allowing for some variation of GHG emissions between cogeneration plants. For a copy of the survey results, see Appendix VI. <sup>4</sup>

None of the identified GHG emission standards listed above is expected to result in an increase in emissions of criteria pollutants.

<sup>4</sup> Note, while some oilfields have emission levels lower than 600 lb-CO<sub>2,equivalent</sub>/MWh, there was noticeable variation in the GHG emissions of cogeneration plants from one oilfield to the next, and even between identical units located in the same oilfield. This variation is believed to be caused by differences in the type and temperature of incoming feedwater available at each site, the size of the cogeneration unit that may be utilized at each site, and the varying utilization rates of each specific cogeneration unit. The 800 lb-CO<sub>2,equivalent</sub> value was chosen as it allows for variation in these parameters, which individual facilities may not be able to control (I.E. feedwater availability or size of the cogeneration unit).

### STEP 3. Identify all Achieved-in-Practice GHG Emission Control Measures

For all technologically feasible GHG emission reduction measures, all GHG reduction measures determined to be Achieved-in-Practice are identified. Achieved-in-Practice is defined as any equipment, technology, practice or operation available in the United States that has been installed and operated or used at a commercial or stationary source site for a reasonable period of time sufficient to demonstrate that the equipment, the technology, the practice or the operation is reliable when operated in a manner that is typical for the process. In determining whether equipment, technology, practice or operation is Achieved-in-Practice, the District will consider the extent to which grants, incentives or other financial subsidies influence the economic feasibility of its use.

#### Natural Gas-Fired IC Engines

Based on a review of available technology and with consideration of input from industry, manufacturers and other members of the public, the following is determined to be the Achieved-in-Practice GHG emission reduction measures for this class and category:

<b>Achieved-in-Practice GHG Control Measures for a Topping-Cycle Cogeneration Plant – Natural Gas-Fired IC Engine</b>	
<b>Control Measure</b>	<b>Achieved-in-Practice Qualifications</b>
Emissions Performance Standard of 1,100 lb-CO <sub>2</sub> e per MWh of Useful Energy	This proposed emissions level is identical to the emissions performance standard adopted by the CPUC for cogeneration units and identical to the emissions performance standard for certification of a combined heat and power system with the CEC. Therefore, this emissions level is considered Achieved in Practice.
Emissions Performance Standard of 700 lb-CO <sub>2</sub> e per MWh of Useful Energy	Several existing engines identified in the District's survey (Appendix IV) of natural gas-fired IC engine cogeneration systems are currently operating at levels below this emissions level. Therefore, this emissions level is considered Achieved in Practice.

Natural Gas-Fired Turbines (not including oilfield cogeneration units)

Based on a review of available technology and with consideration of input from industry, manufacturers and other members of the public, the following is determined to be the Achieved-in-Practice GHG emission reduction measures for this class and category:

<b>Achieved-in-Practice GHG Control Measures for a Topping-Cycle Cogeneration Plant – Natural Gas-Fired Turbine (not including oilfield cogeneration turbines)</b>	
<b>Control Measure</b>	<b>Achieved-in-Practice Qualifications</b>
Emissions Performance Standard of 1,100 lb-CO <sub>2</sub> e per MWh of Useful Energy	This proposed emissions level is identical to the emissions performance standard adopted by the CPUC for cogeneration units and identical to the emissions performance standard for certification of a combined heat and power system with the CEC. Therefore, this emissions level is considered Achieved in Practice.
Emissions Performance Standard of 800 lb-CO <sub>2</sub> e per MWh of Useful Energy	Several existing turbines identified in the District's survey (Appendix V) of natural gas-fired turbine cogeneration plants are currently operating at levels below this emissions level. Therefore, this emissions level is considered Achieved in Practice.

Oilfield Natural Gas-Fired Turbines

Based on a review of available technology and with consideration of input from industry, manufacturers and other members of the public, the following is determined to be the Achieved-in-Practice GHG emission reduction measures for this class and category:

<b>Achieved-in-Practice GHG Control Measures for a Topping-Cycle Cogeneration Plant – Oilfield Natural Gas-Fired Turbine</b>	
<b>Control Measure</b>	<b>Achieved-in-Practice Qualifications</b>
Emissions Performance Standard of 1,100 lb-CO <sub>2</sub> e per MWh of Useful Energy	This proposed emissions level is identical to the emissions performance standard adopted by the CPUC for cogeneration units and identical to the emissions performance standard for certification of a combined heat and power system with the CEC. Therefore, this emissions level is considered Achieved in Practice.
Emissions Performance Standard of 800 lb-CO <sub>2</sub> e per MWh of Useful Energy	Several existing turbines identified in the District's survey (Appendix VI) of oilfield natural gas-fired turbine cogeneration plants are currently operating at levels below this emissions level. Therefore, this emissions level is considered Achieved in Practice.

**STEP 4. Quantify the Potential GHG Emission and Percent Reduction for Each Identified Achieved-in-Practice GHG Emission Control Measure**

**A. Basis and Assumptions:**

No assumptions are necessary as the candidate emission performance standards are already in units of GHG emissions per unit of activity.

**B. Calculation of Potential GHG Emissions per Unit of Activity ( $G_a$ ):**

The candidate emission performance standards are already in units of GHG emissions per unit of activity.

**C. Calculation of Potential GHG Emission Reduction as a Percentage of the Baseline Emission Factor ( $G_p$ ):**

Natural Gas-Fired IC Engines

The following table shows the GHG Emission Reduction Percentage Calculations for each Achieved-in-Practice GHG emission control measure.

<b>GHG Emission Reduction Percentage for Control Measures for a Topping-Cycle Cogeneration Plant – Natural Gas-Fired IC Engine</b>	
<b>Control Measure</b>	<b>Percent GHG Reduction from Baseline</b>
Emissions Performance Standard of 1,100 lb-CO <sub>2</sub> e per MWh of Useful Energy	$\% \text{Reduction} = \frac{1,100 \frac{\text{lb} - \text{CO}_2\text{e}}{\text{MWh}} - 1,100 \frac{\text{lb} - \text{CO}_2\text{e}}{\text{MWh}}}{1,100 \frac{\text{lb} - \text{CO}_2\text{e}}{\text{MWh}}} \times 100\%$ <p style="text-align: center;">Emission Reduction = 0%</p>
Emissions Performance Standard of 700 lb-CO <sub>2</sub> e per MWh of Useful Energy	$\% \text{Reduction} = \frac{1,100 \frac{\text{lb} - \text{CO}_2\text{e}}{\text{MWh}} - 700 \frac{\text{lb} - \text{CO}_2\text{e}}{\text{MWh}}}{1,100 \frac{\text{lb} - \text{CO}_2\text{e}}{\text{MWh}}} \times 100\%$ <p style="text-align: center;">Emission Reduction = 36.4%</p>

Natural Gas-Fired Turbines (not including oilfield cogeneration units)

The following table shows the GHG Emission Reduction Percentage Calculations for each Achieved-in-Practice GHG emission control measure.

<b>GHG Emission Reduction Percentage for Control Measures for a Topping-Cycle Cogeneration Plant – Natural Gas-Fired Turbine (not including oilfield cogeneration turbines)</b>	
<b>Control Measure</b>	<b>Percent GHG Reduction from Baseline</b>
Emissions Performance Standard of 1,100 lb-CO <sub>2</sub> e per MWh of Useful Energy	$\% \text{Reduction} = \frac{1,100 \frac{\text{lb} - \text{CO}_2\text{e}}{\text{MWh}} - 1,100 \frac{\text{lb} - \text{CO}_2\text{e}}{\text{MWh}}}{1,100 \frac{\text{lb} - \text{CO}_2\text{e}}{\text{MWh}}} \times 100\%$ <p style="text-align: center;">Emission Reduction = 0%</p>
Emissions Performance Standard of 800 lb-CO <sub>2</sub> e per MWh of Useful Energy	$\% \text{Reduction} = \frac{1,100 \frac{\text{lb} - \text{CO}_2\text{e}}{\text{MWh}} - 800 \frac{\text{lb} - \text{CO}_2\text{e}}{\text{MWh}}}{1,100 \frac{\text{lb} - \text{CO}_2\text{e}}{\text{MWh}}} \times 100\%$ <p style="text-align: center;">Emission Reduction = 27.3%</p>

Oilfield Natural Gas-Fired Turbines

The following table shows the GHG Emission Reduction Percentage Calculations for each Achieved-in-Practice GHG emission control measure.

<b>GHG Emission Reduction Percentage for Control Measures for a Topping-Cycle Cogeneration Plant – Oilfield Natural Gas-Fired Turbine</b>	
<b>Control Measure</b>	<b>Percent GHG Reduction from Baseline</b>
Emissions Performance Standard of 1,100 lb-CO <sub>2</sub> e per MWh of Useful Energy	$\% \text{Reduction} = \frac{1,100 \frac{\text{lb} - \text{CO}_2\text{e}}{\text{MWh}} - 1,100 \frac{\text{lb} - \text{CO}_2\text{e}}{\text{MWh}}}{1,100 \frac{\text{lb} - \text{CO}_2\text{e}}{\text{MWh}}} \times 100\%$ <p style="text-align: center;">Emission Reduction = 0%</p>
Emissions Performance Standard of 800 lb-CO <sub>2</sub> e per MWh of Useful Energy	$\% \text{Reduction} = \frac{1,100 \frac{\text{lb} - \text{CO}_2\text{e}}{\text{MWh}} - 800 \frac{\text{lb} - \text{CO}_2\text{e}}{\text{MWh}}}{1,100 \frac{\text{lb} - \text{CO}_2\text{e}}{\text{MWh}}} \times 100\%$ <p style="text-align: center;">Emission Reduction = 27.3%</p>

**STEP 5. Rank all Achieved-in-Practice GHG emission reduction measures by order of % GHG emissions reduction**

Natural Gas-Fired IC Engines

Based on the calculations presented in Section II.4 above, the Achieved-in-Practice GHG emission reduction measures are ranked in the table below:

<b>Ranking of Achieved-in-Practice GHG Emission Control Measures for a Topping-Cycle Cogeneration Plant – Natural Gas-Fired IC Engine</b>			
Rank	Control Measure	Potential GHG Emission per Unit of Activity ( $G_a$ ) (lb-CO <sub>2</sub> e/ton)	Potential GHG Emission Reduction as a Percentage of the Baseline Emission Factor ( $G_p$ )
1	Emissions Performance Standard of 700 lb-CO <sub>2</sub> e per MWh of Useful Energy	700	36.4%
2	Emissions Performance Standard of 1,100 lb-CO <sub>2</sub> e per MWh of Useful Energy	1,100	0%

Natural Gas-Fired Turbines (not including oilfield cogeneration units)

Based on the calculations presented in Section II.4 above, the Achieved-in-Practice GHG emission reduction measures are ranked in the table below:

<b>Ranking of Achieved-in-Practice GHG Emission Control Measures for a Topping-Cycle Cogeneration Plant – Natural Gas-Fired Turbine (not including oilfield cogeneration turbines)</b>			
Rank	Control Measure	Potential GHG Emission per Unit of Activity ( $G_a$ ) (lb-CO <sub>2</sub> e/ton)	Potential GHG Emission Reduction as a Percentage of the Baseline Emission Factor ( $G_p$ )
1	Emissions Performance Standard of 800 lb-CO <sub>2</sub> e per MWh of Useful Energy	800	27.3%
2	Emissions Performance Standard of 1,100 lb-CO <sub>2</sub> e per MWh of Useful Energy	1,100	0%

Oilfield Natural Gas-Fired Turbines

Based on the calculations presented in Section II.4 above, the Achieved-in-Practice GHG emission reduction measures are ranked in the table below:

<b>Ranking of Achieved-in-Practice GHG Emission Control Measures for a Topping-Cycle Cogeneration Plant – Oilfield Natural Gas-Fired Turbines</b>			
Rank	Control Measure	Potential GHG Emission per Unit of Activity ( $G_a$ ) (lb-CO <sub>2</sub> e/ton)	Potential GHG Emission Reduction as a Percentage of the Baseline Emission Factor ( $G_p$ )
1	Emissions Performance Standard of 800 lb-CO <sub>2</sub> e per MWh of Useful Energy	800	27.3%
2	Emissions Performance Standard of 1,100 lb-CO <sub>2</sub> e per MWh of Useful Energy	1,100	0%

**STEP 6. Establish the Best Performance Standard (BPS) for this Class and Category**

For Stationary Source Projects for which the District must issue permits, Best Performance Standard is – “For a specific Class and Category, the most effective, District approved, Achieved-In-Practice means of reducing or limiting GHG emissions from a GHG emissions source, that is also economically feasible per the definition of achieved-in-practice. BPS includes equipment type, equipment design, and operational and maintenance practices for the identified service, operation, or emissions unit class and category”.

Based on the definition above and the ranking given in Table 3 from Section II.5, Best Performance Standard (BPS) for this class and category is determined as:

**Best Performance Standards for Topping Cycle Cogeneration Systems**

<b>Draft Best Performance Standards for Topping-Cycle Cogeneration Plants</b>	
<b>Subcategory</b>	<b>Control Measure</b>
Natural Gas-Fired IC Engine	Emissions Performance Standard of 700 lb-CO <sub>2</sub> e per MWh of Useful Energy
Natural Gas-Fired Turbine (not including oilfield cogeneration units)	Emissions Performance Standard of 800 lb-CO <sub>2</sub> e per MWh of Useful Energy
Oilfield Natural Gas-Fired Turbine	Emissions Performance Standard of 800 lb-CO <sub>2</sub> e per MWh of Useful Energy

**STEP 7. Eliminate All Other Achieved-in-Practice Options from Consideration as Best Performance Standard**

The following Achieved-in-Practice GHG control measure, identified in Section II.4 and ranked in Section II.5 has been eliminated from consideration as Best Performance Standard for each subcategory since the GHG control efficiency that are less than that of the selected Best Performance Standard for each subcategory stated in Section II.6:

- Emissions Performance Standard of 1,100 lb-CO<sub>2</sub>e per MWh of Useful Energy

## V. Appendices

Appendix I	Initial Public Process
Appendix II	Public Review Process
Appendix III	Public Comments Received and District Responses
Appendix IV	Survey Results for Natural Gas-Fired IC Engine Cogeneration Systems
Appendix V	Survey Results for Natural Gas-Fired Turbine Cogeneration Systems (non-oilfield)
Appendix VI	Survey Results for Natural Gas-Fired Turbine Cogeneration Systems (oilfield)

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Appendix I  
Initial Public Process

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Appendix II  
Public Review Process

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Appendix III  
Reserved for Public Comments and District Response

DRAFT

Appendix IV  
Survey Results for Natural Gas-Fired IC Engine Cogeneration Systems

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## Survey Results for Natural Gas-Fired IC Engine Cogeneration Systems

The District conducted a survey of the permitted natural gas-fired IC engine cogeneration systems that are currently located in the District. This survey included the collection of fuel usages, useful electricity production, useful thermal energy production, and useful mechanical energy production. Using the provided information and the conversion factors presented in the main body of this document, the District calculated the CO<sub>2</sub> equivalent emissions per unit of activity for each of the permitted cogeneration units for the facilities that responded to the survey. The District identified ten natural gas-fired IC engine cogeneration units and obtained information from six of the units using the survey. The facilities have asked that the raw data and the identity of the facilities be kept confidential; therefore, only the results of the District's analysis are shown below:

<b>Survey Results for Natural Gas IC Engines (based on current configuration)</b>	
<b>Unit</b>	<b>lb-CO<sub>2</sub>e/MWh</b>
Confidential Unit #1	816.5
Confidential Unit #2	555.3
Confidential Unit #3	629.0
Confidential Unit #4	475.0
Confidential Unit #5	687.2
Confidential Unit #6	490.2

Appendix V  
Survey Results for Natural Gas-Fired Turbine Cogeneration Systems  
(non-oilfield)

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Survey Results for Natural Gas-Fired Turbine Cogeneration Systems  
(non-oilfield)

The District conducted a survey of the permitted natural gas-fired non-oilfield turbine cogeneration systems that are currently located in the District. This survey included the collection of fuel usages, useful electricity production, useful thermal energy production, and useful mechanical energy production. Using the provided information and the conversion factors presented in the main body of this document, the District calculated the CO<sub>2</sub> equivalent emissions per unit of activity for each of the permitted cogeneration units for the facilities that responded to the survey. The District obtained information from four non-oilfield units using the survey. The facilities have asked that the raw data and the identity of the facilities be kept confidential; therefore, only the results of the District's analysis are shown below:

<b>Survey Results for Natural Gas-Fired Turbines (non-oilfield) (based on current configuration)</b>	
<b>Unit</b>	<b>lb-CO<sub>2</sub>e/MWh</b>
Confidential Unit #1	683
Confidential Unit #2	825
Confidential Unit #3	809
Confidential Unit #4	746

Appendix VI  
Survey Results for Oilfield Natural Gas-Fired Turbine Cogeneration Systems

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Survey Results for Oilfield Natural Gas-Fired Turbine Cogeneration Systems

The District conducted a survey of the permitted natural gas-fired oilfield turbine cogeneration systems that are currently located in the District. This survey included the collection of fuel usages, useful electricity production, useful thermal energy production, and useful mechanical energy production. Using the provided information and the conversion factors presented in the main body of this document, the District calculated the CO<sub>2</sub> equivalent emissions per unit of activity for each of the permitted cogeneration units for the facilities that responded to the survey. The District obtained information from 36 oilfield cogeneration units using the survey. The facilities have asked that the raw data and the identity of the facilities be kept confidential; therefore, only the results of the District’s analysis are shown below:

<b>Survey Results for Oilfield Natural Gas-Fired Turbines (based on current configuration)</b>	
<b>Unit</b>	<b>lb-CO<sub>2</sub>e/MWh</b>
Confidential Unit #1	951
Confidential Unit #2	794
Confidential Unit #3	794
Confidential Unit #4	794
Confidential Unit #5	794
Confidential Unit #6	794
Confidential Unit #7	794
Confidential Unit #8	794
Confidential Unit #9	571
Confidential Unit #10	628
Confidential Unit #11	664
Confidential Unit #12	960
Confidential Unit #13	960
Confidential Unit #14	960
Confidential Unit #15	952
Confidential Unit #16	529
Confidential Unit #17	483
Confidential Unit #18	533
Confidential Unit #19	614
Confidential Unit #20	643
Confidential Unit #21	593
Confidential Unit #22	655
Confidential Unit #23	655
Confidential Unit #24	639
Confidential Unit #25	553
Confidential Unit #26	553
Confidential Unit #27	553
Confidential Unit #28	553
Confidential Unit #29	553
Confidential Unit #30	553
Confidential Unit #31	553
Confidential Unit #32	553
Confidential Unit #33	518
Confidential Unit #34	509

Confidential Unit #35	454
Confidential Unit #36	492

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