San Joaquin Valley
Unified Air Pollution Control District

Best Performance Standard (BPS) x.x.xx

<table>
<tr><td>Class</td><td>Process Heaters</td></tr>
<tr><td>Category</td><td>All Industries</td></tr>
<tr><td>Best Performance Standard</td><td>1. The process heater shall be either:
A. Designed as a forced draft process heater equipped with an O_2 trim control system and burner designed to operate at an O_2 exhaust percentage of no greater than 4.5%, or
B. Continuously operated at no greater than 4.5% by Volume O_2 exhaust percentage
And
2. Electric motors driving combustion air fans or induced draft fans shall have an efficiency meeting the standards of the National Electrical Manufacturer’s Association (NEMA) for “premium efficiency” motors and shall each be operated with a variable speed control or equivalent for control of flow through the fan.</td></tr>
<tr><td>Percentage Achieved GHG Emission Reduction Relative to Baseline Emissions</td><td>1.5%</td></tr>
</table>

District Project Number	S1104548
Evaluating Engineer	Steven Davidson
Lead Engineer	Arnaud Marjollet
Public Notice: Start Date	December 23,2011
Public Notice: End Date	January 26, 2012
Determination Effective Date	April 10, 2012

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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 polic*y: 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, 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.

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 Process

The District has established Process Heaters – All Industries as a separate class and category which 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 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:

Table 1 BPS Development Process Phases for Process heaters			
Phase	**Description**	**Date**	**Description**
1	Public Notice of Intent	09/28/2010	The District's intent notice is attached as Appendix 1
2	BPS Development	12/20/2011	See evaluation document.
3	Public Participation: Public Notice Start Date	12/23/2011	A Draft BPS evaluation was provided for public comment. The District's notification will be attached as Appendix 3
4	Public Participation: Public Notice End Date	1/26/2012	No public comments were received during the period.
5	Finalization	4/10/2012	The BPS established in this evaluation document is effective on the date of finalization.

III. Class and Category

Process Heaters are recognized as a distinct class based on the following:

- A process heater is defined as any fuel fired combustion equipment which transfers heat from combustion gases to fluid or process streams.

Process heaters are a distinct class with respect to the District's prohibitory rules for criteria pollutant emissions (Rules 4306, 4307, 4308 and 4320).

Process heaters differ from boilers and steam generators as process heaters are not limited to boiling or raising the temperature of fluid.

Process heaters differ from dryers as process heaters do not dry or cure material by direct contact with the products of combustion.

Process heaters differ from dehydrators as process heaters do not drive free fluid from products like fruits, vegetables, and nuts, at an accelerated rate without damage to the product.

There are no other subcategories of process heaters identified; therefore, this BPS determination applies to process heaters used in all industries.

IV Public Notice of Intent

Prior to developing the development of BPS for this class and category, the District published a Notice of Intent. Public notification of the District's intent to develop BPS for this class and category was sent on September 28, 2010 to individuals registered with the CCAP list server. The District's notification is attached as Appendix 1.

The District received the following comments:

1. It is inappropriate to apply a thermal efficiency standard to thermal fluid heaters based on the Higher Heating Value (HHV) of fuels.
2. Fluid heater thermal efficiency is process dependent and should not be regulated generically.
3. The thermal efficiency of thermal fluid heater systems have not been measured with a degree of accuracy required for a policy establishment.
4. Convection sections are not practical on thermal fluid heaters as the return fluid temperature is very high.
5. Testing emission per unit of Btu output delivered to the process would be extremely costly.
6. BTU input size and operating temperature would affect performance.

Comments received during the initial public outreach were considered during this determination and are presented in Appendix 2. A summary of the comments and the District Response can be found in Appendix 3.

V. 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 in the San Joaquin Valley (SJV), expressed as annual GHG emissions per unit of activity. The Baseline Emission Factor was calculated by determining facilities within the SJVAPCD that operated natural design process heaters in 2002 though 2004. Source tests for these units were examined to determine the median O_2 levels of process heaters. These process heaters were exclusively of natural draft design. The mean of these facilities medians was used to determine the Baseline emissions factor.

A. Representative Baseline Operation

For all industries, the representative baseline operation has been determined to be a natural draft design process heater. This determination is based on a review of District permitted process heaters in use during 2002-2004.

B. Basis and Assumptions

- All direct GHG emissions are the result of the combustion of natural gas in the process heater.
- Unit of Activity is 1 MMBtu of heat **delivered** to the process (absorbed duty of the heater)
- Natural draft heaters operate with 6.4% O2
- Stack temperature is 800 F (most are in range of 600-1000 depending upon the feed temperature and the convective surface area)
- Air contains 20.75% O2
- For purposes of analysis, air and flue gas are assumed to have the same molecular weight = 28.0 (actually air = 28.8, flue gas = approx. 27.8 for natural gas)
- For natural gas, net heating value (NHV) = 90%* higher heating value (HHV)
- F factor for natural gas is 8,578 scf/MMBtu (HHV) at 60 F.
- Heat capacity (c_p) of air and flue gas is 0.26 Btu/lb-F (= 0.011 Btu/scf-F)
- The GHG emission factor for natural gas combustion is 117 lb-CO_2e per MMBtu of natural gas fired (per CCAR document)[1]
- Indirect emissions are produced due to operation of the electric air blower motor

[1]EF CO_2e = 52.92 kg/MMBtu x 2.2046 kg/lb
= 116.67 →117 lb·CO_2e/MMBtu (natural gas fired)

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, using the 2002-2004 baseline period as the reference. The resulting emission factor is a combination of direct emissions from fuel consumption and indirect emissions from electricity consumption.

The useful output of the process heaters cannot be correlated to product produced, because the amount of heat and its impact on each system is difficult to determine on an individual basis, and varies considerably due to the varying purposes for the system and industries. Therefore, Unit of Activity is 1 MMBtu of heat delivered to the process (absorbed duty of the heater).

D. Calculations

1. Direct GHG Emissions (Natural draft design efficiency calculated based on excess air)

Actual SCF (Q) of flue gas is dependent on excess O_2 and is given by:

$$Q = E*F*(20.75\%/(20.75\%-O_2))$$

Where:

Q = SCF flue gas per MMBtu fired (HHV)n
E = Fuel fired MMBtu (HHV)
F = F factor = 8,578 scf/MMBtu
O_2 = percentage O_2 in flue gas

An energy balance for a process heater, with a zero energy reference of 60 F for products of combustion with water in the vapor state is represented by the following:

$$S + A + L = 90\% * E$$

Where:

S = thermal energy loss to the stack (MMBtu)
E = Fuel fired MMBtu (HHV)
A = Energy absorbed by the process (MMBtu)
L.= radiation and convective losses from the heater shell (assumed to be zero for purposes of this analysis)
90% * E = net heat value of fuel fired MMBtu

For a stack temperature of 800 F, stack loss is:

S = (Q * cp * (800 – 60))/1,000,000 in MMBtu)
$S = (E*F*(20.75\%/(20.75\%-O2)) * c_p * (800-60))/1,000,000$
S = (E * 8,578 *(20.75%/(20.75%-O2)) * 0.011 * (800-60))/1,000,000

Setting B = (8,578 * 0.011 * (800-60))/1,000,000 = 0.0698

Then $S = E *(20.75\%/(20.75\%-O_2)) * B$

Substituting into the energy balance,

$$(E *(20.75\%/(20.75\%-O_2)) * B) + A = 90\% * E$$

Rearranging to solve for the heater thermal efficiency (absorbed duty/fired duty-NHV)

$$\eta = A/(90\% * E) = 1 – ((20.75\%/(20.75\%-O_2)) * B)/90\%$$

<u>For a heater with 800 F stack operating with 6.4% O2,</u>

η = A/(90% * E) = 1 – ((20.75%/(20.75%-O_2)) * B)/90%

η = 1 – ((20.75%/(20.75%-6.4)) * 0.0698)/90% = 88.8%

η = 88.8% * 90% = 79.9 % (HHV)

Given an absorbed duty of 1.0 MMBtu, the required fired duty is

E = 1.0/79.9% = 1.25 MMBtu fired per MMbtu absorbed

$GHG_{emissions}$ = 117 lb/MMbtu * 1.25 = 146.3 lb CO2e/MMbtu
$GHG_{emissions}$ = **146.3 lb CO2e/MMbtu** x 1 metric ton/2,205 lb
$GHG_{emissions}$ = **0.0664 metric tons•CO2e/MMBtu absorbed duty**

2. Total Baseline Emissions (Direct emissions)

BEF = 146.3 lb·CO_2e/MMBtu
BEF = 146.3 lb·CO_2e/MMBtu ÷ 2,205 lb/metric ton
BEF = 0.0664 metric ton·CO_2e/MMBtu (heat output)

BEF = 0.0664 metric tons·CO_2e/MMBtu (of heat output)

STEP 2. List Technologically Feasible GHG Emission Control Measures

<u>Convection Section</u>

Additional waste-heat can be transferred from the exhaust gasses to the process stream by installing convective heat transfer surface in the stack, further increasing the thermal efficiency. A convection section is essentially additional heat transfer surface which serves to recover heat from the unit's exhaust by transferring heat to the incoming process stream or to other low temperature heat utilization in the facility.

Convection sections are useful in steam generators/boilers in that the boiler feedwater is generally at a low temperature. However, process heaters are used in many industries and in a multitude of processes. Some applications may require the return fluid temperature to be higher than steam generators or boilers. In other applications heat sinks may not be available at a particular facility. Because, process heaters handle multiple transfer fluids, have multiple applications, and are used in a multitude of industries, process heaters, unlike boilers or steam generators, may not be practical in many applications. Therefore, convection sections are not technologically feasible at this time.

Forced Draft Design Process Heater

The combustion process generally requires an excess of air (air in excess of the stoichiometric requirement for combustion of the fuel) to ensure efficient combustion and safe operation. Operations which exceed the minimum amount of excess air required for clean and safe operation, i.e. natural draft design heaters, result in a loss of efficiency as a result of the increased stack losses.

Additionally, natural draft design units may require operation with greater than 6% excess oxygen due to the uncontrolled air flow into the heater. From an efficiency standpoint, the excess O_2 means that there are energy losses incurred to heat the excess air up to the stack temperature.

Forced draft design units control combustion at the burner by supplying the burner with a more controllable air flow. When combined with an O2 trim control, the system allows operation of the heater at an optimum (minimum required) level of excess air over the full range of heater operation. From an efficiency standpoint, reduction in the excess air means not only a reduction in the energy losses which are incurred to heat the excess air up to the stack temperature but, in addition, electrical energy consumption required by the combustion air blower to handle higher excess air is eliminated. This design is currently available from manufactures and in operation throughout the District. This technology will be considered technologically feasible for process heaters.

Use of Premium Efficiency Motors with Speed Control

An electric motor efficiency standard is published by the National Electrical Manufacturers Association (NEMA) which is identified as the "NEMA Premium Efficiency Electric Motors Program". For large motors, the NEMA premium efficiency motor provides a gain of approximately 5-8 percentage points in motor efficiency when compared to a standard efficiency motor. The NEMA specification covers motors up to 500 horsepower and motors meeting this specification are in common use and are available from most major electric motor manufacturers.

Control of the combustion air fan operation by use of a variable speed electric motor will provide substantial energy savings when compared to operation at a fixed speed and controlled by throttling the discharge flow. The most common and economical variable speed drive is the variable frequency drive (VFD) which has become commonly available in the last decade and is typical for new fan applications. The VFD provides especially significant energy savings when operated at substantial turndown rations which can result in throttling away more than half the rated energy output of the motor. Premium Efficiency motors with speed controls are technologically feasible.

Use of High Efficiency Combustion Air Fans

The peak efficiency of centrifugal fans may vary from 60 to 80% depending upon fan design and application. Use of a higher efficiency fan provides either savings in indirect GHG emissions due to the significant reduction in electric motor horsepower for motor-driven fans or savings in direct GHG emissions when the fan is driven by a steam turbine. However, the absolute value of efficiency which can be achieved is highly dependent upon the specific operating conditions including flow, pressure, and temperature, all of which may vary significantly for any specific process heater. Process heaters vary greatly in operation, it is not possible to specify a minimum combustion air efficiency that would be applicable to all process heaters. Given this variability as well as the absence of any effective industry standard for fan efficiency, specification of combustion air fan efficiency cannot be included as a technologically feasible reduction measure at this time.

B. Listing of Technologically Feasible Control Measures

For the specific equipment or operation being proposed, all technologically feasible GHG emissions reduction measures are listed, including equipment selection, design elements and best management practices, that do not result in an increase in criteria pollutant emissions compared to the proposed equipment or operation.

Table 2
Technologically Feasible GHG Reduction Measures for Process Heaters

Reduction Measure	Qualifications
1. The process heater shall be either: A. Designed as a forced draft process heater equipped with an O_2 trim control system and burner designed to operate at an O_2 exhaust percentage of no greater than 4.5%, or B. Continuously operated at no greater than 4.5% by Volume O_2 exhaust percentage	Increased combustion efficiency
2. Electric motors driving combustion air fans or induced draft fans shall have an efficiency meeting the standards of the National Electrical Manufacturer's Association (NEMA) for "premium efficiency" motors and shall each be operated with a variable speed control or equivalent for control of flow through the fan.	Ability to adjust airflow through the process Heater without the need to use restrictive louvers and maximum efficiency for conversion of electrical energy to mechanical energy.

All of the control measures identified above are consistent with control equipment for criteria pollutants which meets current regulatory requirements. None of the identified control measures would result in an increase in emissions of criteria pollutants.

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.

All technologically feasible GHG reduction measures listed in Table 2 above meet the following criteria:

<u>All technology listed is in current commercial use.</u>

All technologically feasible GHG reduction measures listed in Table above are based on technology (forced draft process heater and burner/O2 trim control designed to operate below 4.5 % O_2 and high efficiency motors with variable speed drives) which is currently in commercial use. This technology has been in place for a significant number of years and was developed and implemented without benefit of grants, incentives or other financial subsidies.

<u>Implementation of all listed technology does not result in an increase in criteria pollutant emissions.</u>

In general, since all proposed measures do not affect the criteria pollutant emission factors and generally result in a reduction in the firing of fuel, criteria pollutant emissions will generally be reduced with implementation of BPS.

Therefore, all items are deemed to be Achieved-in-Practice. Since all of the achieved-in-practice measures identified are independent of each other, a concurrent implementation of all measures results in a strictly additive benefit (none of the measures are mutually exclusive). Therefore, all identified reduction measures are considered to be a single measure in effect. Since there are no other mutually exclusive measures identified, in effect there is a single achieved-in-practice reduction measure identified and District proposes to deem the concurrent implementation of all identified achieved-in-practice reduction measures as BPS for this class and category.

Table 3 Achieved-in-Practice GHG Control Measures for Process Heaters	
GHG Control Measures	**Achieved-Qualifications**
1. The process heater shall be either: A. Designed as a forced draft process heater equipped with an O_2 trim control system and burner designed to operate at an O_2 exhaust percentage of no greater than 4.5%, or B. Continuously operated at no greater than 4.5% by Volume O_2 exhaust percentage	Ability to increase combustion efficiency by minimizing exhaust O_2 and ability to vary airflow through the process Heater without the need to use restrictive louvers and maximum efficiency for conversion of electrical energy to mechanical energy
2. Electric motors driving combustion air fans or induced draft fans shall have an efficiency meeting the standards of the National Electrical Manufacturer's Association (NEMA) for "premium efficiency" motors and shall each be operated with a variable speed control or equivalent for control of flow through the fan.	Ability to adjust airflow through the process Heater without the need to use restrictive louvers and maximum efficiency for conversion of electrical energy to mechanical energy.

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

A. Basis and Assumptions:

- All direct GHG emissions are the result of the combustion of natural gas in the process heater.
- Unit of Activity is 1 MMBtu of heat **delivered** to the process (absorbed duty of the heater)
- Forced draft heaters operate with 4.5% O2
- Stack temperature is 800 F (most are in range of 600-1000 depending upon the feed temperature and the convective surface area)
- Air contains 20.75% O2
- For purposes of analysis, air and flue gas are assumed to have the same molecular weight = 28.0 (actually air = 28.8, flue gas = approx. 27.8 for natural gas)
- For natural gas, net heating value (NHV) = 90%* higher heating value (HHV)
- F factor for natural gas is 8,578 scf/MMBtu (HHV) at 60 F.
- Heat capacity (c_p) of air and flue gas is 0.26 Btu/lb-F (= 0.011 Btu/scf-F)

- The GHG emission factor for natural gas combustion is 117 lb-CO_2e per MMBtu of natural gas fired (per CCAR document)[1]
- Indirect emissions are produced due to operation of the electric air blower motor.
- For purposes of analysis, combustion air flow rate in scf is assumed equal to the flue gas rate in scf.
- Since most units operate with significant turndown from rated capacity, use of a variable speed drive is assumed to result in a 30% reduction in energy consumption by the blower.
- Static head requirement for the blower is assumed to be 20 "WC
- Blower static efficiency is assumed to be 60%
- Blower motor electrical efficiency is 94.5%
- Indirect emissions from electric power consumption are calculated based on the current PG&E electric power generation factor of 0.524 lb-CO_2e per kWh (http://www.pge.com/about/environment/calculator/assumptions.shtml)

[1]EF CO_2e = 52.92 kg/MMBtu x 2.2046 kg/lb
= 116.67 →117 lb·CO_2e/MMBtu natural gas fired

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

1. Direct GHG Emissions: (Forced draft design efficiency based on excess air)

Actual SCF (Q) of flue gas is dependent on excess O2 and is given by:

Q = E*F*(20.75%/(20.75%-O2))

Where:

Q = SCF flue gas per MMBtu fired (HHV)n
E = Fuel fired MMBtu (HHV)
F = F factor = 8,578 scf/MMBtu
O_2 = percentage O_2 in flue gas

An energy balance for a process heater, with a zero energy reference of 60 F for products of combustion with water in the vapor state is represented by the following:

S + A + L = 90% * E

Where:

S = thermal energy loss to the stack (MMBtu)
E = Fuel fired MMBtu (HHV)
A = Energy absorbed by the process (MMBtu)
L = radiation and convective losses from the heater shell (assumed to be zero for purposes of this analysis)
90% * E = net heat value of fuel fired MMBtu

For a stack temperature of 800 F, stack loss is:

$$S = (Q * c_p * (800 - 60))/1{,}000{,}000 \text{ in MMBtu}$$
$$S = (E*F*(20.75\%/(20.75\%-O_2)) * c_p * (800-60))/1{,}000{,}000$$
$$S = (E*8{,}578 *(20.75\%/(20.75\%-O_2)) * 0.011 * (800-60))/1{,}000{,}000$$

Setting B = (8,578 * 0.011 * (800-60))/1,000,000 = 0.0698

$$\text{Then } S = E * (20.75\%/(20.75\%-O_2)) * B$$

Substituting into the energy balance,

$$(E *(20.75\%/(20.75\%-O2)) * B) + A = 90\% * E$$

Rearranging to solve for the heater thermal efficiency (absorbed duty/fired duty-NHV)

$$\eta = A/(90\% * E) = 1 - ((20.75\%/(20.75\%-O2))*B)/90\%$$

<u>For a heater with 800 F stack operating with 4.5% O2,</u>

$$\eta = 1 - (20.75\%/(20.75\%-4.5\%)*0.0698)/90\% = 90.1\% \text{ (NHV)}$$

$$\eta = 90.1\% * 90\% = 81.1 \% \text{ (HHV)}$$

Given an absorbed duty of 1.0 MMBtu, the required fired duty is

$$E = 1.0/81.1\% = 1.23 \text{ MMBtu fired per MMBtu absorbed}$$

$GHG_{emissions}$ = 117 lb/MMbtu * 1.23 = 143.9 lb CO2(eq)
$GHG_{emissions}$ = **143.9 lb CO2e/MMbtu** x 1 metric ton/2,205 lb
$GHG_{emissions}$ = **0.0653 metric tons•CO2e/MMBtu absorbed**

2. **Indirect GHG Emissions:** (Variable frequency drive high efficiency electrical motor driving the blower)

Blower
Specific electricity consumption and GHG emissions for the high efficiency blower motor

For a fuel consumption of 1.23 MMBtu, flue gas produced is:

$$Q = E*F*(20.75\%/(20.75\%-O2))$$
$$Q = 1.23*8{,}578*(20.75\%/(20.75\%-4.5\%))$$
$$Q = 13{,}472 \text{ scf}$$

Assuming the combustion air rate is equal to the flue gas rate, the blower must deliver 13,472 scf of air at a differential head of 20” WC

For ambient air at 60 F and neglecting the compressibility of the gas, it can be demonstrated that the horsepower requirement may be calculated as:

Bhp/scf = static head (" WC) ÷ (381,360 x static efficiency %)

Bhp-hr/scf = 20" WC ÷ (381,360 x 60%) = 8.74×10^{-5}

And therefore the power consumption for providing combustion air for 1.23 MMBtu of natural gas is:

Bhp-hr = 8.74×10^{-5} * 13,472 = 1.18 bhp-hr

Assuming a 30% reduction for use of a variable speed drive, the net energy required is:

1.18 bhp-hr * (1-30%) = 0.83 bhp-hr

Energy draw by the motor is:

0.83 bhp-hr * 0.746 kWh/hp-hr/94.5% = 0.66 kWh per MMBtu of absorbed duty

Indirect emissions:

0.66 * 0.524 = 0.35 lb·CO_2e

3. Total GHG Emissions (Direct emissions + Indirect emissions)

G_a = (143.9 + 0.4) lb·CO_2e/MMBtu = 144.3 lb·CO_2e/MMBtu (heat output)
G_a = 144.3 lb·CO_2e/MMBtu x 1 metric ton/2,205 lb
= 0.0654 metric tons·CO_2e/MMBtu (heat output)

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

$G_p = (BEF_{total} - G_{a\ Total}) \div BEF_{Total}$ metric tons/MMBtu
Gp = (0.0664 –0.0654) ÷ 0.0664 = 0.015= 1.5 %

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

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

Table 4
Ranking of Achieved-in-Practice GHG Emission Control Measures

Rank	GHG Control Measures	Potential GHG Emission per Unit of Activity (G_a) (Metric Ton-CO_2e/MMBtu)	Potential GHG Emission Reduction as a Percentage of the Baseline Emission Factor (G_p)
1	1. The process heater shall be either: A. Designed as a forced draft process heater equipped with an O_2 trim control system and burner designed to operate at an O_2 exhaust percentage of no greater than 4.5%, or B. Continuously operated at no greater than 4.5% by Volume O_2 exhaust percentage And 2. Electric motors driving combustion air fans or induced draft fans shall have an efficiency meeting the standards of the National Electrical Manufacturer's Association (NEMA) for "premium efficiency" motors and shall each be operated with a variable speed control or equivalent for control of flow through the fan.	**0.0654**	**1.5%**

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 of evaluated technologies, Best Performance Standard (BPS) for this class and category is determined as:

Best Performance Standard for **Process Heaters**

1. The process heater shall be either:

A. Designed as a forced draft process heater equipped with an O_2 trim control system and burner designed to operate at an O_2 exhaust percentage of no greater than 4.5%, or

B. Continuously operated at no greater than 4.5% by Volume O_2 exhaust percentage

And

2. Electric motors driving combustion air fans or induced draft fans shall have an efficiency meeting the standards of the National Electrical Manufacturer's Association (NEMA) for "premium efficiency" motors and shall each be operated with a variable speed control or equivalent for control of flow through the fan.

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

No other Achieved-in-Practice options were identified.

VI. Public Participation

A Draft BPS evaluation was provided for public comment. Public notification was sent on December 23, 2011 to individuals registered with the CCAP list server. The District's notification is attached as Appendix 4. No comments were received

VII. Appendices

Appendix 1:	Public Notice of Intent
Appendix 2:	Comments received during the initial public outreach
Appendix 3:	District Response to Comments
Appendix 4:	Notice of Public Participation: Posting of Draft BPS

Appendix 1

Public Notice of Intent

San Joaquin Valley
AIR POLLUTION CONTROL DISTRICT

HEALTHY AIR LIVING

NOTICE OF DEVELOPMENT of

Best Performance Standards

NOTICE IS HEREBY GIVEN that the San Joaquin Valley Air Pollution Control District solicits public comment on development of Best Performance Standards for the following Stationary Source class and category of greenhouse gas emissions:

Thermal Fluid Heat Transfer Systems (water heaters, indirect-fired oil heaters, pipeline heaters, tank heaters, etc)

The District is soliciting public input on the following topics for the subject Class and Category of greenhouse gas emission source. The District needs your input in order to quantify "typical" greenhouse gas (GHG) emissions from thermal fluid heat transfer systems that operated during the "baseline period" from the years 2002 - 2004, and currently have the lowest overall level of GHG emissions (achieved in practice).

Please supply any input and data regarding any thermal fluid heat transfer systems that:

1. Operated during the three year period from 2002 - 2004 (baseline), and
2. Other units that are currently operating at the lowest modern level of GHG emissions.

Information request for both categories include:

a. Actual overall thermal efficiencies (heat output vs. heat input),
b. Actual amount of electrical input (kilowatts or kilowatt hours) required,
c. List of the equipment utilized with the thermal fluid heat transfer systems (i.e. constant hp. electric motors, variable frequency drive motors, high efficiency motors, economizers of any kind, pre-heaters, etc.),
d. Proposals for a method to quantify the emissions per unit of activity, either in lbs of GHG produced per unit of heat output, or lbs of GHG per unit of steam produced, or other method, and
e. Suggestions for defining the classes and categories of source, (i.e. size range, industry etc.)

Information or any other comments regarding development of the proposed Best Performance Standard can be obtained from the District's website at http://www.valleyair.org/Programs/CCAP/CCAP_idx.htm. Written comments regarding the proposed Best Performance Standard should be addressed to Steven Davidson by email, steven.davidson@valleyair.org, or by mail at SJVUAPCD, 34946 Flyover Ct. Bakersfield, CA 93312 and must be received by **October 15, 2010**. For additional information, please contact Steven Davidson at steven.davidson@valleyair.org or by phone at (661) 392-5681.

Information regarding the District's Climate Action Plan and how to address GHG emissions impacts under CEQA, can be obtained from the District's website by clicking on http://www.valleyair.org/Programs/CCAP/CCAP_idx.htm.

Appendix 2

Comments received during the initial public outreach

Steven Davidson

From: Rick Martin [rmartin@martinthermal.com]
Sent: Tuesday, October 19, 2010 4:15 PM
To: Steven Davidson
Subject: Comments on proposed rulemaking for Thermal Fluid Heaters

Mr. Steven Davidson,

Please consider my comments on your proposed development of Best Performance Standards for thermal fluid heater.

1. My qualifications:
    a. I am an independent engineering consultant with place of business in California.
    b. I am a registered Professional Engineer in California.
    c. I am Secretary of the National Fire Protection Association's Technical Committee on Fluid Heaters.
        1. NOTE: This is a volunteer position and I am neither a representative of nor a spokesperson for NFPA.
    d. I am a part-time lecturer in the Aerospace and Mechanical Engineering Department at the University of Southern California. I teach undergraduate Heat Transfer and undergraduate Thermal Systems Design.
        1. NOTE: My opinions are independent of the University and I am neither a representative of nor a spokesperson for USC.

2. My opinions:
    A. It is inappropriate to apply a thermal efficiency standard to thermal fluid heaters that is based on the Higher Heating Value (HHV) of fuels.
        a. The HHV of a fuel includes the exothermic energy available from the conversion of fuel to gaseous combustion products plus the latent heat from condensation of the combustion-generated water vapor to liquid water at ambient pressure.
        b. Thermal fluid heaters are frequently operated with heat transfer fluids flowing in a continuous loop, and where the fluid temperature is maintained well above 212°F (the boiling point of water) at all points in the loop.
        c. It is therefore impossible for such fluid heaters to utilize an "economizer" to condense the water vapor generated from fuel combustion and therefore, the combustion-generated H_2O will not be able to exit the system as a liquid.
        d. Since the energy from the latent heat of condensation is unavailable to these fluid heaters, it is inappropriate to base the thermal efficiency of a fluid heater on the HHV of the fuel.
        e. The thermal efficiency of a fluid heater should be based upon its ability to extract heat from the hot combustion gases (as computed by the Lower Heating Value or LHV), down to whatever is the minimum operating temperature of the thermal fluid.
    B. Fluid heater thermal efficiency is process dependent and should not be regulated generically.
        a. The minimum operating temperature of the fluid in a thermal fluid heater is process-dependent, and the exit temperature of the combustion exhaust is largely dependent on the minimum fluid temperature.
        b. Hot presses, tenter-frame ovens, desulfurization processes, and other operations that rely on thermal fluid heat transfer, require their fluids to operate at widely divergent temperatures (roughly from 200°F to 600°F).

3/4/2011

c. Attempting to require a generic thermal efficiency rating for all fluid heaters as a single technology class (i.e., one that is independent of the process to which the devices are providing heat) would likely be problematic and could have the unintended consequence of making it impossible to operate certain categories of thermal processes within the regulated jurisdiction.

Thank you for considering my comments.

Rick

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October 15, 2010

Attn: Steven Davidson
San Joaquin Air Pollution Control District
34946 Flyover Ct.
Bakersfield, CA 93312
Tel: 661-392-5681
Email: steven.davidson@valleyair.org

Subject Ref: Thermal Fluid Best Performance Standard
Dear Steven,

We have become aware of your Best Performance Standard Rule Development for Thermal Fluid Heaters. We are a manufacturer of these Thermal Fluid Heaters and boilers. We do not manufacture many thermal fluid heaters and our largest unit is 6,250,000 BTUH input. We have only a small number located in the SJVAPCD & none under permit to my knowledge.

The following is your request:
"Please supply any input and data regarding thermal fluid heat transfer systems that:

1. Operated during the three year period from 2002-2004 (baseline), and
2. Other units that are currently operating at the lowest modern level of GHG emissions.
   What is the lowest modern level GHG emissions? Please clarify. I know this would depend on operating temperature. As a hotter process fluid is required the stack heat loss is increased.

Information request for both categories include:

a. Actual overall thermal efficiencies (heat output vs. heat input),
b. Actual amount of electrical input (kilowatts or kilowatt hours) required,
c. List of the equipment utilized with the thermal fluid heat transfer systems (i.e. constant hp. Electric motors, variable frequency drive motors, high efficiency motors, economizers of any kind, pre-heaters, etc),
d. Proposals for a method to quantify the emissions per unit of activity, either in lbs. of GHG produced per unit of heat output, or lbs. of GHG per unit of steam produced, or other method, and
e. Suggestions for defining the classes and categories of source, (i.e. size range, industry, etc.)"

A. We do not know of any thermal fluid heater system where thermal efficiency has been measured with a degree of accuracy required for a policy establishment. If data were to accurately be provided calibrated fuel meters and mass flow meters (calibrated) would be required.

We normally rate our small thermal heaters at 80% efficiency (combustion) but derate the output as the medium temperature increases.

B. Typical HP's of Parker Boiler fans for BTU's are as follows:
2.0 MM – 1 HP
3.0 MM – 2 HP
4.0 MM – 5 HP
6.25 MM – 7 1/2 HP

C. (1) The following is a rough estimate of heater pump HP:
2.0 MM – 7 1/2 HP
3.0 MM – 7 1/2 HP
4.0 MM – 10 HP
6.25 MM – 20 HP

Never a Compromise for Quality or Safety

(2) *Economizers are not practical on thermal fluid heaters as the return fluid temperature is very high. If a related water or heat load is always available as a heat sink then the possibility may exist to install an economizer to capture heat.*

D. *The emissions per unit of BTUH output delivered to the process should be extremely carefully measured for any policy or rule activity. For UL testing calibrated fuel meters, temperature gauges, and flow meters are required. The testing must be done and witnessed by an independent testing lab. The cost of this testing will be very high on a thermal fluid system. Keep in mind specific heat and specific gravity of the fluid can change significantly from the inlet to outlet of the heater. This type of accurate testing is the only acceptable data for this type policy. We are not aware of any site doing this.*

E. *Classes: Of course BTU input size and operating temperature would effect performance.*

F. *Additional Questions:*
1. *How many permitted thermal fluid heaters are in the district?*
2. *How many new thermal fluid heaters were permitted in 2010, 2009, and 2008?*

Thank you for your consideration.

Yours truly,

Greg Danenhauer
Vice President – Engineering
State Of California Registered Professional Mechanical Engineer
M-21981
Member: ASHRAE
Member: ASPE
Past Member: California Boiler Inspectors Organization
Member: SCAQMD Rule 1146 Advisory Committee
1146.1 Advisory Committee
1146.2 Advisory Committee
1121 Advisory Committee
Contributor to Development of NFPA Standard 87 Recommended Practice for Fluid Heaters 2011 Edition
Certified: SCAQMD Portable Analyzer Operation

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Appendix 3

District Response to Comments

Email Comments from Rick Martin of Martin Thermal Engineering:

Comment Summary:

It is inappropriate to apply a thermal efficiency standard to thermal fluid heaters.

District Response:

The District has created a design standard for BPS not a thermal efficiency standard.

Comment Summary:

Fluid heater thermal efficiency is process dependent and should not be regulated generically.

District Response:

BPS is one method of streamlining the Districts CEQA process. A permittee may request the District perform a project specific GHG emissions evaluation demonstrating that project's specific GHG emissions would be reduced or mitigated by at least 29%. Projects achieving at least a 29% GHG emission reduction compared to BAU would be determined to have a less than significant individual and cumulative impact for GHG.

Email Comments from Greg Danenhauer of Parker Boiler:

Comment Summary:

Thermal efficiency of thermal fluid heaters has not been measured with a degree of accuracy to establish policy.

District Response:

The District has created a design standard for BPS.

Comment Summary:

Economizers are not practical on thermal fluid heaters

District Response:

Economizers will not be required to satisfy BPS.

Comment Summary:

Emissions per unit of BTUH output delivered to the process should be carefully measured for any Policy.

District Response:

BPS is based on design criteria and not emissions per unit of BTUH output delivered.

Appendix 4

Notice of Public Participation: Posting of Draft BPS

San Joaquin Valley
Unified Air Pollution Control District

Best Performance Standard (BPS) x.x.xx

Date: December 23, 2011

Class	Process Heaters
Category	All Industries
Best Performance Standard	1. The process heater shall be either: A. Designed as a forced draft process heater equipped with an O_2 trim control system and burner designed to operate at an O_2 exhaust percentage of no greater than 4.5%, or B. Continuously operated at no greater than 4.5% by Volume O_2 exhaust percentage And 2. Electric motors driving combustion air fans or induced draft fans shall have an efficiency meeting the standards of the National Electrical Manufacturer's Association (NEMA) for "premium efficiency" motors and shall each be operated with a variable speed control or equivalent for control of flow through the fan.
Percentage Achieved GHG Emission Reduction Relative to Baseline Emissions	1.5%

District Project Number	S1104548
Evaluating Engineer	Steven Davidson
Lead Engineer	Arnaud Marjollet
Public Notice: Start Date	December 23,2011
Public Notice: End Date	January 26, 2012
Determination Effective Date	TBD