San Joaquin Valley
Unified Air Pollution Control District
Best Performance Standard (BPS) x.x.xx

June 22, 2010

Class	**Dryers**
Category	**Fruit and Vegetable Drying Operations with a Gaseous Fuel-Fired Tunnel Dryer**
Best Performance Standard	Average annual specific fuel consumption not exceeding 1,877 Btu per pound of moisture evaporated from the fruit processed. Compliance with this standard shall be demonstrated by monitoring and recordkeeping of fuel consumption, quantity of fruit processed, and the initial and final moisture content of fruit processed.
Percentage Achieved GHG Emission Reduction Relative to Baseline Emissions	**17.0%**

District Project Number	C-1100390
Evaluating Engineer	Dennis Roberts, P.E.
Lead Engineer	Martin Keast
Initial Public Notice Date	June 24, 2010
Final Public Notice Date	July 15, 2010
Determination Effective Date	

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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 is – 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.

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 *Fruit and Vegetable Drying Operations with a Gaseous Fuel-Fired Tunnel Dryer* 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 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:

Table 1
BPS Development Process Phases for
Fruit and Vegetable Drying Operations with a Gaseous Fuel-Fired Tunnel Dryer

Phase	Description	Date	Comments
1	Public Notice of Intent	2/1/10	The District's intent notice sent by email to interested parties registered on the District's GHG web site for this class and category is attached as Appendix 1.
2	BPS Development	N/A	See Section III of this evaluation document.
3	Public Participation	6/24/10	
4	Public Comments	7/15/10	

III. Class and Category

Dryers are recognized as a distinct class based on the following:

- A dryer is defined as a device in which material is dried or cured in direct contact with the products of combustion. This class includes dehydrators which are used to drive free water from products like fruits, vegetables, and nuts, at an accelerated rate without damage to the product.

Fruit and Vegetable Drying Operations with a Gaseous Fuel-Fired Tunnel Dryer is recognized as a distinct category of *Dryers* based on the following:

These units are designed to dry fruit placed in trays in a semi-continuous mode of operation

- The District already considers this a distinct category of dryers with respect to Best Available Control Technology (BACT) for criteria pollutant emissions. The following BACT determinations have been made with respect to this operation: *1.6.14 Dehydrator Tunnel - Fruit, Natural Gas Fired (5/18/1998).*

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 February 1, 2010 to parties registered with the CCAP list server. The District's notification is attached as Appendix 2.

Comments received during the initial public outreach are presented in Appendix 2. These comments have been used in the development of this BPS as presented below.

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 is calculated by first defining an operation which is representative of the average population of units of this type in the SJV during the Baseline Period and then determining the specific emissions per unit throughput for the representative unit.

A. Representative Baseline Operation

For *Fruit and Vegetable Drying Operations with a Gaseous Fuel-Fired Tunnel Dryer*, the representative baseline operation has been determined to be a tunnel dryer with the following attributes:

Natural gas-fired tunnel dryer consisting of 1) a lower chamber (drying chamber) through which trucks or dollies, loaded with trays of fruit or vegetables, are moved for purposes of drying and 2) a connected upper chamber (air return channel) in which the air circulation fan and the direct-fired natural gas or LPG-fired burner are located. Manual dampers are included in the upper chamber for purposes of admitting fresh air to the dryer and for exhausting moisture-laden air to the atmosphere.

B. Basis and Assumptions

- All direct GHG emissions are produced due to combustion of natural gas in this unit.
- Specific fuel consumption is 2,260 Btu per pound of moisture evaporated (per discussion in Section D).
- GHG emissions are stated as "CO_2 equivalents" (CO_2(e)) which includes the global warming potential of methane and nitrous oxide emissions associated with gaseous fuel combustion.
- The GHG emission factor for natural gas combustion is 117 lb-CO_2e/MMBtu per CCAR document[1].
- Indirect emissions associated with the air circulation fan electric motor are not considered since the motors are relatively small and do not provide a significant potential for reduction in GHG.

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 emissions factor is the combination of:

1) GHG emission reductions achieved through technology, and
2) GHG emission reductions achieved through changes in activity efficiencies

A unit of activity for this class and category will be taken as <u>one pound of moisture evaporated</u>.

[1] California Climate Change Action Registry (CCAR), Version 3.1, January, 2009 (Appendix C, Tables C.7 and C.8)

For purposes of this BPS determination, it will be assumed that GHG emissions reductions achieved through changes in activity efficiencies are not significant since this class and category of operation has been relatively static for several decades with respect to developments in processing technology.

D. Calculations

The Baseline Emission Factor (BEF) is the sum of the direct (GHG_D) and indirect (GHG_I) emissions, on a per unit of activity basis, stated as lb-CO_2e equivalent:

$BEF = GHG_D + GHG_I$

As stated above, indirect emissions for this category are not significant. Therefore,

$BEF = GHG_D$

$GHG_D = E_f \times SFC$

E_f = 117 lb-CO_2e/MMBtu of natural gas

SFC = Specific Fuel Consumption = Energy Required to Evaporate One Pound of Moisture

Specific fuel consumption of the baseline unit is based on energy audits performed on commercial operating units by Thompson et al[2]. In this study, data collected from three existing commercial units operating with an average wet bulb temperature of 113 ^oF at the exhaust indicated that an average specific energy consumption of 2,260 Btu per pound of moisture evaporated was attained. Although this study was performed in 1980, many units currently in the District were installed prior to 1980 and essentially all units currently permitted within the District were in place at the time that permits were initially required due to a loss in exemption status in the 1990's. Thus the units included in this study are assumed to be representative of the baseline period.

Direct emissions are then calculated as:

GHG_D = 117 lb CO_2e/MMBtu x 0.00226 MMBtu/ lb moisture
= 0.264 lb-CO_2e/lb moisture

The Baseline Emission Factor is equal to the direct emissions:

$BEF = GHG_D$ = 0.264 lb-CO_2e/lb moisture

[2] Thompson, James F., Manjeet Chhinnan, Martin Miller, and Gerald Knutson, Energy Conservation in Drying of Fruits in Tunnel Dehydrators, Journal of Food Process Engineering 4 (1981) 155-169.

STEP 2. Technologically Feasible GHG Emission Control Measures

A. Background and Analysis

The following findings and/or considerations are applicable to this class and category:

- Although average fuel consumption reported by Thompson et al was 2,260 Btu/lb moisture as reported above, the best performing unit surveyed in that study exhibited an average specific fuel consumption of 1,877 Btu/lb moisture at an average wet bulb temperature of 113 ^{o}F with individual data points ranging from a low of 1,500 Btu/lb moisture to a high of 2,086 Btu/lb moisture.

- Based on the energy audits performed on existing operations, Thompson et al provided recommendations for achieving maximum energy efficiency as follows:

  – Increased air recirculation (which increases the wet bulb temperature and relative humidity of the air stream).

  – Operate with fully loaded fruit trays to maximize the throughput capacity of the unit.

  – Seal the enclosure to minimize air leakage

  – Use of insulation on roof and walls and installation of radiant heat shield to reduce radiant losses from the burner

- A report[3] by the United States International Development Agency recommends operation with a 60% relative humidity at the exhaust end which indicates an operating wet bulb temperature potentially exceeding 120 ^{o}F at typical dryer exhaust temperatures of 140 ^{o}F. Operation at a wet bulb temperature of 120 ^{o}F would result in an even higher efficiency 1,877 Btu/lb recorded above at a wet bulb temperature of 113 ^{o}F.

- In an overview of industry operation, a specific fuel consumption of 1,900 to 2,500 Btu per pound of moisture evaporated was given by in another report by Thompson.[4]

[3] Fruit Drying Tunnels, Design and Operation, United States Agency for International Development (USAID), http://www.cnfa.md/report/712/index.html

[4] Thompson, James F., Tunnel Dehydration, http://ucce.ucdavis.edu/files/filelibrary/5760/28627.pdf

B. Listing of Technologically Feasible Control Techniques

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 Control Measures for
Fruit and Vegetable Drying Operations with a Gaseous Fuel-Fired Tunnel Dryer

GHG Control Measure	Qualifications
1. Average annual specific fuel consumption not exceeding 1,877 Btu per pound of moisture evaporated from the fruit processed. Compliance with this standard shall be demonstrated by monitoring and recordkeeping of fuel consumption, quantity of fruit processed, and the initial and final moisture content of fruit processed.	Based on energy audits for commercial facilities, a average specific energy consumption of 1,877 Btu per pound of moisture is achieved-in-practice standard for tunnel dryers
2. Recovery of heat from the exhaust of the dry using an air pre-heater or other recovery device.	Due to the low temperature of the dryer exhaust (and the low temperature differential between the exhaust and the incoming air. A heat exchange device would be large and expensive. Other heat recovery schemes would require that the facility have a need for low temperature heat.
3. Use of a steam-heated indirect-fired tunnel dryer	An indirect-fired unit would have no GHG emissions; however, GHG emissions may be associated with the heating source.

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.

The following findings or considerations are applicable to this class and category:

- Operating data to determine specific fuel consumption is generally not available. The energy audits performed by Thompson et al on actual commercial operations are considered to be representative of achieved-in-practice performance. The study included data collected over a three-year period at 14 different locations and indicated specific fuel consumptions as low as 1,500 Btu/lb-moisture. A BPS based on 1,877 Btu/lb-moisture is considered to be the best achieved in practice (control measure 1 from the table above).

- A review of District-permitted facilities and of the literature revealed no known operations which recover heat from the exhaust of a tunnel dryer. Due to the potential technical difficulties and the absence of known heat recovery operations on similar equipment, the recovery of heat from the exhaust (control measure 2 from the table above) is not considered to be achieved in practice.

- A review of District-permitted facilities and of the literature revealed no known operations which utilize indirect heating in a tunnel dryer. However, indirect heating using steam from a boiler of other similar dryers such as conveyor dryers is common. Use of indirect heating from steam is considered to be achieved in practice based on a technology transfer from conveyorized systems. Indirect heating using other heat sources such as waste heat from other operations is not considered sufficiently general to qualify as achieved in practice.

As discussed above, all control measures 1 and 3 listed in the table above are deemed to be Achieved-in-Practice.

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

For each Achieved-in-Practice GHG emission reduction measure identified:

a. Quantify the potential GHG emissions per unit of activity (G_a)
b. Express the potential GHG emission reduction as a percent (G_p) of Baseline GHG emissions factor per unit of activity (BEF)

A. Basis and Assumptions:

- All direct GHG emissions are produced due to combustion of natural gas in this unit.
- Best achieved in practice specific fuel consumption for a direct-fired unit is 1,877 Btu per pound of moisture evaporated (per discussion above).
- GHG emissions are stated as "CO_2 equivalents" (CO_2e) which includes the global warming potential of methane and nitrous oxide emissions associated with gaseous fuel combustion.
- The GHG emission factor for natural gas combustion is 117 lb-CO_2(e)/MMBtu[5] which includes both carbon dioxide and the carbon dioxide equivalent for emissions of methane and nitrous oxide associated with natural gas combustion.
- Indirect emissions associated with the air circulation fan electric motor are not considered since the motors are relatively small and do not provide a significant potential for reduction in GHG.
- All direct GHG emissions are produced due to combustion of natural gas directly in the tunnel dryer unit or in a separate boiler providing heat to an indirect steam-heated tunnel dryer. Boiler thermal efficiency is assumed to be 90 percent.

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

G_a is the sum of the direct (GHG_D) and indirect (GHG_I) emissions (per unit of activity):

$$G_a = GHG_D + GHG_I$$

As stated above, indirect emissions for this category are not significant. Therefore,

$$G_a = GHG_D$$

[5] California Code of Regulations, Title 17, Sections 95100-95133

Control measure 1 (operation with a specific fuel consumption no greater than 1,877 Btu/lb moisture):

$GHG_D = E_f$ x SFC
GHG_D = 117 lb-$CO_{2(e)}$/MMBtu x 0.001877 MMBtu/ lb moisture
= 0.219 lb-$CO_{2(e)}$/lb moisture

The GHG Emissions per Unit of Activity are equal to the direct emissions:

$G_a = GHG_D$ = 0.219 lb-$CO_{2(e)}$/lb moisture

Potential GHG Emission Reduction as a Percentage of the Baseline Emission Factor (G_p):

G_p = (BEF - G_a) / BEF = (0.264 – 0.219)/0.264 = 17.0 %

Control measure 3 (indirect-heated tunnel dryer):

For this control measure, emissions are produced by a boiler supplying steam to the dryer and operating with a 90% efficiency. The steam is used by the dryer to heat the air stream in a heat exchanger. It is assumed that the heat requirement at the dryer is the same as that specified in control measure 1 (1,900 Btu/lb moisture removed). Therefore,

Heat delivered to the dryer	=	boiler absorbed duty
	=	1,877 Btu per lb moisture removed
Fuel consumption by the boiler	=	boiler absorbed duty/boiler efficiency
	=	SFC = 1,877/90%
	=	2,085 Btu per lb moisture removed

$GHG_D = E_f$ x SFC

GHG_D = 117 lb-CO_2(e)/MMBtu x 0.002085 MMBtu/ lb moisture
= 0.244 lb-CO_2(e)/lb moisture

The GHG Emissions per Unit of Activity are equal to the direct emissions:

$G_a = GHG_D$ = 0.244 lb-CO_2(e)/lb moisture

Potential GHG Emission Reduction as a Percentage of the Baseline Emission Factor (G_p):

G_p = (BEF - G_a) / BEF = (0.264 – 0.244)/0.264 = 7.6 %

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

Table 3
Ranking of Achieved in Practice GHG Emission Control Measures for
Fruit and Vegetable Drying Operations with a Gaseous Fuel-Fired Tunnel Dryer

Rank	Description	GHG Emission Reductions Relative to the Baseline
1	1. Average annual specific fuel consumption not exceeding 1,877 Btu per pound of moisture evaporated from the fruit processed. Compliance with this standard shall be demonstrated by monitoring and recordkeeping of fuel consumption, quantity of fruit processed, and the initial and final moisture content of fruit processed.	17.0%
2	3. Use of a steam-heated indirect-fired tunnel dryer	7.6%

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

<u>Best Performance Standard for Fruit Drying Operations in a Tunnel Dryer</u>

Average annual specific fuel consumption not exceeding 1,877 Btu per pound of moisture evaporated from the fruit processed. Compliance with this standard shall be demonstrated by monitoring and recordkeeping of fuel consumption, quantity of fruit processed, and the initial and final moisture content of fruit processed.

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

The following Achieved-in-Practice GHG control measures identified and ranked in the table above are eliminated from consideration as Best Performance Standard since they have GHG control efficiencies which are less than that of the selected Best Performance Standard as stated in Step 6 of this evaluation:

Use of a steam-heated indirect-fired tunnel dryer

VI. Appendices

Appendix 1: Public Notice of Intent
Appendix 2: Comments Received During the Public Notice of Intent and Responses to Comments

Appendix 1

Public Notice of Intent: Notice

Appendix 2

Comments Received During the Public Notice of Intent and Responses to Comments

Stakeholders Written Comments:

California League of Food Processors (CLFP)

1. **Comment:** PUC quality natural gas is used by all commercial food processing dryer and dehydrator operations. Natural gas is the lowest carbon content fuel that is commercially available, and so the use of PUC quality gas should constitute BPS. (CLFP)

Response: Since natural gas is subject to curtailment of may not be available at certain locations, the BPS will only recognize the general category of "gaseous" fuels which include propane or LPG.

2. **Comment:** Current dehydrator and dryer operations and maintenance plans should be documented and implemented. The industry knows how to operate these systems and have no financial incentive to use excessive amounts of natural gas and generate greenhouse gasses. (CLFP)

Response: The District has based the BPS on documented field studies which have determined the typical ranges of specific fuel consumption for tunnel dryers. Consistent with the requirement for "Achieved-In-Practice", BPS has been established at the lower end of the typical range of efficiencies.

3. **Comment:** Variable frequency drives, soft starts, and some other load limiting controls may be appropriate in specific equipment design specifications for dehydrators and other food processing stationary source equipment. However, every facility is unique and the District should not take a one size fits all approach. (CLFP)

Response: The District does not consider indirect GHG emissions from tunnel dryers to be significant. Therefore, no motor controls have been included in the BPS.

4. **Comment:** Vegetable dehydrators typically operate at low temperatures which are not adequate for most heat recovery systems such as boiler economizers. These systems should not be included as BPS. (CLFP)

Response: The District concurs. No heat recovery specification has been included in the BPS