San Joaquin Valley
Unified Air Pollution Control District

Best Performance Standard (BPS) x.x.xx

Date: 04/24/12

Class	Oven
Category	**≤ 10 MMBtu/hr Rotomolding System Oven**
Best Performance Standard	Closed rotomolding oven with - Natural gas firing - Internal air recirculating system, with remotely adjustable directional flaps or dampers, - Multiple, independent mold stations, and - Premium-efficiency electric motors.
Percentage Achieved GHG Emission Reduction Relative to Baseline Emissions	**0.08%**

District Project Number	C-1113332
Evaluating Engineer	G. Heinen
Lead Engineer	Sheraz Gill
Initial Public Notice Date	July 12, 2012
Final Public Notice Date	August 11, 2012
Determination Effective Date	TBD

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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 Phases

The District has established Oven, <10 MMBtu/hr Rotomolding System 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, <u>Addressing Greenhouse Gas Emissions under the California Environmental Quality Act</u>. 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 Oven, <10 MMBtu/hr Rotomolding System			
Phase	**Description**	**Date**	**Comments**
1	Initial Public Process	03/13/12	The District's intent notice and a list of individuals receiving notification are attached as Appendix 1.
2	BPS Development	04/23/12	See Section III of this evaluation document.
3	Public Review	05/17/12	The District's BPS determination notice and a list of individuals receiving notification are attached as Appendix 2.
4	Public Comments	06/16/12	The public comment period ended on the date given. All public comments received and the District's responses will be attached as Appendix 3.
5	Public Workshop	xx/xx/xx	All comments received during the workshop and the District's responses will be included in Appendix 3.
6	Finalization	xx/xx/xx	The BPS established in this evaluation document is effective on the date of finalization.

III. Class and Category

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

- An oven, for the purposes of this analysis, is defined as any fuel fired combustion equipment which transfers heat from combustion gases to any material, but is not a boiler, steam generator, process heater, or dryer.

Ovens are a distinct class with respect to the District's prohibitory rules for criteria pollutant emissions (Rules 4306, 4307, 4308 and 4320).
- Ovens differ from boilers and steam generators as ovens are not limited to boiling or raising the temperature of fluid.
- Ovens differ from dryers as ovens do not dry or cure material by direct contact with the products of combustion.
- Ovens differ from dehydrators as ovens do not drive free fluid from products like fruits, vegetables, and nuts, at an accelerated rate without damage to the product.

- Ovens differ from process heaters as ovens do not transfers heat from combustion gases to a process stream.

The subcategory of ovens identified is a $\leq$ 10 MMBtu/hr rotomolding system. The specific design of the rotomolding system depends on the size and type of product being produced. Also, the oven must have sufficient clearance for the mold carrier and/or carrier arm to enter, exit, and rotate the mold in the oven. These considerations may limit the applicable BPS compared to ovens for other processes and products and for larger rotomolding systems. Therefore, this BPS will specifically apply to $\leq$ 10 MMBtu/hr rotomolding systems.

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 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

Rotomolding basically involve four steps: 1) placing a plastic powder in a mold; 2) heating the mold to melt the plastic and allow it to closely conform to the mold's shape; 3) cooling the mold, often with forced air or water spray; and 4) removing the molded plastic product. Key to the process is a device which rotates the mold on two axes to allow proper distribution of the melted plastic within the mold.

Heating the mold is generally performed within an enclosed oven, although larger molds may be heated in open top troughs. Enclosed ovens will have a fan to supply combustion air to the burner(s), which provides heated air to the oven. Inside the oven, a recirculating fan uses flaps or dampers to direct the heated air around the mold for more efficient, uniform heating. An exhaust fan is used to remove combustion gases from the oven. Oven design also incorporates provisions to allow for the moving the mold into and out of the oven as well as rotation of the mold while it is in the oven. Natural gas is the most common fuel, although ovens firing on diesel fuel oil or propane are manufactured for locations where a natural gas supply is not available.

Smaller rotomolding systems may have a single, fixed mold, but most current commercial molders typically have multiple mold system. The two most

common multiple mold systems are shuttle systems and rotational arms systems. Shuttle systems involve independent molds on rollers or a track system which are quickly shuttled into the oven as the previous mold leaves it. Rotational arms systems involve two or more molds on independent arms which pivot at a central point. One arm can be in the oven while the other arms are cooled, emptied, or filled. Use of the multiple mold system reduces oven refill time which allows for a more efficient operation by increasing the production rate and decreasing the amount of fuel needed to reheat the oven between batches.

For **< 10 MMBtu/hr Rotomolding System Ovens**, the representative baseline operation was determined based on a review of the permitted units which were active in the District during the 2002-2004 baseline period. The number of < 10 MMBtu/hr rotomolders operated in the Valley is limited. During the baseline period, eight units were operated but only three of those units remain under permit today. Four more units were permitted since 2004, for a total of six currently permitted units. The rotomolder inventory is summarized in the following table. These number do not include units rated 11 MMBtu/hr or greater.

Table 2. Rotomolder Inventory, rated ≤ 10 MMBtu/hr			
Unit	Baseline Period Operation?	Permit Active?	Rating (MMBtu/hr)
1	Yes	No	6
2	Yes	No	10
3	Yes	No	9
4	Yes	No	10
5	No	Yes	7
6	Yes	No	2
7	Yes	Yes	5
8	No	Yes	10
9	No	Yes	6
10	Yes	Yes	10
11	No	No	3
12	Yes	Yes	7

Based on review of the units operated during the baseline period, a representative rotomolding unit has been determined to be an oven the following attributes:

- Natural gas fired, forced draft burners
- Electrical motors powering the recirculating air fan, combustion air supply fan, and exhaust fan.
- Mold transport system
- Enclosed heating area with insulated walls.
- Thermally controlled burner and recirculating fan operation.

Because the high efficiency standard for electrical motors was not promulgated at this time, it is assumed that the fans were driven with standard efficiency motors.

B. Basis and Assumptions

All direct GHG emissions are produced due to combustion of natural gas in this unit:
- 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.
- Fuel consumption for this unit is 10 MMBtu/hr but with a limit of 45,630 MMBtu/yr, an increase from its current permit limit of 6,640 MMBtu/yr.
- The GHG emission factor for natural gas combustion is 52.9199 kg-CO_2e/MMBtu per CCAR document[1].

Indirect emissions are produced due to operation of the main process fans. For the subject oven, the three fans require a total of 31 horsepower.

- Electric motor efficiency will depend on the size and efficiency classification of the motor, as shown in the following table:

Table 3. Electric Motor Efficiency (%)		
Rating HP	Standard	Premium
1 - 4	78.8	85.5
5 - 9	84.0	86.5
10 - 19	85.5	89.5
20 - 49	88.5	91.7
50 - 99	90.2	93.0

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

Notes:
- Standard Efficiency values reflect NEMA Design B motors, 1 hp and larger that operate more than 500 hours per year.
- Premium Efficiency values reflect the nominal efficiency standards for motors manufactured after December 19, 2010, under the *Energy Independence and Security Act of 2007.*

- 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

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 melting time and temperature for each batch operation is precisely calculated depending on the mold size, product composition and wall thickness, oven volume, internal air recirculation rate, and other oven specific parameters. Therefore, it is not possible to determine a unit specific emission rate. Since the process is a sequential batch process, it will be assumed that the burner and motors operate at a relatively consistent rate during the operating day. In reality, the equipment cycles on and off during the melting cycle to achieve and maintain a uniform melting temperature and is switched off to minimize heat loss when the molds are inserted into and removed from the oven. To normalize the activity on an hourly basis, however, continuous operation will be assumed.

D. Calculations

This determination was based on a review of the permitted units which were operating in the District during the baseline period. Standard Efficiency is used for Baseline Emission calculations since such motors would be the most commonly encountered motors in furnaces produced prior to the baseline period.

1. Direct GHG emissions from the burning of natural gas were calculated assuming the maximum burner firing rate and using the following formula:

Direct GHG $= 5.4$ MMBtu/hr x 117 lb-CO_2e/MMBtu
$= 631.8$ lb-CO_2e/hr

2. Indirect GHG emissions from the production of electricity of the electrical power for the motors were calculated using the following equations:

$$kW/hr = hp/hr \times 0.7457 \text{ kW/hp} \times (1/\text{efficiency})$$

$$lb\text{-}CO_2e/hr = kW/hr \times 0.524 \text{ lb-}CO_2e/kWh$$

The results of these calculations are shown in the following table:

Table 4. Baseline Emissions – Indirect						
Fan Type	hp/hr	kW/hp	Efficiency	kW/hr	lb-CO_2e /kW	lb-CO_2e /hr
Burner	10	0.7457	85.5	8.72	0.524	4.57
Recirculating	20	0.7457	88.5	16.85	0.524	8.83
Exhaust	1	0.7457	78.8	0.95	0.524	0.50
Total						13.9

3. The Baseline Emission Factor (BEF) is the sum of the direct and the indirect GHG emissions:

$$BEF = (631.8 + 13.9) \text{ lb-}CO_2e/hr$$
$$= 645.7 \text{ lb-}CO_2e/hr$$

STEP 2. List Technologically Feasible GHG Emission 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. The following findings or considerations are applicable to this class and category:

- Closed oven, which retain combustion heat more efficiently than open design oven, reducing fuel use and therefore reducing GHG combustion emissions.
- Natural gas firing, with emissions of 116.4 lb-CO_2e/MMBtu/hr, produces less GHG emissions per unit of thermal output than a higher carbon fuels such as diesel fuel oil, with emissions of 161.4 lb-CO_2e/MMBtu.
- Internal air recirculating system, with remotely adjustable directional flaps or dampers, which improve thermal efficiency by concentrating the heated air close to the mold, increasing heat transfer and reducing the required amount of fuel need for the melting process.
- Multiple, independent mold stations which maximize oven utilization and reduce thermal energy lost from the cooling of the oven between batches. Since less heat is lost from the oven walls, less fuel is needed to bring the new oven back up to the required melting temperature.

- High-efficiency (Premium Efficiency) motors, which more efficiently utilize electrical power for combustion, recirculation and exhaust purposes.

Although the oven operates at 600° F, the recirculation system efficiently retains the thermal energy and the exhaust temperature was measured to be in the range of 160 to 180° F. This temperature range is not considered to ideal for heat recovery systems since a certain amount of thermal energy is needed to prevent condensation of corrosive elements of the exhaust that could compromise the exhaust system.

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 technologically feasible GHG emission reduction measures for this class and category:

Table 5. Technologically Feasible GHG Control Measures for Ovens, $\leq$ 10 MMBtu/hr Rotomolding Systems	
GHG Control Measures	**Qualifications**
Closed rotomolding oven with - Natural gas firing - Internal air recirculating system, with remotely adjustable directional flaps or dampers, - Multiple, independent mold stations, and - Premium-efficiency electric motors.	Higher thermal efficiency oven reduces direct GHG emissions from fuel combustion. High efficiency fan motors reduce indirect GHG emissions by reducing electrical power demand.

All of the control measures identified above are compatible 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.

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

- Closed ovens are used as part of all permitted units. Some larger products in other locations may be manufactured using open heating systems, but the automated oven door controls and rotary mold rotational systems for this size product make the more efficient closed oven design feasible. Based on use of some of these units during the past decade, the practice is considered to be Achieved in Practice.
- All of the permitted units are required to run on natural gas. Some of these units have been in commercial operation for as long as eleven years, therefore this technology is considered to be Achieved in Practice.
- Internal air recirculation is common on currently permitted units. Although the efficiency of the system may have improved somewhat with the better damper controls on the newer units, recirculation systems have been employed for a decade to conserve fuel and provide a uniform heat to the product, therefore this technology is consider to be Achieved in Practice.
- Multiple, independent molds are common to all existing units. Typically, these are rotary systems with three or four arms that hold the molds undergoing one of the various stages in the process. In the past, single mold or shuttle systems with two or more molds were used. Based on the use of the multiple mold systems on units over the past decade, this technology is considered to be Achieved in Practice.
- High efficiency motors do not have as long a history as the other technologies but have been available and in use for at least the past five years. With the Premium Standard becoming effective in 2010, it is expected that such motors will become the industry standard. Based on the use of such motors in units installed since the Baseline Period, this technology is considered to be Achieved in Practice.

Based on a review of available technology and permitted units, the following is determined to be the Achieved-in-Practice GHG emission reduction measures for this class and category:

<table>
<tr><td colspan="2" align="center">**Table 6. Achieved-in-Practice GHG Control Measures for Ovens, < 10 MMBtu/hr Rotomolding Systems**</td></tr>
<tr><td align="center">**GHG Control Measures**</td><td align="center">**Achieved-Qualifications**</td></tr>
<tr><td>Closed rotomolding oven with
  - Natural gas firing
  - Internal air recirculating system, with remotely adjustable directional flaps or dampers,
  - Multiple, independent mold stations, and
  - Premium-efficiency electric motors.</td><td>Higher thermal efficiency oven reduces direct GHG emissions from fuel combustion.

High efficiency fan motors reduce indirect GHG emissions by reducing electrical power demand.</td></tr>
</table>

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)

- Closed rotomolding oven with
  - Natural gas firing
  - Internal air recirculating system, with remotely adjustable directional flaps or dampers,
  - Multiple, independent mold stations, and
  - Premium-efficiency electric motors.

Except for the premium-efficiency motors, all of the Achieved in Practice technology was in use during the Baseline Period and is commonly found in new installations. As a result, there is no GHG emission reduction associated with those control options. Therefore, this section will only examine the GHG reduction resulting from the use of the premium-efficiency motors.

A. Basis and Assumptions:

- *All direct GHG emissions are produced due to combustion of natural gas in this unit.*
- *Indirect emissions are produced due to operation of the main process fan. The fan requires 250 horsepower when operating the unit at a rate of 100 tons per hour.*
- *Electric motor efficiency is based on engine size and efficiency rating, as shown earlier in Table 3.*

- *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*

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

1. Direct GHG emissions: The combustion process of the baseline ovens is already highly efficient in controlling GHG emissions due to the use of natural gas, which has a lower carbon content than diesel fuel oil; recirculating fans, which maximize heat transfer and reduce fuel combustion requirements; and multiple mold systems, which minimizes thermal losses between batches, further reducing fuel combustion requirements. There are no known improvements which could further enhance the combustion process; therefore, there are no potential reductions in direct GHG emissions from this class and category.

The GHG emissions from the burning of natural gas were calculated assuming the maximum burner firing rate and using the following formula:

$$\text{Direct GHG} = 5.4 \text{ MMBtu/hr x } 117 \text{ lb-}CO_2\text{e/MMBtu}$$
$$= 631.8 \text{ lb-}CO_2\text{e/hr}$$

2. Indirect GHG emissions: The baseline units were constructed prior to the promulgation of high efficiency (Premium Efficiency) standards for electrical motors. Use of the newly developed Premium Efficiency motors to power the oven fans will reduce the indirect GHG emissions from electrical power generation by providing more horsepower output for every kilowatt input.

The GHG emissions from the production of electricity of the power for the motors were calculated using the following equations, assuming the use of Premium Efficiency motors:

$$\text{kW/hr} = \text{hp/hr x } 0.7457 \text{ kW/hp x } (1/\text{efficiency})$$

$$\text{lb-}CO_2\text{e/hr} = \text{kW/hr x } 0.524 \text{ lb-}CO_2\text{e/kWh}$$

The results of these calculations are shown in the following table:

Table 7. Potential GHG Emissions – Indirect with Premium Efficiency motors						
Fan Type	hp/hr	kW/hp	Premium Efficiency	kW/hr	lb-CO_2e /kW	lb-CO_2e /hr
Burner	10	0.7457	89.5%	8.33	0.524	4.36
Recirculating	20	0.7457	91.7%	16.26	0.524	8.52
Exhaust	1	0.7457	85.5%	0.78	0.524	0.41
Total						13.4

- Premium Efficiency values reflect the nominal efficiency standards for motors manufactured after December 19, 2010, under the *Energy Independence and Security Act of 2007*.

3. The GHG Emissions per Unit of Activity *(G_a) is the sum of the direct and the indirect GHG emissions:*

G_a = (631.8 + 13.4) lb-CO_2e/hr
    = 645.2 lb-CO_2e/hr

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

G_p = (BEF - G_a) / BEF
    = (645.7 – 645.2)/645.7
0   = 0.08%

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 Table 8 below:

Table 8. Ranking of Achieved-in-Practice GHG Emission Control Measures			
Rank	GHG Control Measures	Potential GHG Emission per Unit of Activity (G_a) (lb-CO_2e/hr)	Potential GHG Emission Reduction as a Percentage of the Baseline Emission Factor (G_p)
1	Closed rotomolding oven with - Natural gas firing - Internal air recirculating system, with remotely adjustable directional flaps or dampers, - Multiple, independent mold stations, and - Premium-efficiency electric motors.	645.2	0.08%

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 8 from Section II.5, Best Performance Standard (BPS) for this class and category is determined as:

Best Performance for Standard Oven, <10 MMBtu/hr Rotomolding System

Closed rotomolding oven with
- Natural gas firing
- Internal air recirculating system, with remotely adjustable directional flaps or dampers,
- Multiple, independent mold stations, and
- Premium-efficiency electric motors.

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

The following Achieved-in-Practice GHG control measures, identified in Section II.4 and ranked in Table 8 of Section II.5 are specifically 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 Section II.6:

No other Achieved-in-Practice options were identified.

V. Appendices

Appendix 1 District's intent notice and a list of individuals receiving notification
Appendix 2 District's BPS determination notice and a list of individuals receiving notification
Appendix 3 Public comments received and the District's responses