Best Available Control Technology (BACT) Determination for Dairy Digester Gas Flares
(District BACT Guideline 1.4.10)

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San Joaquin Valley Air Pollution Control District
Best Available Control Technology (BACT) Guideline 1.4.10*

Emissions Unit: Dairy Digester Gas Flare

Facility: N/A

Equipment Rating: > 26,000 MMBtu/yr or > 876 hours per year

Last Update: November 18, 2024

Pollutant	Achieved in Practice or contained in SIP	Technologically Feasible	Alternate Basic Equipment
NOx	0.025 lb/MMBtu		No flare – Excess gas is recycled or not combusted
SOx	Sulfur content of digester gas flared ≤ 40 ppmv as H_2S		
PM10			
VOC	0.038 lb/MMBtu		

BACT is the most stringent control technique for the emissions unit and class of source. Control techniques that are not achieved in practice or contained in a state implementation plan must be cost effective as well as feasible. Economic analysis to demonstrate cost effectiveness is required for all determinations that are not achieved in practice or contained in an EPA approved State Implementation Plan.

***This is a Summary Page for this Class of Source**

I. Introduction

The objective of this project is to proactively update the District's Best Available Control Technology (BACT) clearinghouse and create a new BACT guideline applicable to dairy digester gas flares.

This BACT determination will evaluate and incorporate any applicable emission control standards that have been achieved in practice or determined to be technologically feasible, in accordance with the District's BACT policy (APR 1305).

II. Background

The District's regulatory authority covers criteria pollutants and air toxics emitted from stationary sources. However, the District is a public health agency whose mission, under federal and California law, is to protect the air quality of Valley residents.

Greenhouse Gases

In 2006, the California legislature passed the California Global Warming Solutions Act of 2006, Assembly Bill (AB) 32 that requires the California Air Resources Board (CARB) to ensure that the statewide greenhouse gas (GHG) emissions are reduced to the 1990 levels by 2020. As a follow up to AB 32, Senate Bill (SB) 32 was signed into law in 2016 to require further GHG emissions reductions of 40 percent below the 1990 emission levels by 2030, then most recently AB 1279 was signed into law in 2022 to ensure that by 2045 statewide GHG emissions are reduced to at least 85% below the 1990 levels.

Since the passage of AB 32, various regulations and programs (e.g. SB 605, AB 3232, SB 253, SB 1383) have been implemented to achieve said targets. Especially, SB 1383 (Short-lived Climate Pollutants) requires CARB to work with a broad range of stakeholders to identify and address challenges and barriers to the development of dairy methane emissions reduction projects. The bill required state agencies to adopt policies and incentives to significantly increase the sustainable production and use of renewable gas, including biomethane.

GHGs trap some of the Earth's outgoing energy and retain heat in the atmosphere, which results in an alteration of climate and weather patterns. GHGs include, but are not limited to, methane (CH_4), carbon dioxide (CO_2), hydrofluorocarbons (HFC), nitrous oxide (N_2O), and various synthetic chemicals. Although methane's lifetime in the atmosphere is much shorter than that of carbon dioxide, which is the most abundant anthropogenic GHG, methane is more than 28 times as potent as carbon dioxide at trapping heat in the atmosphere, and estimated to be causing 20 percent of the global warming causing climate change.

In California, more than half of methane emissions come from dairy and livestock manure and enteric fermentation.[1] In accordance with SB 32, AB 32, and SB 1383, California has adopted a GHG reduction strategy that includes the capture and use of biomethane that would otherwise be emitted from liquid manure handling operations at dairies. Although the cost to produce biomethane from dairies can be four to ten times more expensive than that of fossil-derived natural gas, these projects can be financially viable because of state and federal government subsidies. For example, the California Department of Food and Agriculture (CDFA) has provided numerous grants for up to half the capital cost for the construction of a dairy digester.

In addition, the revenue stream for dairy digester projects relies on the value of credits generated from the California Low Carbon Fuel Standard (LCFS) and the federal Renewable Fuel Standard.[2] The LCFS is a market-based incentive program designed to reduce GHG emissions in the transportation sector, which is responsible for about 50 percent of GHG emissions in California.[3] Fuels and fuel blendstocks introduced into the California fuel system that have carbon intensities (as measured in units of gCO_2e/MJ) higher than the declining LCFS benchmark generate deficits. Similarly, fuels and fuel blendstocks with carbon intensities lower than the benchmark generate credits. Annual compliance is achieved when a regulated fuel producer obtains and uses credits to match its deficits. According to current LCFS methodology, biomethane produced from dairy digesters has one of the lowest carbon intensity scores on average,[4] which means dairy digester projects have the potential to generate a large amount of valuable LCFS credits, contributing to their financial viability.

Most of the GHG benefit (i.e. LCFS credit generating potential) from dairy biomethane projects comes from the avoided methane emissions. Methane emissions can be avoided by capturing and upgrading the biomethane for use as a renewable fuel, displacing an equal amount of fossil-fuel derived natural gas; or, methane emissions can be avoided by on-site flaring. The less methane emitted by a dairy digester project, the lower the carbon intensity score for biomethane fuel it produces, the more valuable the credit the specific project can generate.

Although the goal is to capture and use all the biomethane from a dairy digester, some amount of methane is inevitably lost in the upgrading process, and due to emergencies, equipment repairs, insufficient gas processing capacity (undersized facilities), and/or because the gas produced is found to not meet fuel quality specifications. For managing the biomethane that is lost, the District has issued permits to numerous dairy digesters to date, both with and without backup flares.

[1] https://ww2.arb.ca.gov/our-work/programs/slcp/about

[2] https://asmith.ucdavis.edu/news/digester-update

[3] https://ww2.arb.ca.gov/sites/default/files/2020-09/basics-notes.pdf

[4] https://ww2.arb.ca.gov/resources/documents/lcfs-pathway-certified-carbon-intensities

Those operations without a backup flare can typically process (clean up) and inject the biomethane into the utility's gas pipeline, recirculate biomethane back through the facility, and/or vent small amounts of methane as necessary. Whereas facilities with a backup flare, in lieu of gas recirculation and/or venting, can avoid methane emissions by flaring. Thus, assuming the operations are otherwise equal in all respects, the operations with flares, having less methane emissions, can thus produce biomethane fuel that has a lower carbon intensity score, generating a more valuable LCFS credit. And, as noted above, the value of the LCFS credit is a large piece of the revenue stream for these projects.

In addition to the fact that flaring may contribute to the financial viability of these projects and that these projects are an important part of the state's GHG reduction strategy with considerable public investment committed to them, flaring may be required in some cases for the safe handling of excess methane. For example, flaring is a common method of more safely disposing of produced gas or refinery gas at oil production and refinery operations. For these reasons, based on current knowledge of these operations, the District accepts that limited flaring may be necessary at some dairy digesters and biogas upgrading stations. In instances in which limited flaring is necessary, emissions from flaring must be minimized to reduce potential impacts to air quality.

San Joaquin Valley Attainment Plans

The federal Clean Air Act (CAA) is the comprehensive federal law that regulates air emissions, and requires the U.S. Environmental Protection Agency (EPA) to establish health-based national ambient air quality standards (NAAQS), designate nonattainment areas, and promulgate planning requirements, for six criteria pollutants (i.e. carbon monoxide, lead, ground-level ozone, particulate matter, nitrogen dioxide, and sulfur dioxide). In accordance with the CAA, the EPA classified the San Joaquin Valley (Valley) as extreme nonattainment for ozone and serious non-attainment for PM2.5 (particulate matter 2.5 microns or less). The Valley is also classified as nonattainment for the California state ambient air quality standards for ozone and PM2.5.

Ozone, while not emitted directly into the air, is created through chemical reactions between nitrogen oxides (NOx) and volatile organic compounds (VOC) in the presence of heat and sunlight. For PM2.5 there are two types: primary PM2.5, which refers to particles directly emitted as a particle (e.g. soot from combustion); and secondary PM2.5, which forms when precursors (e.g. NOx, VOC, SOx, and ammonia) react in the atmosphere to form PM2.5.

In order to attain the NAAQS for ozone and for PM2.5, the District, in coordination with CARB, has adopted numerous rules and regulations as part of its State Implementation Plan or SIP for ozone and PM2.5. Since the District is a NOx-limited area for ozone and NOx is also a significant precursor to PM2.5, the District's SIP relies on reducing NOx emissions from existing sources while ensuring any increases in NOx emissions from new and modified sources do not interfere with these attainment efforts. The District's New and Modified Stationary Source Review Rule 2201 is a part of the SIP, and its requirements (e.g. BACT) are, therefore, principally concerned with pollutants affecting the attainment status of the Valley.

Flares - Emissions Unit Determination

A flare is a combustion system used to control air pollution by combusting waste gases from various operations that are not captured or processed. Flares are commonly used to combust VOC-laden exhaust streams for safety and emergency situations, and in many cases, are required to be installed as a control device for VOC emissions. In these cases, since the purpose of the flare is to control a regulated air pollutant (e.g. VOC), the flare would be considered an *air pollution abatement device*, and would not be subject to District Rule 2201 BACT requirements.

Dairy biogas is mainly comprised of methane (CH_4) and negligible amounts of VOC emissions. Therefore, when a flare is installed for the purpose of combusting dairy biogas, the flare will be controlling methane emissions (a GHG not regulated by the District's permitting program) and not an affected pollutant (such as VOCs). In these installations, the flare itself becomes a source of emissions of regulated air pollutants and their precursors and is considered an *emissions unit* subject to BACT requirements under Rule 2201. The following sections will further explain the key definitions and concepts that establish this conclusion.

Emission Unit Determination Basis

This section will explain the pollutants regulated by the District's permitting program and will show that the dairy biogas flare is not reducing or controlling emissions regulated by the District; rather, the dairy biogas flare is producing emissions regulated by the District.

The cornerstone of the District's pre-construction permitting program is Rule 2201 (New and Modified Stationary Source Review Rule). Under Rule 2201, BACT applies to emission units and is triggered on a pollutant-by-pollutant basis (for affected pollutants). *Emissions Unit* is defined per Rule 2201:

> *"Emissions Unit: an identifiable operation or piece of process equipment such as a source operation which emits, may emit, or results in the emissions of any affected pollutant directly or as fugitive emissions."*

In addition, the definition for *emissions unit* refers to *source operation* and *affected pollutants*. The definition of *affected pollutant* does not include GHGs, and the District has never interpreted the definition to include GHGs as such. *Source operation* is defined per Rule 1020 (Definitions):

> *"Source Operation: the last operation preceding the emission of any air contaminant, which:*
>
> > *Results in the separation of the air contaminant from the process materials or in the conversion of the process materials into air contaminants, as in the case of combustion of fuels; and*
> >
> > *Is not an air pollution abatement operation; and*
> >
> > *Is any operation, article, machine, equipment or other contrivance."*

As explained below, a flare utilized to combust dairy digester gas (methane) is not an air pollution abatement operation; therefore, a flare is considered a *source operation* and an *emissions unit* subject to BACT under Rule 2201.

Dairy biogas consists principally of methane (CH_4) and carbon dioxide (CO_2) with only trace amounts of other gases such as water vapor and hydrogen sulfide (H_2S). The amount of VOC and ammonia in raw dairy biogas is negligible, usually at non-detect levels. H_2S has a California AAQS; therefore, H_2S is an NSR regulated pollutant, and so BACT could be applied to the potential release of H_2S in dairy biogas. However, a flare is not an effective control device for H_2S in the context of NSR. The flare merely converts H_2S into SOx, and SOx is a PM2.5 precursor, and, as discussed above, the District is classified as serious non-attainment for federal PM2.5 standards. The District's attainment status for the state AAQS for H_2S is "unclassified"; therefore, there is no net benefit to converting H_2S to SOx with respect to the District's air quality attainment goals.

The purpose of a dairy biogas flare is to combust methane, mostly converting it to carbon dioxide and water. Rule 1020 (Definitions), Section 3.54 explicitly excludes methane from the definition of VOC because methane is not an ozone precursor. More generally, methane is not a pollutant or precursor to a pollutant that affects the District's attainment status with respect to any national or state AAQS. For this reason, methane is not a *NSR regulated pollutant*. Methane is also not a toxic air contaminant or hazardous air pollutant. Thus, a dairy biogas flare cannot be regarded as controlling or reducing the emissions of a District/NSR regulated pollutant.

While the flaring of dairy biogas does not control or reduce any regulated pollutant, it does produce emissions of regulated pollutants, including NOx, VOC, CO, SOx, PM10, and PM2.5. Flaring of dairy biogas produces air toxics as well. As noted above, the District is classified as an extreme non-attainment area for federal ozone standard(s) and a serious non-attainment area for federal PM2.5 standard(s). In particular, the NOx emissions created from flaring dairy biogas contribute disproportionately to the air quality challenges in the Valley when compared to the reduction in methane emissions the flare achieves. While the flaring of dairy biogas reduces methane emissions and contributes to the state's

GHG/AB32 efforts, the District is a NOx-limited area for ozone and NOx is a significant precursor to PM2.5 in the Valley. It is clear that the flaring of dairy biogas in no way abates, and, in fact, adds to the NOx pollution load in the Valley.

Air Pollution Abatement Device Exclusion from BACT

The District does not apply BACT to *air pollution abatement devices* (i.e. control devices) for regulated pollutants. For example, a flare can be considered as BACT if it is installed for the control of VOC from an emission source.

Although the District does not apply BACT to the *pollution abatement device*, the District can, nevertheless, consider the emissions created by said control device when determining the best piece of control technology to consider as BACT. EPA has longstanding guidance that supports the discretionary authority of air pollution control agencies to consider pollutant tradeoffs when evaluating BACT for a project:

> *One environmental impact that could be examined is the trade-off between emissions of the various pollutants resulting from the application of a specific control technology. The use of certain control technologies may lead to increases in emissions of pollutants other than those the technology was designed to control. For example, the use of certain volatile organic compound (VOC) control technologies can increase nitrogen oxides (NOx) emissions. In this instance, the reviewing authority may want to give consideration to any relevant local air quality concern relative to the secondary pollutant (in this case NOx) in the region of the proposed source. For example, if the region in the example were nonattainment for NOx, a premium could be placed on the potential NOx impact. This could lead to elimination of the most stringent VOC technology (assuming it generated high quantities of NOx) in favor of one having less of an impact on ambient NOx concentrations. [New Source Review Workshop Manual (Draft October 1990), p. B.49]*

The above EPA guidance makes it clear that the controls selected as BACT should support the air quality goals of the area. Although BACT is evaluated on a pollutant-by-pollutant basis, the control of a single pollutant that triggers BACT requirements should not be maximized if that maximization leads to the detriment of achieving or maintaining an AAQS.

The preceding discussions of the pollutants of foremost concern to the District and the actual emissions created by the dairy biogas flare show the dairy biogas flare cannot be considered an *air pollution abatement operation* because (1) it is not abating any pollutants regulated by the District's permitting program, and (2) it is producing emissions of regulated pollutants, especially ozone and PM2.5-forming NOx emissions, that are contributing to a worsening of air quality with respect to the ambient air quality standards the District is attempting to attain.

This interpretation is consistent with the statutory and regulatory purpose of NSR and the practical application of BACT.

Review of Emissions Units at a Dairy Digester and Biogas Upgrading Operation

Although equipment used at each dairy digester site may vary, a typical dairy digester system consists of a covered digester lagoon, oxygen/air injection system, H_2S removal system, gas blowers/compressors and chiller/dryers, and, depending on the location, flare(s) and membrane CO_2 removal system. Based on the rule analysis above, the District has evaluated each of the identified equipment and determined the *emission units* to which BACT applies for dairy digester system operations:

Covered Digester lagoon

A covered digester lagoon is a sealed basin that is designed to accelerate and control the decomposition of organic matter by microorganisms in the absence of oxygen. Anaerobic decomposition results in the conversion of organic compounds in the substrate into biogas, which consists of methane (CH_4), carbon dioxide (CO_2), and water (H_2O), as well as small amounts of nitrogen (N_2), oxygen (O_2), hydrogen sulfide (H_2S), and ammonia (NH_3). Biogas may also include trace amounts of various VOCs that remain from incomplete digestion of the volatile solids in the incoming substrate.

Since CH_4, CO_2, N_2, and O_2 are not affected pollutants, these gases will not be taken into consideration. Whereas, H_2S, NH_3, and VOCs are affected pollutants and may be emitted directly or as fugitive emissions; therefore, the covered digester lagoon is potentially an *emission unit*. However, those affected pollutants are coming from the lagoon, which is part of the dairy operation, and lagoon is already counted as an *emissions unit* at the dairy operation. If the covered digester lagoon was considered as an emissions unit at dairy digester operations, the lagoon would be double-counted as an *emissions unit*. Therefore, the covered digester lagoon is not an emissions unit at the dairy digester operation.

Oxygen/air injection system

The system for injection of purified oxygen functions to reduce H_2S in the digester gas. The benefit of injection of purified oxygen rather than atmospheric air, which is mostly nitrogen, is that injection of purified oxygen reduces the total amount of gas that must be separated from the methane and removed when the digester gas will be upgraded for injection into a natural gas pipeline. The continuous injection of controlled quantities of oxygen under the digester covers increases the amount of oxygen in the space under the digester covers and in the surface layer of the digester liquid, which facilitates oxidation of sulfides in the digester gas and at the surface of the liquid to elemental sulfur and water. Injection of oxygen also promotes biological removal of H_2S from the digester gas by facilitating the establishment of sulfur oxidizing microorganisms, such as Thiobacillus species, which have the ability to grow under various environmental conditions and oxidize H_2S to elemental sulfur.

In order to determine whether this is an *emissions unit* or not, District Rule 1020 (Definitions) will be referenced. Pursuant to Section 3.47 of Rule 1020, a source operation is the last operation preceding the emissions of any air contaminant, which:

- Results in the separation of the air contaminant from the process materials or in the conversion of the process into air contaminants, as in the case of combustion of fuels; and
- Is not an air pollution abatement operation; and
- Is any operation, article, machine, equipment or other contrivance.

As discussed above, the oxygen/air system is used to reduce the amount of H_2S in the digester gas. Therefore, the system is an air pollution abatement operation that controls an affected pollutant and will not be considered an *emissions unit*.

H_2S removal system

After initial removal of H_2S by the oxygen/air injection system, the digester gas is sent through an iron sponge H_2S scrubber and/or an activated carbon H_2S scrubber or an equivalent dry media H_2S scrubber for the removal of additional H_2S prior to delivery to the gas upgrading plant via a pipeline.

Iron sponge

An iron sponge scrubber is composed of vessel(s) containing iron sponge, which consists of a hydrated form of iron oxide infused onto wood shavings. The wood shavings serve only as a carrier for the iron oxide powder. The iron oxide infused into the wood surface will not wash off or migrate with the gas.

Activated carbon

Specially treated activated carbon is used to remove H_2S from gas streams. H_2S will be adsorbed as the gas flows through the activated carbon bed. Activated carbon has a large number of pores, which greatly increase the surface area for adsorption. Contaminants in the gas diffuse into these pores and are retained on the carbon surface due to both chemical and physical forces. Activated carbon used for the removal of H_2S is usually treated with chemical bases to increase the holding capacity for H_2S.

Therefore, the H_2S removal system is an *air pollution abatement operation* that controls an *affected pollutant* and is, therefore, not considered an *emissions unit*.

Gas blowers/compressors and chillers/dryers

Gas blowers/compressors are used to process biogas at specified flow rate, inlet and outlet pressures, and temperatures to increase the biogas pressure. Chillers/dryers are used to remove moisture from the biogas following the H_2S scrubber system. No *affected pollutants* are expected to be emitted by operating this equipment. Therefore, these are not *emissions units*.

Membrane CO_2 removal system

Carbon dioxide (CO_2) is removed from the biogas using membrane CO_2 removal system. In a membrane CO_2 removal system, pressurized biogas is upgraded by passing the gas through thousands of tiny polymer fiber tubes. Separation of the different components in the biogas, such as CH_4, CO_2, and H_2O, is a result of the difference in the permeability of these components through the polymer. CO_2 diffuses through the polymer fibers at a much higher rate than that of any other components in the biogas. As the pressurized biogas is pushed through the polymer fiber tubes, the CO_2 passes through the polymer tube surface and resulting in upgraded gas containing mostly CH_4 at the outlet of the membrane. The separated gas, consisting primarily of CO_2, gets discharged from a different outlet of the membrane. Also, the biogas that does not meet pipeline specifications (off-spec gas) may be vented through the membrane CO_2 removal system stack in case of system maintenance and/or start-ups.

During the separated CO_2 vent or off-spec gas vent, other components in the biogas, especially H_2S, can also pass through the membrane. Therefore, the membrane CO_2 removal system is an *emissions unit* at dairy digester operations. However, since this is a proactive BACT determination for dairy digester gas flares, membrane CO_2 removal systems will not be further discussed in this analysis.

Flare

The flare at dairy digester sites are used to dispose of excess biogas that cannot be further captured and processed or that does not meet pipeline specifications.

Raw dairy digester biogas is composed of approximately 60 – 70% methane (CH_4) and 30 – 40% carbon dioxide (CO_2) and 0% or at most only trace amounts of Volatile Organic Compounds (VOC) and ammonia (NH_3). As noted above, methane is not classified as a VOC and is, therefore, not an NSR regulated pollutant. The raw biogas also contains hydrogen sulfide (H_2S) at concentrations ranging from approximately 100 – 7,000 ppmv. H_2S is a regulated pollutant; however, the flare merely converts the H_2S into SOx, which is PM2.5 precursor, a regulated pollutant for which the District is classified as serious non-attainment for the federal AAQS. Thus, the flare by itself is not a control device for H_2S with respect to NSR.

Given the composition of dairy digester gas contains negligible VOC, the flare cannot be regarded as a VOC control device. The flare serves to dispose of methane, not to control VOC. Another indicator that the flare is not a VOC control device for dairy digesters is evident from CARB's GHG Offset Protocol for California's Cap-and-Trade Program, "Capturing and Destroying Methane from Manure Management Systems", where it is clear that the purpose of flaring dairy digester biogas is to dispose of methane in pursuit of state climate change goals.

In summary, flaring converts the methane into carbon dioxide and water, resulting in a decrease in GHG emissions measured in terms of overall global warming potential; however, more importantly within the scope of the District's jurisdiction and public health mission, flaring of biogas also results in an increase in criteria air pollutants (particularly NOx emissions), which may affect the ability of the District to achieve AAQS. Therefore, for these reasons, the District regards the flare at dairy digester operations as an *emissions unit* rather than an *air pollution abatement operation*.

<u>Scope of BACT Determination</u>

There are dairy digester gas processing and upgrading facilities with District permits that operate without any flaring of digester gas. At those sites the digester gas is primarily injected into the utility pipeline, excess gas is recycled back through the facility where small amounts of excess gas is vented to the atmosphere, resulting in emissions of GHGs, primarily methane. Compared to flaring the gas, not flaring is a less polluting alternative when considering the mission of Valley to reach challenging ozone and PM2.5 attainment goals. Typically, one or more installs of a control technique or equipment configuration is enough to establish an achieved-in-practice BACT requirement for the class or category of emission source. However, in this case, the District also acknowledges state goals and initiatives regarding GHG reductions and the concerns over climate change. Therefore, the District is willing to evaluate flaring as a means of supporting state climate change goals on a project-by-project basis, while minimizing criteria emissions to address local air quality challenges and concerns.

Prior to establishing the class and category of this BACT guideline, the District will first determine the class and category of a BACT guideline for *backup limited use flares*, then any flares outside the scope of such BACT guideline will be subject to this BACT guideline.

Since the primary function of operating a covered digester system is to capture and process the biogas for utility pipeline injection, flaring should only occur as a backup measure during limited circumstances, including:

- Emergency situations (e.g. equipment breakdown/malfunction)
- Digester gas system maintenance
- Initial commissioning of the facility
- Utility temporarily rejects gas

The District has issued ATCs or PTOs to approximately two dozen dairy biogas project with "backup" flares located at a single dairy since 2015. Evaluating these projects, the median level of flaring permitted was equivalent to approximately 500 to 750 hours per year[5]. In addition, the District surveyed five recent permitting actions at dairy digesters for both dairy clusters (multiple dairies sending digester gas to a biogas facility) and single dairies where the approximate percentage of flareable biogas[6] to total gas processing capacity was known and found a range of 4 – 17% (4%, 6%, 9%, 10%, and 17%), with an average of 9.2%. Converting these percentages into annual hours of flaring, and allowing some margin for the variability of different operations, *backup limited use flares* should operate no more than approximately 10% of the time, i.e. 876 hours out of a possible 8,760 hours per year.

Note that the commissioning/proving period is included in the 876 hours. The commissioning/proving period is a period where the facility conducts activities such as checking all mechanical, electrical, and control systems for equipment associated with the operation. These activities can include confirming the performance metrics specified for the associated equipment, testing the process and control equipment, and tuning of the equipment prior to normal source operation.

Additionally, since the emissions from a flare are directly proportional to heat input of the unit, and in order to ensure the overall NOx emissions from operating a *backup limited use flare* is consistent regardless of the size of the flare, the BACT guideline for backup limited use flares will also include an annual heat input limit (MMBtu/yr). To determine the appropriate annual heat input limit, the District surveyed the existing dairy digester flares discussed above. The District identified

[5] Many of the backup flares permitted above the median level of flaring have actual levels of flaring well below the median level. The flares that have hours of operation, per permitted heat input and maximum flare rating, above 750 hr/yr were equivalent to 791 hr/yr, 854 hr/yr, 859 hr/yr, 2,035 hr/yr, and 4,987 hr/yr. Assuming that these flares operated at a half of the maximum hourly heat rating at all times, these flares had actual annual operation between 0 hours to less than 450 hours, meaning it is likely many of the flares permitted for more hours of operation have much larger than needed compliance margins are not different in practice from the backup flares permitted below the median level of flaring.

[6] By *flareable biogas*, the District is using the amount (in Btu or scf) of permitted flaring in operations with flares; or, for operations without flares, gas that may be lost during the upgrade process that could hypothetically be flared.

the dairy digester flares that would meet the 876 hr/yr operational limitation to qualify as backup limited use and either their permitted heat input limits or actual heat inputs are at or below approximately 26,000 MMBtu/yr. Consequently, the scope of the BACT guideline 1.4.9 for backup limited use dairy digester gas flares is limited to no more than 876 hr/yr of operation and 26,000 MMBtu/yr.

Given the scope of the BACT guideline 1.4.9 for *backup limited use flares* above, the scope of this BACT guideline for full-time dairy digester gas flares is applicable to more than 876 hr/yr of operation or more than 26,000 MMBtu/yr.

III. Source of emissions

Dairy digester gas flares combust excess biogas from the dairy digester system, and produce NOx, SOx, PM10, CO, and VOC emissions. Note, BACT for CO is not included in this analysis since BACT for CO will likely not be triggered for any project (facility must be >200,000 lb-CO/yr in order to trigger BACT).

IV. Top-Down BACT Analysis

Step 1 - Identify All Possible Control Technologies

A. BACT Clearinghouses Survey

The following references were surveyed to determine emission limits and controls required to reduce NOx, SOx, PM10, and VOC emissions for dairy digester gas flares:

- EPA RACT/BACT/LAER clearinghouse
- CARB BACT clearinghouse
- South Coast AQMD BACT clearinghouse
- Bay Area AQMD BACT clearinghouse
- Sacramento Metro AQMD BACT clearinghouse
- Santa Barbara County APCD BACT clearinghouse
- San Diego County APCD BACT clearinghouse
- San Joaquin Valley APCD BACT clearinghouse

EPA RACT/BACT/LAER Clearinghouse[7]

The database was searched using the following criteria:

Permit Date: 1/1/2014 to 6/12/2024
Process Type: 19.320 – Digester and Landfill Gas Flares
Pollutant Name: All pollutants

[7] https://cfpub.epa.gov/rblc/index.cfm?action=Search.BasicSearch&lang=en

There were no relevant guidelines or determinations in the EPA RACT/BACT/LAER Clearinghouse.[8]

CARB BACT Clearinghouse[9]

CARB BACT clearinghouses includes the following guidelines and determinations made by individual agencies:

Santa Barbara County APCD BACT Determination

Stationary Source: PetroRock – Sisquoc Tunnell Lease
Description: 17 MMBtu/hr enclosed flare, produced gas fired[10]

The flare is located at an oil and gas operating facility. As this BACT guideline will apply to flares solely firing dairy digester gas, this flare in the SBCAPCD BACT Clearinghouse will not be considered in this analysis.

South Coast AQMD BACT Determination

Source Type: Major/LAER
Application No: 245157
Description: Four fulltime 248 MMBtu/hr flares, landfill gas fired

Source Type: Major/LAER
Application No: 491442 [(11)]
Description: Fulltime 120 MMBtu/hr enclosed flare, landfill gas fired with propane gas pilots.

According to SCAQMD's Facility INformation Detail (F.I.N.D) [(12)], these flares are no longer in operation; therefore, these flares will not be considered in this analysis.

Source Type: Major/LAER
Application No: 538706 [(13)]
Description: Fulltime 27 MMBtu/hr enclosed flare, produced gas fired with propane pilots.

[8] Although 9 digester gas flares appeared in the search, none of the 9 flares were dairy digester gas flares.

[9] https://ww2.arb.ca.gov/our-work/programs/technology-clearinghouse

[10] https://ww2.arb.ca.gov/sites/default/files/classic/technology-clearinghouse/bact/PTO2.pdf

[11] https://ww2.arb.ca.gov/sites/default/files/classic/technology-clearinghouse/bact/BACTID232.pdf

[12] https://xappprod.aqmd.gov/find

[13] https://ww2.arb.ca.gov/sites/default/files/classic/technology-clearinghouse/bact/BACTID233.pdf

The flare is located at an oil and gas operating facility. As this BACT guideline will apply to flares solely firing dairy digester gas, this flare in the SCAQMD BACT Clearinghouse will not be considered in this analysis.

Source Type: Major/LAER
Application No: 513835 [14]
Description: Fulltime 12 MMBtu/hr enclosed flare, digester gas fired with natural gas pilots. Flare incinerates excess digester gas not used as fuel in the boilers or fuel cell system, or to relieve pressure from storage tanks.

Source Type: Major/LAER
Application No: 448345 [15]
Description: Fulltime 39.9 MMBtu/hr enclosed flare, digester gas fired with natural gas pilots. Flare incinerates digester gas vented from food waste and manure anaerobic digesters.

Both flares are located at a municipal water district, Inland Empire Utilities Agency, which generates biogas through an anaerobic digestion process using food and dairy waste.[16] As this BACT guideline will apply to flares solely firing dairy digester gas, the above two flares in the SCAMQD BACT Clearinghouse will not be considered in this analysis.

Bay Area AQMD BACT Clearinghouse

Note, although there are no dairy digester gas flares operating within the BAAQMD jurisdiction, since the below requirements would apply if there was one, the BAAQMD requirements are included in this analysis.

Flare – Digester gas or landfill gas from non-hazardous waste landfill, all rating, Date 12/16/91[17]

Pollutant	BACT 1. Technologically Feasible/Cost Effective 2. Achieved in Practice	Typical Technology

[14] http://www.aqmd.gov/docs/default-source/bact/laer-bact-determinations/aqmd-laer-bact/2-2-18_laer_emwd_513835_digester_flare.pdf?sfvrsn=6

[15] http://www.aqmd.gov/docs/default-source/bact/laer-bact-determinations/aqmd-laer-bact/2-2-18_laer-ieua-448345-manure-food-waste-flare.pdf?sfvrsn=13

[16] https://www.ieua.org/regional-water-recycling-plant-no-5-shf/

[17] https://www.baaqmd.gov/~/media/files/engineering/bact-tbact-workshop/waste-processing-industry/80-1.pdf?rev=ba5f01e9c0c94bd2891b5b54d0544bf7&sc_lang=en

POC[18]	1. n/d[19] 2. Ground level, enclosed, >=0.6 second retention time at >=1,400˚F, auto combustion air control, automatic shutoff gas valve and automatic re-start system[b]	1. n/d[19] 2. BAAQMD Approved Design and Operation[b]
NOx	1. =<0.06 lb/MMBtu 2. 0.06 lb/MMBtu	1. n/s[20] 2. n/s[20]
SO2	1. Scrubbing and/or carbon adsorption for hydrogen sulfide removal[c (21)] 2. n/d[19]	1. BAAQMD Approved Design and Operation[b] 2. n/d[19]
PM10	1. n/s[20] 2. n/s[20]	1. Fuel Gas Filter 2. Knockout Vessel
NPOC	1. n/a[22] 2. n/a[22]	1. n/a[22] 2. n/a[22]

b. BAAQMD
c. CARB/CAPCOA Clearinghouse

Flare – Digester gas or landfill gas from hazardous waste landfill, all rating, Date 10/18/91[(23)]

Pollutant	BACT 1. Technologically Feasible/Cost Effective 2. Achieved in Practice	Typical Technology
POC[18]	1. n/d[19] 2. Ground level, enclosed, >=0.6 second retention time at >=1,500˚F, auto combustion air control, automatic shutoff gas valve and automatic re-start system[b]	1. n/d[19] 2. BAAQMD Approved Design and Operation[b]
NOx	1. =<0.06 lb/MMBtu 2. 0.06 lb/MMBtu	1. n/s[20] 2. n/s[20]
SO2	1. Scrubbing and/or carbon adsorption for hydrogen sulfide removal[21] 2. n/d[19]	1. BAAQMD Approved Design and Operation[b] 2. n/d[19]
CO	1. n/d[19] 2. same as for POC above[b]	1. n/a[22] 2. BAAQMD Approved Design and Operation[b]

[18] Precursor organic compounds. Any organic compound that photochemically reacts in the atmosphere to form ozone (any organic compound as defined in BAAQMD Rules and Regulations Section 1-233 excepting the non-precursor organic compounds defined in Section 2-1-207)

[19] No Determination. No BACT or TBACT determination was made for the source category or BACT or TBACT category under consideration.

[20] Not Specified. A BACT or TBACT determination was made but no specific emission limitation was set or the detailed equipment/process technology was not specified.

[21] Since no control efficiency is specified, it will be assumed that the installation of H_2S scrubber and/or carbon adsorption suffice the SO_2 technologically feasible requirement when such control technology is cost effective.

[22] Not applicable. For example, the pollutant in question is not a significant emission for the source category under consideration.

[23] https://ww2.arb.ca.gov/sites/default/files/classic/technology-clearinghouse/bact/BACTID427.pdf?:linktarget=_self&:embed=yes

PM10	1. n/s[20] 2. n/s[20]	1. Fuel Gas Filter 2. Knockout Vessel
NPOC	1. n/a[22] 2. n/a[22]	1. n/a[22] 2. n/a[22]

b. BAAQMD

Given POC/VOC destruction efficiency of a flare depends on flame temperature, residence time in the combustion zone, auto-ignition temperature, and turbulent mixing, and a properly operated flare can achieve a VOC destruction efficiency of 98% or greater[24], the AIP requirement for POC in the above BAAQMD BACT guidelines can be considered equivalent to the use of a flare that achieves 98% or greater POC destruction efficiency. Nonetheless, as seen above in Section II of this document, since dairy digester gas has negligible amounts of VOC, 98% POC/VOC destruction efficiency is not relevant to this BACT guideline. As a result, the flare is the source of VOC and cannot be regarded as a VOC control device. Therefore, 98% VOC destruction efficiency option will not be further discussed in this document.

Knockout vessels are used to slow down gas flow by creating a pressure drop, allowing condensates and particulates to fall out of the vented gas stream ahead of combustion in the flare if otherwise would cause the following:

- Irregular combustion and excess smoking;
- Unstable burning and becoming a safety hazard;
- Extinguishing the flare flame

Fuel gas filters are also used to remove particulates and sulfur compounds from the vented gas stream ahead of combustion in the flare for similar reasons noted above.

Knockout vessels/fuel gas filters are largely used at landfills and oil and gas industries as the gas from those operations typically contains oil contaminates/particulates/water. Whereas, the biogas from the dairy digester system does not contain oil contaminants or particulates[25], and although the biogas may contain water from the covered digester lagoon, the chillers/dryers installed at upstream of the flare already function as the knockout vessels/fuel gas filter.

Furthermore, according to CARB document "Air Quality Guidance for Siting Biorefineries in California," (26) a knockout vessel is identified as BACT for PM10

[24] https://www3.epa.gov/ttncatc1/dir1/fflare.pdf

[25] As methane is the main component in the dairy digester biogas, there are no heavy hydrocarbons to form particulates.

[26] https://ww2.arb.ca.gov/sites/default/files/classic/fuels/lcfs/bioguidance/biodocs/finalbiorefineryguidenov2011.pdf

for landfill gas-fired flares, and a fuel gas filter is identified as BACT for SOx and PM10 for biogas-fired internal combustion engines and biogas-fired turbines, respectively.

Therefore, considering the discussions above, the knockout vessel/fuel gas filter will not be considered in this analysis.

South Coast AQMD BACT Clearinghouse

BACT Guidelines for Non-Major Sources[27]

Note, although there are no dairy digester gas flares operating at non-major polluting facilities within the SCAQMD jurisdiction, since the below requirements would apply if there was one, the SCAQMD requirements are included in this analysis.

Rating/Size	VOC	NOx	SOx	PM10
Digester gas or landfill gas from non-hazardous waste landfill	Ground level, shrouded, >=0.6 second retention time at >=1,400˚F, auto combustion air control, automatic shutoff gas valve and automatic re-start system (1988)	0.06 lb/MMBtu (1988) Compliance with Rule 1118.1 (2-5-2021)	-	Knockout Vessel (1988)

For the same reason as above in the BAAQMD BACT discussion for POC, the VOC destruction efficiency of 98% will not be further discussed in this document.

For the same reason as above in the BAAQMD BACT discussion for PM10, the knockout vessel will not be considered in this analysis.

BACT Determinations for Major Sources

Refer to the SCAQMD BACT Clearinghouse discussion above in the CARB BACT Clearinghouse section.

Bay Area AQMD BACT Clearinghouse[28]

Refer to the BAAQMD BACT Clearinghouse discussion above in the CARB BACT Clearinghouse section.

[27] http://www.aqmd.gov/docs/default-source/bact/bact-guidelines/bact-guidelines-2024/part-d_bact-guidelines-for-non-major-polluting-facilities.pdf

[28] https://www.baaqmd.gov/permits/permitting-manuals/bact-tbact-workbook

Sacramento Metro AQMD BACT Clearinghouse[29]

There were no relevant determinations/guidelines in the clearinghouse.

Santa Barbara County APCD BACT Clearinghouse[30]

There were no relevant determinations/guidelines in the clearinghouse.

San Diego County APCD BACT Clearinghouse[31]

There were no relevant determinations/guidelines in the clearinghouse.

Summary of BACT Clearinghouse Survey

Based on the information above, the current most stringent BACT requirement for dairy digester gas flares is:

NOx
0.06 lb/MMBtu

B. Survey of Permits Issued by SJVAPCD

See Appendix A for a list of flares associated with dairy digester permits issued by SJVAPCD. Based on Appendix A, the most stringent emission limits for District permitted dairy digester gas flares are:

NOx	SOx and PM10	VOC
0.024 lb/MMBtu	Sulfur content of digester gas flared ≤ 40 ppmv as H_2S	0.003 lb/MMBtu

The NOx limit is from Madera DP2 (C-9220-5-1) installed 6/08/2021. The VOC limit is from Fiscalini Farms (N-6311-10-2) installed 4/19/2021. Numerous installations include the 40 ppmv H_2S limit on flare gas.

C. Survey of Source Tests

The District surveyed source test results of dairy digester gas flares with an active valid ATC or PTO, and summarized in the following table:

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29 http://www.airquality.org/businesses/permits-registration-programs/best-available-control-technology-(bact)

30 https://www.ourair.org/permits-compliance/

31 https://www.sdapcd.org/content/dam/sdapcd/documents/permits/SDAPCD-BACT-Guidance.pdf

Facility Name	District Permit #	Flare Rating	Throughput	Test Results
Madera DP2, LLC	C-9220-5-1	27 MMBtu/hr	111,000 MMBtu/yr	NOx: 7 ppm @ 3% O_2, 0.0089 lb/MMBtu (Permit limit: 16 ppm @ 3% O_2, 0.024 lb/MMBtu)
Fiscalini Farms & Fiscalini Dairy	N-6311-10-2	5.3 MMBtu/hr	11,601.6 MMBtu/yr	NOx: 0.0426 lb/MMBtu (Permit limit: 0.047 lb/MMBtu) VOC: 0.0023 lb/MMBtu (Permit limit: 0.003 lb/MMBtu)

As seen above in the table, 7 ppm NOx @ 3% O_2 (equivalent to 0.0089 lb/MMBtu) was reported for the Madera DP2, LLC flare source test and 0.0426 lb-NOx/MMBtu and 0.0023 lb-VOC/MMBtu were reported for the Fiscalini flare source test. The source test results show the permitted emission limits (and the low NOx flare manufacturer's guarantee in the case of Madera DP2) are achievable with dairy digester gas with a reasonable compliance margin. The source test results are lower than the most stringent BACT requirements established in the *Permits Issued by SJVAPCD* and in the *BACT Clearinghouse Survey* above. However, variability in source test results are typically expected when multiple tests are done, and, because these results are limited data points for each flare, using these results would be inadequate for establishing the BACT requirements. In addition, pursuant to project C-1200188 under which the Madera DP2, LLC flare was initially authorized to construct, the manufacturer guaranteed NOx emissions of 0.024 lb/MMBtu. Therefore, these data will not be considered in this analysis, and no further discussion is required.

D. Survey of Applicable Rules and Regulations

The EPA, CARB, SCAQMD, BAAQMD, SMAQMD, SDAPCD, SBCAPCD, and the District rules and regulations were also reviewed to determine applicable control requirements on dairy digester gas flares. EPA, CARB, BAAQMD, SMAQMD, SBCAPCD, and SDAPCD have not published rules or regulations for such operations.

South Coast AQMD Rule

SCAQMD Rule 1118.1 (Non-Refinery Flares) [32] applies to owners and operators of flares that require a SCAQMD permit at non-refinery facilities, including but not limited to, oil and gas production facilities, waste water treatment facilities, landfills, and organic liquid handling facilities. The requirements in this rule are as follows:

[32] https://www.aqmd.gov/docs/default-source/rule-book/reg-xi/R1118-1.pdf?sfvrsn=9

Digester Gas Flare	NOx (lb/MMBtu)	VOC (lb/MMBtu)
Major facility	0.025	0.038
Minor facility	0.06	N/A

Note, that there are no dairy digester gas flares installed within the SCAQMD jurisdiction as mentioned above.

San Joaquin Valley APCD Rule
SJVAPCD Rule 4311 (Flares) [(33)] applies to operations involving the use of flares. Flares permitted to operate more than 100,000 MMBtu/hr are subject to the following:

Table 3 – VOC and NOx Emissions Requirements for Flares		
Flare Category	VOC (lb/MMBtu)	NOx (lb/MMBtu)
C. Flares at Digester Operations (Located at a Major Source)	0.038	0.025
D. Flares at Digester Operations (Not Located at a Major Source)	N/A	0.060

Summary of Applicable Rules and Regulations

Based on the information above, the current most stringent rule requirements for dairy digester gas flares are:

	NOx (lb/MMBtu)	VOC (lb/MMBtu)
Major facility	0.025	0.038
Minor facility	0.06	N/A

Summary of Step 1 Identify All Possible Control Technologies

Pursuant to the District's BACT policy, in order for a control technology to be deemed as having been achieved in practice, the following conditions must be met:

- The rating and capacity for the unit where the control was achieved must be approximately the same as that for the proposed unit.
- The type of business (i.e. class of source) where the emissions units are utilized must be the same.
- The availability of resources (i.e. fuel, water) necessary for the control technology must be approximately the same.

Based on the preceding analyses, the control technology options identified are listed below:

[33] https://ww2.valleyair.org/media/e54fao3u/rule-4311.pdf

<u>Achieved in Practice</u>

- NOx: 0.025 lb/MMBtu (Low-NOx Flare)
- PM10 and SOx: sulfur content of digester gas flared ≤ 40 ppmv as H_2S
- VOC: 0.038 lb/MMBtu

<u>Alternative Basic Equipment</u>

- No flare – Excess gas is recycled or not combusted

Step 2 - Eliminate Technologically Infeasible Options

The control options listed in Step 1 are all technologically feasible; therefore, are not eliminated as infeasible.

Step 3 - Rank Remaining Control Technologies by Control Effectiveness

1. Alternate Basic Equipment: No Flaring (Excess gas is recycled or not combusted)

2. Achieved in Practice:
   - NOx: 0.025 lb/MMBtu (Low-NOx Flare)
   - PM10 and SOx: sulfur content of digester gas flared ≤ 40 ppmv as H_2S
   - VOC: 0.038 lb/MMBtu.

   The BACT standard for VOC that is compatible with the proposed low NOx BACT standard is 0.038 lb/MMBtu. As indicated in District Rule 4311 (Flares), and South Coast AQMD Rule 1118.1 (Control of Emissions from Non-Refinery Flares), both of which reflect BARCT levels of control for NOx and VOC, VOC emissions from low NOx flares tend to be greater than the VOC emissions from standard flares because the combustion characteristics that optimize for the lowest NOx emissions do not optimize for the lowest VOC emissions. The BARCT emission standards for NOx and VOC in both of these rules for digester gas flares at major sources is 0.025 lb-NOx/MMBtu and 0.038 lb-VOC/MMBtu, respectively. Given the priority of NOx emissions for the District's attainment efforts, BACT for VOC will be contingent on BACT for NOx in this guideline. However, the District will increase the stringency of the VOC standard as data becomes available to support such a determination.

Step 4 - Cost Effectiveness Analysis

Since this is a proactive BACT determination that is not part of a specific permitting action, a cost effectiveness analysis is not applicable.

Step 5 - Select BACT

This is a proactive determination that is not part of a specific permitting action. Therefore, selecting BACT is not necessary. However, the following emission control technologies and requirements have been determined to be achieved in practice and alternate basic equipment BACT for dairy digester gas flares:

1. Alternate Basic Equipment: No Flaring (Excess gas is recycled or not combusted)

2. Achieved in Practice:
   - NOx: 0.025 lb/MMBtu (Low-NOx Flare)
   - PM10 and SOx: sulfur content of digester gas flared ≤ 40 ppmv as H_2S
   - VOC: 0.038 lb/MMBtu

Appendices:
Appendix A: List of Dairy Digester Gas Flare Permits Issued by SJVAPCD
Appendix B: District Response to Public Comments

Appendix A
List of Dairy Digester Gas Flare Permits Issued by SJVAPCD

Facility Name	Permit #	Flare Rating (MMBtu/hr)	Permitted Heat Input/Equivalent hour per Max Rating	Actual Heat Input********	Emission Limit/Control (lb/MMBtu)					Gas Disposition	PTO Converted?
					NOx	SOx	H_2S	PM10	VOC		
Hanford Renewable Energy LLC	C-9011-4-0	11.2	55,864 MMBtu/yr (= 79,805,714 scf), 4,987 hr/yr	159 scf/yr	0.056	0.0096	1) flared gas ≤ 40 ppmv 2) H_2S scrubber upstream of flare	0.021	0.063	Power Generation	Y
Madera Renewable Energy LLC	C-9139-2-0	11.2	9,568 MMBtu/yr (= 13,668,581 scf), 854 hr/yr	251,028 scf/yr	0.056	0.0096	1) flared gas ≤ 40 ppmv 2) H_2S scrubber upstream of flare	0.021	0.063	Power Generation	Y
Open Sky Power LLC	C-9143-3-0	44.8	114.286 MMscf/yr (= 80,000 MMBtu/yr), 1,785 hr/yr*	Not Available	0.056	0.0096	1) flared gas ≤ 40 ppmv 2) H_2S scrubber upstream of flare	0.021	0.063	Power Generation	Y
Still Water Power LLC	C-9145-2-1******	15	7,272 MMBtu/yr (= 12.12 MMscf), 500 hr/yr	375 MMBtu/yr	0.06	0.0113	1) flared gas ≤ 40 ppmv 2) H_2S scrubber upstream of flare	0.015	0.006	Power Generation	Y
Madera DP2, LLC	C-9220-5-1	27	111,000 MMBtu/yr, 4,111 hr/yr	Not Available	0.024	0.01	1) flared gas ≤ 40 ppmv 2) H_2S scrubber upstream of flare	0.008	0.011	Power Generation	Y
Env-Two, LLC	C-9312-1-0	11.7	7.813 MMscf/yr (= 5,859 MMBtu/yr), 500 hr/yr**	Not Available	0.06	0.009	1) flared gas ≤ 40 ppmv 2) H_2S scrubber upstream of flare	0.02	0.006	Power Generation and Pipeline	N
Env-Two, LLC	C-9312-3-0***	11.7	7.813 MMscf/yr (= 5,859 MMBtu/yr), 500 hr/yr**	Not Available	0.06	0.01	1) flared gas ≤ 40 ppmv 2) H_2S scrubber upstream of flare	0.02	0.006	Power Generation and Pipeline	N
Ruann Dairy Digester	C-9325-1-0	5.1	2,236 MMBtu/yr, 438 hr/yr	Not Available	0.06	0.815	1) flared gas ≤ 3,080 ppmv 2) H_2S scrubber upstream of flare	0.015	0.006	Power Generation	Y
Lakeside Pipeline LLC	C-9441-1-2*******	107	48,332 MMBtu/yr, (= 80,553,333 scf/yr) 452 hr/yr	3,524 MMBtu/yr (3.428 MMscf/yr)	0.06	-	1) flared gas ≤ 65 ppmv 2) H_2S scrubber upstream of flare	0.015	0.006	Power Generation and Pipeline	Y
Five Points Pipeline, LLC	C-9560-1-3*******	64	50,632.2 MMBtu/yr, 791 hr/yr	14,394 MMBtu/yr*********	0.068	-	1) flared gas ≤ 40 ppmv 2) H_2S scrubber upstream of flare	0.008	0.006	Pipeline	Y
Brightmark Vlot RNG LLC	C-9639-1-0	44.8	22,400 MMBtu/yr, 500 hr/yr	Not Available	0.06	0.002*	1) 1 gr S/100 scf (17 ppmv) 2) H_2S scrubber upstream of flare	0.015	0.006	Pipeline	N
SAR1, LLC	C-9774-1-0	14.83	6,495.54 MMBtu/yr, 438 hr/yr	Not Available	0.06	0.01	1) flared gas ≤ 40 ppmv 2) H_2S scrubber upstream of flare	0.015	0.006	Pipeline	N
Env-Four, LLC	C-9967-1-0	11.7	7.813 MMscf/yr (= 5,859 MMBtu/yr), 500 hr/yr**	Not Available	0.06	0.009	1) flared gas ≤ 40 ppmv 2) H_2S scrubber upstream of flare	0.02	0.006	Pipeline	N

DB Digester LLC	N-10009-1-0	34.4	44.48 MMscf/yr (= 25,800 MMBtu/yr), 749 hr/yr****	Not Available	0.06	0.64	1) flared gas ≤ 2,200 ppmv 2) H_2S scrubber upstream of flare	0.008	0.006	Pipeline	N
Fiscalini Farms & Fiscalini Dairy	N-6311-10-2	5.3	11,601.6 MMBtu/yr, (= 19.336 MMscf/yr) 2,188 hr/yr	Not Available	0.047	0.141	1) flared gas ≤ 500 ppmv 2) air injection system	0.015	0.003	Power Generation	Y
VS Digester	N-9354-1-1	34.4	44.48 MMscf/yr (= 25,800 MMBtu/yr), 749 hr/yr****	Not Available	0.06	0.64	1) flared gas ≤ 2,200 ppmv 2) H_2S scrubber upstream of flare	0.008	0.006	Pipeline	N
Merced Pipeline, LLC	N-9642-1-2*******	116.4	100,000 MMBtu/yr, 859 hr/yr	816.6 MMBtu/yr	0.068	-	1) flared gas ≤ 50 ppmv 2) H_2S scrubber upstream of flare	0.008	0.006	Pipeline	Y
MD Digester LLC	N-9880-1-1	34.4	44.48 MMscf/yr (= 25,800 MMBtu/yr), 749 hr/yr****	Not Available	0.06	2.04	1) flared gas ≤ 7,000 ppmv 2) H_2S scrubber upstream of flare	0.025	0.006	Pipeline	N
Hilarides Dairy	S-5058-11-1*****	6	200 hr/yr	Not used	0.068	0.241	1) S ≤ 2,000 ppmv	0.026	0.0055	Power Generation	Y
Coronado Dairy Farms	S-6991-13-0	44.8	91,166 MMBtu/yr, (= 130.238 MMscf/yr) 2,035 hr/yr	8.846588 MMBtu/yr	0.056	0.0096	1) flared gas ≤ 40 ppmv 2) H_2S scrubber upstream of flare	0.021	0.063	Power Generation	Y
Brownie LLC	S-9908-1-0	34.4	25,800 MMBtu/yr, (= 44.483 MMscf/yr) 750 hr/yr	Not Available	0.06	0.35	1) flared gas ≤ 1,200 ppmv 2) H_2S scrubber upstream of flare	0.008	0.006	Pipeline	N

* Based on HHV of 700 Btu/scf
** Based on HHV of 750 Btu/scf
*** This ATC cancels ATC C-9312-1-0.
**** Based on HHV of 580 Btu/scf
***** In-house PTO
****** Although ATC '-2-2 was issued under C-1230282, there was no change in emissions for the flare as result of the project.
******* Issued ATCs
******** Data collected from the most recent inspection report for each of the facilities
********* This was recorded amount of dairy digester gas flared from January 1, 2023 to November 17, 2023.

Appendix B
District Response to Public Comments

District Response to Public Comments

The District published the draft BACT analyses on the District website (https://www.valleyair.org) on September 16, 2024 to gather comments from regulated facilities, oversight agencies, the public, and other interested parties during a 30-day public notice period, which ended on October 16, 2024. Comments received during the public notice period and District's responses to these comments are given below.

Comments were received from the following:

Anna Reville, Maas Energy Works, Inc.

1. **Comment:** Our only comment at this time is to remove the clause indicating that annual flare limits also include the commissioning period. This is a difficult clause considering that the numerous variables that occur during commissioning, and in general during the first several months of a project.

Response: The District finds the following two reasons as to why the proposed operational limits (i.e. 26,000 MMBtu/yr and 876 hour/yr) should include the commissioning/proving period:

1) The District established the 876 hour limitation (~10% of the number of hours in a year) based on a survey of five facilities for which the dairy digester gas processing capacity (on a volume basis) and gas flaring or venting was known. Out of the five facilities, three facilities are currently in operation and are solely or principally processing the dairy digester gas for pipeline injection, and, therefore, would have been subject to a commissioning period. Although these three facilities have permit limits above the proposed BACT operational limits, District inspection reports indicate the actual amounts of dairy digester gas flared have been much smaller than the proposed BACT limit of 26,000 MMBtu/yr (1,259 MMBtu/yr, 3,525 MMBtu/yr, and 14,394 MMBtu/yr). To date, these facilities have operated below the proposed BACT heat input limits, demonstrating that the proposed BACT limits are reasonable.

2) There are dairy digester gas processing and upgrade facilities that operate without any flaring of dairy digester gas in the San Joaquin Valley (Valley). At those sites, excess gas is captured and stored in the system, recycled back through the facility, and/or vented to the atmosphere. Additionally, these facilities have been designed in a manner to prevent the need to flare dairy digester gas.

While the District accepts that limited flaring may be necessary at some dairy digesters and dairy digester gas upgrade stations, non-flaring dairy digester gas options have been built and are successfully operating without reported issues within the Valley. Therefore, at a minimum, alternative, non-flaring options should be utilized in combination with flaring to minimize emissions from these types of operations. As discussed in the BACT analysis, the installation of dairy digester gas upgrading/processing facilities helps with the state's GHG/AB32 efforts, but when flaring occurs, they also add to the NOx pollution load in the Valley.

In conclusion, the District has not obtained sufficient justification as to why flaring during the commissioning/proving period should be excluded from the proposed limited use operational limits (i.e. 26,000 MMBtu/yr and 876 hour/yr). Therefore, the commissioning/proving period will remain included in the 876 hour/yr and 26,000 MMBtu/yr operational limits at this time.

Gerrud Wallaert, Brightmark

2. **Comment:** The upgraded RNG from a dairy digester facility has a methane content of 98% or greater. There are periods of times when this gas cannot go into the pipeline. These periods include commissioning to prove pipeline specifications, or the facility is shut out of the pipeline.

When commissioning and prior to the pipeline accepting the RNG, a facility must prove the RNG meets certain pipeline specifications. The gas pipeline company specifies the amount of time that the facility must prove that they meet pipeline specifications in a contract with the RNG provider prior to the RNG facility injecting gas into the pipeline. The timeline is estimated to take two to four weeks for a facility but can take longer. This timeline is dependent on the gas pipeline company and how quickly the facility can produce pipeline specification gas. In some instances, the gas pipeline company can restart the clock if the RNG is out of specification. The gas is flared when proving pipeline specifications, and the gas can't be recirculated through the system because that is not an approved method for proving that the facility meets pipeline specifications.

During normal operations there are periods of time when the gas does not meet pipeline specifications, or the gas pipeline company prevents the facility from injecting RNG into the pipeline. There can be issues on the gas pipeline company's side that are outside of the RNG facility's control. These occasions may be rare, but they can include unscheduled work performed by the natural gas pipeline.

Facilities producing renewable natural gas may be subject to 17 CCR, sections 95665-95677, officially Greenhouse Gas Emission Standards for Crude Oil and Natural Gas Facilities, but better known as California Oil and Gas Rule (COGR). Given that the gas to be vented may meet the COGR definition of natural gas, it is unclear if such venting would be legal under COGR venting prohibitions. The District's concerns about NOx are undoubtedly real but such facilities are subject to a variety of real-world safety, liability, and other-agency regulatory constraints that venting 98% methane can't be considered a broadly available option for Dairy RNG facilities.

Response: To date, the three pipeline injection facilities mentioned in the District's response to Comment #1 have operated their flares in compliance with these limits, demonstrating that these limits are reasonable. If additional flaring is needed beyond the proposed backup limited use operation limits of 26,000 MMBtu/yr and 876 hour/yr, the District has created an alternate draft BACT analysis (1.4.10) that outlines the emission requirements for a non-limited use flare.

Regarding the applicability of COGR, neither the regulation language nor the rulemaking record support applying COGR requirements to the production or processing of dairy digester gas. In its published Final Statement of Reasons for the "Regulation for Greenhouse Gas Emission Standards for Crude Oil and Natural Gas Facilities" (May 2017), the California Air Resources Board (CARB) dismissed multiple comments received from stakeholders requesting the inclusion of GHG emissions from dairies, cattle, and livestock industry in the COGR as "beyond the scope of this rulemaking" (p. 11). Thus, the District has never applied COGR to dairy digester operations, nor has the District received guidance from CARB that COGR should be applied to these operations. More generally, the District has not identified other rules or regulations that would prohibit venting of dairy digester gas or would require flaring of dairy digester gas. However, if the District were to identify rules and/or regulations that would require flaring or prohibit venting of dairy digester gas operations in the future, the District would revise the proposed BACT guidelines (1.4.9 and 1.4.10) accordingly as needed.

3. **Comment:** The goal of California's Low Carbon Fuel Standard (LCFS) program is to reduce the carbon intensity of transportation fuels through greenhouse gas emission reductions. The LCFS is currently the only market with the economic incentive to develop carbon negative projects, including dairy biomethane. Due to the low energy density feedstock and higher required residence time, dairy digester projects result in higher costs per MMBtu produced.

LCFS credit prices have been at historically low levels for over two years. Increases of LCFS credits in the bank in 2024 due to low targets and delayed rule implementation are causing downward price pressure needing immediate attention. In Q1 2024, the credit bank increased 2.4 million credits to a total of 26 million credits. The bank is projected to reach 30-35 million credits by the end of 2024 reporting, with the bank projected to increase in size by up to 7-12 million credits in 2024 alone.

Any additional costs for these facilities will add more burden to an already strained market. Additional costs can also prevent more companies investing in and ultimately building new RNG facilities in the San Joaquin Valley, where there is a need to reduce methane emissions.

California has a long history of supporting aggressive actions to address environmental challenges, like climate change. Governor Newsom has called for an even more aggressive approach to achieve climate neutrality. As the California Air Resources Board (CARB) has stated, "[s]ignificant reductions in transportation emissions are needed to achieve state's air quality and climate goals."

Market and regulatory certainty are based on trust in California as a reliable place to build projects and sell low-carbon fuel and credits to meet and exceed climate goals. Markets with additional regulatory burdens and wide fluctuations between high and low prices are not sustainable. Regulatory uncertainty and sustained low price environments damage industries and erode confidence and incent investment in other markets.

Negative CI fuels require significant economic incentives, and market and regulatory certainty, which has eroded with current LCFS prices. Additional regulations, coupled with long-term depression of credit prices will lead to stranded assets and a lack of private investment in decarbonizing California's economy.

Response: The District understands that LCFS is a market-based incentive program, and therefore the LCFS credit values are subject to fluctuation. The LCFS is part of the reasoning that the District is willing to concede limited flaring or controlled (i.e. low NOx) flaring at dairy digester gas processing and upgrade sites even though numerous dairy digester gas projects within the San Joaquin Valley have been designed, built and operated without flaring. However, as for controlled flaring, once a technology has been installed and operated for a sufficient time to be considered achieved in practice, cost may no longer be considered for BACT purposes. As discussed below in the District's responses to Comments #5 and #6, the District has identified that a low NOx flare has been installed at a dairy digester site that is currently in operation (Madera DP2, LLC), and this example is sufficient for the District to deem the low NOx flare technology achieved in practice for dairy digester gas flares that are not *backup limited use*.

Also, the District acknowledges flaring of dairy digester gas reduces methane emissions and contributes to the state's greenhouse gas (GHG)/AB32 efforts. However, given that the District is a NOx-limited area for ozone and NOx is a significant precursor to PM2.5 in the Valley, minimizing NOx emissions from flaring is a priority for the District to achieve the region's air quality goals. Therefore, the low NOx flare technology will remain listed as a technologically feasible option in draft BACT Guideline 1.4.9 and as an achieved in practice option in draft BACT Guideline 1.4.10.

4. **Comment:** The percentage of flareable biogas to total gas processing capacity is based on five facilities, but the guidance fails to mention if these are dairy to pipeline RNG facilities. The guidance also fails to mention if these percentages are based on facilities already operating or if this is just the proposed number of hours included in the air permit application. The guidance also states that the hours for commissioning are already included in the 876 hours.

   With dairy to pipeline RNG projects there are two variables that impact the total amount of flaring needed during commissioning years. The first is the amount of time it takes to get the upgrader system running. The first-time that gas runs through the upgrader system is during commissioning. It takes substantial time to reach process stability and reliability (e.g., blower or compressor not working).

   The second variable is proving pipeline specifications are met. The specifics are listed in Comment #2 above.

   For facilities that are not converting dairy to pipeline RNG, such as digester facilities using the gas to run engines, the commissioning period is different for several reasons. The first is that these facilities are not commissioning complex upgrader units. The second is that these facilities do not need to prove they meet pipeline spec gas, which requires flaring 98% methane for multiple weeks.

Due to all the reasons listed above, digester to pipeline RNG facilities should have their own separate BACT that includes an evaluation of hours allowed for flaring that is only based on operating dairy RNG facilities. This separate BACT needs to include a commissioning period. See Comment #2 above for why dairy RNG facilities need a commissioning period.

Response: The comment notes the longer commissioning duration required for RNG (i.e. pipeline injection) facilities as compared to power generation facilities and questions whether the flaring limits in draft BACT Guideline 1.4.9 are reasonable for RNG facilities.

As discussed in the draft BACT analysis, the District established the 876 hour limitation (~10% of the number of hours in a year) from a survey of five facilities for which the dairy digester gas processing capacity (on a volume basis) and gas flaring or venting was known. Out of the five facilities, four facilities are currently in operation, and out of the four facilities, three are facilities that are solely or principally processing the dairy digester gas for pipeline injection and have flares. Considering only this RNG subset of facilities, the average percentage of allowed flaring to total gas processing capacity from these three facilities is 6.3% (4%, 6%, and 9%), which is within the District limited use estimate of 10%. Moreover, as indicated in Response #1 above, these three RNG facilities also have reported flaring levels within the heat input limits of BACT Guideline 1.4.9.

From this sample of RNG facilities, the District concludes that the proposed limits on flaring in BACT Guideline 1.4.9 (i.e. 876 hours/year and 26,000 MMBtu/yr) are reasonable regardless of whether a facility processes the dairy digester gas for pipeline injection or for power generation. Facilities that wish or need to flare more, have the option of installing a low NOx flare indicated under BACT Guideline 1.4.10.

5. **Comment:** Typical BACT Guidelines are based on differences between major and minor sources. It is unclear why this BACT guideline is based on the 26,000 MMBtu value. The 2020 amendments to Rule 4311 amendments considered the cost-effectiveness of ultra-low-NOx flares and determined that only major sources of NOx should be required to use ultra-low NOx flares. Minor sources at digester operations are allowed up to 0.06 lb/MMBtu flares. What new information indicates that ultra-low NOx flares are now more feasible or cost effective than they were in 2020?

   Additionally, if an operational threshold will gate access to an alternative BACT Guideline for flares, the relationship of the dual limit is unclear. Must a flare operate under both 876 hr/year and 26,000 MMBtu/year to qualify, or can a flare qualify by meeting either criterion?

   Response: While other air pollution control agencies may separate BACT guidelines for minor sources and major sources, District Rule 2201 (New and Modified Stationary Source Rule) does not differentiate the applicability/feasibility of emissions limits or control technologies between minor sources and major sources. Historically, the SJVAPCD has only established BACT guidelines that would apply to an emissions source category, regardless of whether or not the facility was a minor source or a major source. The emissions source category may take account of the size of the emissions unit in a manner that tracks emissions; however, the status of the facility as a minor or major source is not a factor by rule.

Additionally, the requirements for BACT are derived from District Rule 2201 and apply to new and modified equipment. Whereas District Rule 4311 is classified as a prohibitory rule and establishes requirements for existing equipment. Since new and modified equipment can be designed to meet certain requirements/limitations, BACT is generally more stringent than requirements found in prohibitory rules. During the rule development process for amending District Rule 4311, the District considered the cost-effectiveness of requiring existing flares to be replaced with low NOx flares and found that it was only cost-effective for major sources to install low NOx flares. This is why District Rule 4311 contains different sets of emissions limits for minor sources and major sources.

Furthermore, at the time of Rule 4311 amendments in 2020, there were no low-NOx flares installed or in operation at dairy digester operations, whereas at the time of these draft BACT determinations, one low-NOx flare was identified to have been installed at a dairy digester site that is currently in operation. As discussed in the response to Comment #3, once a control has been achieved in practice, costs may no longer be considered for BACT purposes.

Yes, a flare must operate under both the 876 hr/yr and the 26,000 MMBtu/yr limits to qualify as a *backup limited use flare* under BACT Guideline 1.4.9. As explained in the draft BACT determinations, since the emissions from a flare are directly proportional to heat input of the unit, the District also included an annual heat input limit of 26,000 MMBtu/yr in addition to the operation limit of 876 hr/year to ensure the overall NOx emissions from operating a *backup limited use flare* are consistent regardless of the size of the flare. For example, the District did not want a 10 MMBtu/hr flare operating 2,500 hours per year and meeting the 26,000 MMBtu/year limit, but operating almost 3 times the 876 hr/year limit, or a 100 MMBtu/hr flare operating 876 hours/year, but combusting more than 3 times the amount of dairy digester gas (87,600 MMBtu) than the 26,000 MMBtu/year limit.

Flare throughputs of those flares in Appendix A and would meet the 876 hr/year operational limits to qualify as *backup limited use* were rated at or below approximately 26,000 MMBtu/yr. Therefore, if either the 876 hr/yr limit or the 26,000 MMBtu/yr limit is exceeded for a given flare, the flare would not be considered a *backup limited use flare*, and therefore would be subject to the draft BACT Guideline 1.4.10.

6. **Comment:** Brightmark evaluated the cost effectives of standard enclosed flares and ultra-low NOx flares based on written quotes from a manufacturer of both flare types. These are attached as confidential redacted versions provided in a separate attachment for District use only. However, in general the quotes indicate that based on capital purchase expense and the incremental electrical cost of operating a 50 HP combustion air blower for 2,000 hours per year at $0.1885/kWh,[1] the cost of ultra-low NOx flares is far outside the range of cost-effectiveness in the District's Policy APR-1305 cost effectiveness guidance, updated June 2024, up to operating levels of at least 130,000 MMBtu/year. Please see Table 1 below that details the cost-effectiveness analysis of an ultra-low flare.

Table 1. Cost Effectiveness Analysis of Ultra-Low NOx Enclosed Flare

	0.06 lb/MMBtu Enclosed Flare (base case)	**0.025 lb/MMBtu Ultra-Low NOx Enclosed Flare**
Design Capacity	39.8 MMBtu/hour 1,000 scfm at maximum 64% CH_4	39.8 MMBtu/hour 1,000 scfm at maximum 64% CH_4
Combustion Air Blower Electric Motor Power	None	50 HP
Quoted One-Time Capital Equipment Cost	$550,000	$1,100,000
Incremental One-Time Capital Equipment Cost	N/A (base case)	$550,000
26,000 MMBtu/Year Threshold		
Expected NOx Emissions at 26,000 MMBtu/year	0.78 tons/year	0.33 tons/year
NOx Emissions Reduction	N/A (base case)	0.45 tons/year
Incremental Cost Effectiveness of Ultra-Low NOx at 26,000 MMBtu/year	-	$192,877/ton
100,000 MMBtu/Year Rule 4311 Compliance Option		
Expected NOx Emissions at 100,000 MMBtu/year	3.00 tons/year	1.25 tons/year
NOx Emissions Reduction	N/A (base case)	1.75 tons/year
Incremental Cost Effectiveness of Ultra-Low NOx at 100,000 MMBtu/year	-	$49,597/ton
130,000 MMBtu/Year (Approximate Cost Effectiveness Boundary)		
Expected NOx Emissions at 130,000 MMBtu/year	3.9 tons/year	1.63 tons/year
NOx Emissions Reduction	N/A (base case)	2.27 tons/year
Incremental Cost Effectiveness of Ultra-Low NOx at 130,000 MMBtu/year	-	$29,807/ton

[1] US Department of Energy, Energy Information Administration, average cost of industrial electricity to California facilities in 2023

The NOx cost-effectiveness threshold for mid-2024 to mid-2025 is $36,700/ton.[2] The ultra-low NOx flare is not cost-effective for each of the three scenarios in Table 1.

There are also incremental installation, operating, and repair costs, when compared to a traditional enclosed flare due to the additional complexity and electrical power requirements of a forced draft lean premix combustion system relative to a natural draft system. These costs have not been estimated for the purposes of this analysis but would further increase the level of operation under which ultra-low-NOx would not be cost effective.

Response: For flares that would be subject to the draft BACT Guideline 1.4.9, a low NOx flare is a technologically feasible option, where cost is a consideration under the District's BACT policy.

For flares that would be subject to the draft BACT Guideline 1.4.10, the cost of a low NOx flare is not an Achieved-in-Practice consideration under the District's BACT policy. Based on the District's survey, there is one low NOx flare that has been installed at a dairy digester site that is currently in operation (Madera DP2, LLC) with a valid Permit to Operate (PTO) in the Valley with a flaring throughput greater than 26,000 MMBtu/yr (i.e. not considered a *backup limited use flare*). Madera DP2 is not a pipeline injection facility. Its purpose is to produce electricity from the treated digester gas combusted in IC engines. Given that the low NOx flare is located at a site where excess gas is also combusted in engines, and such sites may have less need for flaring than a pipeline injection facility during the commissioning/proving period, the fact that such a facility has installed a low NOx flare and has a successful business operating history is presumptive evidence that a low NOx flare is not cost prohibitive for dairy digester gas operations generally. Thus, for flares that would be subject to BACT Guideline 1.4.10, the District has determined that a low NOx flare has been achieved in practice, and, therefore, a low NOx flare is required without performing a cost effectiveness determination.

[2] San Joaquin Valley Air Pollution Control (2024). *District Policy APR 1305 Best Available Control Technology (BACT)*. https://ww2.valleyair.org/media/041j2iew/apr-1305.pdf