Draft Further Study

Rule 4311 Flare Minimization Plans

2015

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San Joaquin Valley
AIR POLLUTION CONTROL DISTRICT

HEALTHY AIR LIVING™

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I. EXECUTIVE SUMMARY

The San Joaquin Valley air basin (Valley) faces unique and unprecedented air quality challenges in attaining the federal air quality standards (also called National Ambient Air Quality Standards, or NAAQS). The San Joaquin Valley Air Pollution Control District (District) must explore all available emission reduction opportunities in order to demonstrate attainment for multiple federal ozone and PM2.5 standards in the coming years. In an effort to leave no stone unturned, in its *2015 Plan for the 1997 PM2.5 Standard* (*2015 PM2.5 Plan*), the District committed to a further study to review submitted Flare Minimization Plans (FMPs) under District Rule 4311 (Flares) and identify the most effective flare minimization practices utilized by operators. As a result of this comprehensive study the District offers the following findings and recommendations:

1. **The District identified minimization practices currently performed at facilities that have the potential to be applied to other facilities.**

   a. **The District recommends conducting a thorough evaluation of the most effective flare minimization practices included in approved FMPs and requiring the implementation of these practices where technologically achievable and economically feasible**. Even though operators of flares in the Valley have already taken extensive measures to reduce flaring, through this study the District has identified effective minimization practices currently performed at some facilities that could be employed at other facilities to further reduce flaring. To further evaluate opportunities for emission reductions from flaring, the District will perform an exhaustive evaluation of these flare minimization practices in its upcoming 2016 ozone and PM2.5 attainment plans and propose potential rule amendments requiring the use of these practices where technologically achievable and economically feasible.

   b. **The District recommends exploring options to further promote the implementation of the most effective flare minimization practices during the FMP submittal and review process.** Under Rule 4311, FMPs are required to be submitted and approved for existing, new, and modified flaring systems. For existing systems, an updated FMP is required to be submitted and approved every five years. Working with operators to identify potential flare minimization practices during the FMP review process provides operators the opportunity to incorporate feasible flare minimization practices when new and modified systems are proposed and during the ongoing review of FMPs.

2. **Ultra low NOx technologies with the potential to further reduce emissions from flaring have recently become available. The District recommends conducting a thorough evaluation of new ultra low NOx control technologies for flaring and requiring the implementation of these technologies where technologically achievable and economically feasible.** Through this further study, the District has identified new low NOx control technologies that may serve as suitable options for further reducing NOx emissions from flaring in the San Joaquin Valley. To further evaluate opportunities for emission reductions from flaring, the District will perform an exhaustive evaluation of NOx emission reduction control technologies in its upcoming 2016 ozone and PM2.5 attainment plans and propose potential rule amendments requiring the use of these technologies where technologically achievable and economically feasible.

II. BACKGROUND

The development of the District's *2012 PM2.5 Plan* involved extensive research and analyses of technologies for potential opportunities to further reduce emissions of particulate matter (PM) and oxides of nitrogen (NOx), which is a predominant pollutant in the formation of fine particulate matter (particulate matter that is 2.5 microns or less in diameter, or PM2.5) and ozone. Although the results of the analyses for this plan did not indicate that regulatory action to further reduce flaring emissions would accelerate PM2.5 attainment, the District committed to continue evaluating flares through a further study measure. Furthermore, the District also committed to this further study in the District's *2013 Plan for the Revoked 1-Hour Ozone Standard.*

To satisfy these commitments, the District completed and published the *Rule 4311 (Flares) Further Study* report on September 16, 2014 (*2014 Study*).[1] In that study, District staff reviewed the submitted Flare Minimization Plans, Annual Monitoring Report data, Reportable Flaring Event data, and new NSPS requirements to identify and evaluate potential opportunities to further reduce emissions from flaring. In addition to the review committed in the plans, the District also reviewed the flare emission inventory in the Valley and analogous rules in other air districts in California. As a result of that extensive effort, the District made the following findings:

1. **Flare Emissions Comprise a Small Percentage of the Overall NOx Emissions in the Valley**
   A review of the flare emission inventory indicates that emissions from all flares operating in the Valley, regardless of permit status and requirements,

[1] SJVAPCD. (2014) *Rule 4311 (Flares) Further Study 2014.* Retrieved from http://www.valleyair.org/Air_Quality_Plans/docs/R4311.pdf.

contributed to 0.14% of the total annual NOx emitted from all Valley stationary and area sources in 2012. This is in part because these control devices are primarily engineered for emergency operation during process upsets and emergency situations and achieve 98% destruction efficiency when operated properly.[2]

2. **Rule 4311 is as Stringent as Other Air Districts' Rules**
District analysis confirmed that Rule 4311 is as stringent as similar rules in South Coast Air Quality Management District (SCAQMD), Bay Area Air Quality Management District (BAAQMD), Ventura County Air Pollution Control District (VCAPCD), and Santa Barbara County Air Pollution Control District (SBCAPCD). Those analogous rules have some minor differences in requirements, due to the differences in types of facilities and sizes of flares, which would not result in additional emission reductions if implemented in the Valley. Furthermore, Rule 4311 has been confirmed by EPA in its most recent approval of amendments to the rule as satisfying Reasonable Available Control Technology (RACT) requirements.

3. **Flare Minimization Plans Contain Effective Measures to Reduce Flaring**
In the Valley, 95 flares are either operated at petroleum refineries or have large enough flaring capacities to trigger the FMP requirements of Rule 4311. These flares are operated in multiple industries, including the oil and gas industry, wastewater treatment, and wine and cheese production. Operators with FMPs are including feasible measures in the FMPs and actively taking steps to reduce flaring at their facilities.

4. **Annual Monitoring Reports Assist with Enforceability**
Flares are subject to annual monitoring report requirements if the flare is subject to flare minimization plan requirements and can produce a reportable flaring event. Many Valley operators of flares are proactive in reducing flaring emissions by including Specific Limiting Conditions (SLCs) to their permits that limit the amount of flaring possible by their flare; consequently many of the 95 flares subject to FMP requirements are not required to submit annual monitoring reports. Annual monitoring reports are submitted from a variety of industries including, but not limited to, oil and gas production, wastewater treatment, and wine and cheese making. The annual monitoring reports add an important layer of enforceability to Rule 4311 by providing inspectors with verifiable data to ensure that larger sources of flaring are compliant.

[2] U.S. EPA Office of Air Quality Planning and Standards, "Parameters for Properly Designed and Operated Flares". 2012. Retrieved from http://www.epa.gov/ttn/atw/flare/2012flaretechreport.pdf.

5. Reportable Flaring Events are Non-repeating

A flaring event is considered a "Reportable Flaring Event" if, during a 24-hour period, more than 500,000 standard cubic feet (scf) of vent gas is flared or sulfur oxide emissions are greater than 500 pounds. Of the 235 flares in the Valley, 21 experienced reportable flaring events in the 2011-2012 reporting period. Most of these reportable flaring events were planned flaring events and were due to new equipment installations—some of which were new air pollution control devices—and repair or maintenance at the facilities. Since most of the events were due to equipment installation or repair, they are not likely to occur again in the near future. Of the gas flared, only 20% was salable quality.

6. Flared Gas Occurs Under Abnormal Conditions

To provide a more in-depth look at different flaring scenarios in the Valley the District performed case studies of flaring events at a light-oil production facility and a wastewater treatment plant (WWTP). Both facilities experienced abnormally high flaring activities over periods of several months.

The by-product of light-oil production, generally referred to as off-gas, is a high quality gas; therefore, these facilities normally sell as much of the off-gas as possible. However, in this aberrant instance, the light-oil production facility discussed in the case study was unable to sell the gas during the 2012-2013 reporting period because the sales transmission pipeline was offline for repairs. The facility had no other feasible options to flaring.

Wastewater treatment plants produce waste gas that has a far lower heating value than the off-gas from oil production facilities and requires more extensive treatment prior to use; it is therefore not considered to be salable. In the WWTP case study, the flare gas produced by the facility is normally sent as a supplemental fuel to onsite equipment used to produce electricity and generate heat for some of the treatment processes. However, during the 2011-2012 reporting period, the waste gases could not be sent to the equipment because additional air pollution control devices were being installed.

As seen from the case studies, gas is typically flared only under abnormal conditions. Most facilities actively avoid flaring because these control devices only operate during process upsets and emergency situations.

7. Rule 4311 Requirements are more stringent than Federal NSPS Requirements

The 2012 promulgated NSPS requirements in 40 CFR 60 subparts Ja and OOOO do not implement requirements that are more stringent than those already implemented in District Rule 4311. Therefore, Rule 4311 satisfies the requirements of these NSPS requirements.

In the *2014 Study*, the District concluded that operators of flares in the Valley were subject to the most stringent emission requirements and were proactively implementing alternatives and committing to activities that reduce flaring. Based on that conclusion, the District recommended no rulemaking action for Rule 4311 at that time.

On April 16, 2015, the District's Governing Board adopted the *2015 Plan for the 1997 PM2.5 Standard* (*2015 PM2.5 Plan*)[3]. As demonstrated in the District's *2015 PM2.5 Plan*, Rule 4311 already meets the Environmental Protection Agency's (EPA) Best Available Control Measures (BACM) and Most Stringent Measure (MSM) requirements. In fact, EPA approved Rule 4311 as satisfying all applicable federal requirements on November 3, 2011.[4] However, due to the need to demonstrate attainment for multiple federal ozone and PM2.5 standards in the coming years and the need to search for all available emissions reductions, the District committed to undertaking a comprehensive review of FMPs submitted under Rule 4311, publish a draft report for public review and commenting by December 1, 2015, and finalize the report by March 31, 2016 after receiving input from flare operators and addressing public comments. This further study includes the following elements:

1. *Review submitted FMPs to identify the most effective flare minimization practices utilized by operators to reduce flaring in various source categories and applications. Upon completion of review, work closely with affected operators to evaluate and implement, when feasible, the most effective flare minimization practices through the FMP submittal and approval process under Rule 4311.*

2. *Evaluate the technological achievability and economic feasibility of implementing new/additional minimization practices or technologies at affected facilities.*

[3] SJVAPCD. (2015). *2015 Plan for the 1997 PM2.5 Standard*. Retrieved from http://www.valleyair.org/Air_Quality_Plans/PM25Plans2015.htm
[4] EPA. 76 Federal Register 213, 68106-68107. 11/3/2011. http://www.gpo.gov/fdsys/pkg/FR-2011-11-03/pdf/2011-28391.pdf

III. WHAT IS FLARING?

Flares serve two basic functions: 1) as an emission control device for VOC emissions, and/or 2) as a safety device during unforeseeable and unpreventable emergency situations. Any unreasonable restrictions on flaring could potentially result in catastrophic consequences which may lead to explosions resulting in loss of property, injury and potentially loss of human life.

Flaring is a high temperature oxidation process used to burn mostly hydrocarbons of waste gases from industrial operations, with a destruction efficiency of 98 percent or greater. During combustion, gaseous hydrocarbons react with atmospheric oxygen to form carbon dioxide (CO_2) and water. Flares used for emergency situations generally have large flaring capacities to enable them to handle large volumes of gas. Emergency situations, as defined in District Rule 4311, include any situation or condition arising from a sudden and reasonably unforeseeable and unpreventable event beyond the control of the operator and requiring immediate corrective action to restore safe operation at the facility or site. Examples of emergency events include, but are not limited to, equipment failure, natural disasters, external power curtailment, and acts of terrorism. Operators consider feasible alternatives to flaring because it is generally costly, and therefore avoided when possible.

A. General Equipment Description

There are two general types of flares: elevated and ground flares. Flares are further categorized by the height of the flare tip, and by the method of enhancing combustion by mixing at the flare tip (i.e., steam-assisted, air-assisted, pressure-assisted, or non-assisted).

Elevated flares are more common in the Valley and have larger capacities than ground flares. In an elevated flare, a waste gas stream is fed through a stack and is combusted near the tip of the stack. An elevated flare consists of five components: a gas collection header (to collect gases from various process units); a proprietary seal; a water seal, or purge gas supply (to prevent flash back); a single or multiple-burner unit in the flare stack; and gas pilots and an igniter. Figure 1, below, depicts a typical configuration for a steam-assisted elevated flare.

Ground flares, which are not typically found in the Valley, vary in complexity and can consist of either conventional flare burners discharging horizontally with no enclosures or multiple burners in refractory-lined steel enclosures.

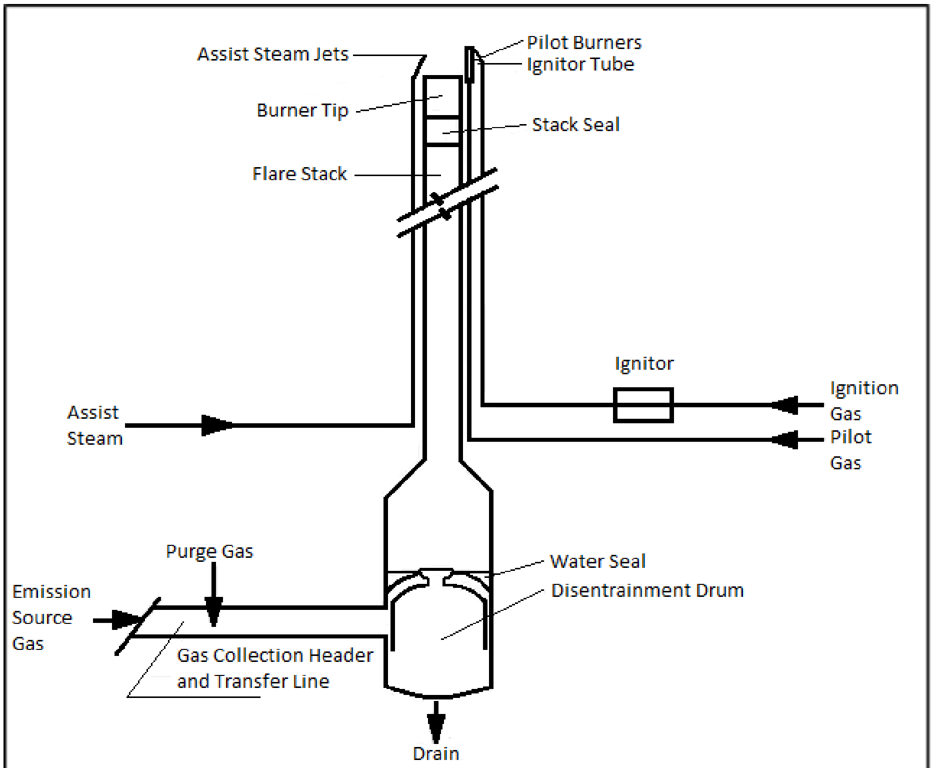

Figure 1. Flare Diagram[5]

B. General Process Description

Complete combustion requires proper mixing of air and gas. Smoking may result from incomplete combustion, depending upon the flare gas components and the quantity and distribution of combustion air. Gases containing methane, hydrogen, CO, and ammonia usually burn without smoke, while gases containing heavy hydrocarbons may cause smoke.

The tendency of a fuel to smoke or make soot is influenced by fuel characteristics and by the amount and distribution of oxygen in the combustion zone. Fuel characteristics include the carbon-to-hydrogen ratio and the molecular structure of the gases to be burned. Soot is eliminated by adding steam or air; hence, most industrial flares are steam-assisted and some are air-assisted. Flare gas composition is a critical factor in determining the amount of steam necessary.

Air is supplied to the flame as primary and secondary air. Primary air is mixed with the gas before combustion. If the amount of primary air is insufficient, the gases entering

[5] EPA. (1995). *13.5 Industrial Flares.* Retrieved from http://www.epa.gov/ttnchie1/ap42/ch13/final/c13s05.pdf

the base of the flare are preheated by the combustion zone, and larger hydrocarbon molecules crack to form hydrogen, unsaturated hydrocarbons, and carbon. The carbon particles may escape further combustion and cool down to form soot or smoke.

An external momentum force, such as steam injection, is used for turbulence and efficient mixing of air and waste gas, which promotes smokeless flaring of heavy hydrocarbon waste. Other external forces may also be used, including water spray, high velocity vortex action, or natural gas. External momentum force is rarely required in ground flares.

Combustion efficiency depends on flame temperature, residence time in the combustion zone, vent gas flammability, auto ignition temperature, heating value measured in British thermal units per standard cubic feet (Btu/scf), and turbulent mixing. Through combinations of these factors, flares have a destruction efficiency of 98 percent or greater. Complete combustion converts all volatile organic compounds (VOCs) to CO_2 and water.

Flare gases must have a fuel value of at least 200 to 250 Btu/ft^3 for complete combustion; otherwise another fuel must be added to achieve the required value. Flares for which supplemental fuel must be supplied are known as “fired” or “endothermic” flares. In some cases, even flaring gases with the necessary heat content will require supplemental heat to ensure complete combustion.

Flares are normally used to dispose of low volume continuous streams of gases but are designed to handle large quantities of gases associated with potential plant emergencies. As safety devices, it is necessary for flares to have high volume capacities so that they may prevent injury and loss of property during unforeseeable and unpreventable emergency situations. Emergency flaring occurs when necessary, to prevent an accident, hazard, or release of vent gas directly into the atmosphere. Emergency events may occur because of process malfunctions, relief valve leakage, power outages, and equipment breakdown. Consequently, flare gas volumes can vary from a few cubic feet per hour during regular operations up to several thousand cubic feet per hour under emergency conditions.

IV. FLARING IN THE SAN JOAQUIN VALLEY

The information in this section is based on data analysis from the District’s *Rule 4311 (Flares) Further Study* report published on September 16, 2014.[6]

[6] SJVAPCD. (2014) *Rule 4311 (Flares) Further Study 2014.* Retrieved from http://www.valleyair.org/Air_Quality_Plans/docs/R4311.pdf.

There are 235 flares in the Valley subject to Rule 4311 requirements. Of those 235 flares, 126 are exempt (except for recordkeeping requirements) from District Rule 4311 because they are subject to the requirements of District Rule 4642 (Solid Waste Disposal Sites), subject to the requirements of 40 CFR 60 Subpart WWW (Standards of Performance for Municipal Waste Landfills), subject to the requirements of 40 CFR 60 Subpart Cc (Emission Guidelines and Compliance Times for Municipal Solid Waste Landfills), or are operated at stationary sources with the potential to emit for all processes of less than 10 tons per year of VOC and less than 10 tons per year of NOx. However, all new or modified flares are subject to New Source Review (NSR) requirements including Best Available Control Technology (BACT), meaning they may be required to implement even more stringent controls regardless of whether or not they are subject to the requirements of Rule 4311.

Of the 109 flares in the Valley subject to Rule 4311 requirements, 95 are subject to FMP requirements. The remaining 14 flares are not required to submit FMPs to the District because they have a flaring capacity less than 5.0 MMBtu/hr and are operated at facilities other than petroleum refineries.

Flares subject to Rule 4311 requirements in the Valley are utilized by a diverse group of industries as illustrated by Table 1 below.

Table 1. Facility Types for Flares that Submitted FMPs

Facility Type	# of Flares
Oil and Gas Production	68
Petroleum Refining	7
Natural Gas Processing	6
Natural Gas Transmission	2
Wastewater Treatment (Wastewater Treatment Plants, Cheese Production, Wineries, Dairy, Beef Packer)	10
Miscellaneous (Correctional Facility, Flat Glass Manufacturer)	2
Total	**95**

The majority of the Valley flares are standby or emergency flares. Standby flares are only utilized intermittently to dispose of gas during maintenance or periods when gas is in excess of steady state gas collection system capacity, and are not used as a method of primary disposal for collected gases. Emergency flares are only used during emergency events, which include any situation or condition arising from a sudden and reasonably unforeseeable and unpreventable event beyond the control of the operator and requiring immediate corrective action to restore safe operation at the facility or site.

Of the 95 facilities subject to FMP requirements, 92 are permitted for standby or emergency use, while only 3 are permitted as primary disposal devices.

Due to their limited use, flares are currently a small contributor to overall Valley emissions. The emissions from all 235 flares operating in the Valley contributed 0.14% of the total annual NOx and 0.17% of total annual PM2.5 emitted from all stationary, area, and mobile sources in 2012.

V. FLARE MINIMIZATION PLANS

A. Rule 4311 Flare Minimization Plan (FMP) Requirements

Sections 5.8 and 6.5 of District Rule 4311 require an FMP be submitted to and approved by the District for any petroleum refinery with a flare or any flare with a flaring capacity greater than or equal to 5.0 MMBtu/hr. The rule prohibits facilities subject to FMP requirements from flaring unless it is consistent with a District-approved FMP and all commitments in that FMP have been met. To ensure FMPs are up-to-date without undue redundancy in paperwork requirements from stakeholders, FMPs are to be updated every five years. Updates to the FMP are also required to address any new or modified equipment that requires an Authority to Construct permit and impacts emissions from the flare.

Pursuant to Section 6.5.1, FMPs submitted to the District are required to include at least the following information:

- Description and technical specifications for each flare and associated knock-out pots, surge drums, water seals and flare gas recovery systems

- Process flow diagrams of upstream equipment and process units venting to each flare, identifying the type and location of all control equipment

- Description of equipment, processes, or procedures the operator plans to install or implement to eliminate or minimize flaring, and planned date of installation or implementation

- Evaluation of prevention measures to reduce flaring that has occurred or may be expected to occur during planned major maintenance activities, including startup and shutdown

- Evaluation of preventative measures to reduce flaring that may be expected to occur due to issues of gas quantity and quality. This includes an audit of vent gas recovery capacity of each flare system, storage capacity for excess vent gas, and scrubbing capacity available for vent gas for use as a fuel as well as determination of the feasibility of reducing flaring through the recovery, treatment and use of the gas.

- Evaluation of preventative measures to reduce flaring caused by the recurrent failure of air pollution control equipment, process equipment, or a process to operate in a normal or usual manner. This includes determination of adequacy of existing maintenance schedules and protocols for such equipment. A failure is considered recurrent if it occurs more than twice during any five year period as a result of the same cause.

B. Flare Minimization Practices

District staff with extensive expertise in flare operations conducted a detailed review of all approved FMPs to identify the variety of flare minimization practices used by affected facilities. In addition, District staff also worked closely with affected facilities to gain more in-depth understanding of the minimization practices.

In reviewing the FMPs, the District found a variety of flare minimization practices specific to each facility that could potentially be employed at other facilities to further reduce flaring at their operations. These practices may not only serve to reduce flaring activities and associated emissions but may also provide economic, safety, and other benefits to affected facilities. Because of the unique nature of each facility, the technological achievability and economic feasibility of transferring these minimization practices or technologies from one facility to another will require further analysis.
A description of effective flare minimization practices identified in approved FMPs is presented below:

Alternatives to Flaring

One way to prevent flaring is to capture the gas and utilize it for some beneficial purpose as flaring can be a waste of a precious resource. The following alternative uses for flare gas were identified in submitted FMPs to minimize flaring.

- **Use gas as a fuel for equipment rather than flaring.** Capturing gas and routing it into a fuel gas system to power various processes is a great means of utilizing gas that would otherwise be flared. There is a financial incentive to utilize this practice to the greatest extent feasible across all facility types as the gas can be used to supplement, or in some cases even completely supply, the process energy needed, (i.e. IC engines) to produce electricity, and boilers for steam generation and process heating.

There are several barriers with implementing this practice. Some facilities do not have a use for combustion equipment on-site. For those that do have a use for the combustion equipment, it may not be economically feasible to purchase, install and operate such equipment, the multiple stages of treatment equipment to make the gas suitable for use at the facility, and the infrastructure required to connect process streams and utilities to the fuel gas system. Additionally, the installation of extra equipment to handle the waste gas can potentially add more complexity to the maintenance and testing, and can increase the number of potential points of failure.

- **Injection of oil field gas into DOGGR-approved disposal wells**. Reinjection of gas into subsurface geologic formations disposal wells is a potential alternative to flaring. These wells are regulated by the California Department of Conservation, Division of Oil, Gas and Geothermal Resources (DOGGR). However, the permits for these wells can be extremely difficult to obtain from the state, and require significant capital investment to complete the various studies and installation of infrastructure in California. Additionally, the permits place a limit on volume reinjected that if exceeded requires the facility to dispose of gas by other means.

- **Send oilfield gas to a sales gas line**. Gas that is of high enough quality (i.e. high energy content, low sulfur or nitrogen content) can be sold through a sales gas line. There can be many barriers associated with this alternative including proximity to an existing gas line, quantity and quality of gas generated, and the economics of purchasing, installing, and maintaining a new sales gas line and all the associated treatment and transmission equipment and infrastructure.

Maintenance and Testing

A proactive and preventative maintenance and testing program can greatly reduce flaring by minimizing downtime from equipment failure. Furthermore, testing helps predict potential equipment failure and provides an opportunity to coordinate repair/replacement in a way that reduces flaring. If failures occur unexpectedly, the equipment may need to be taken offline immediately, requiring gas to be routed to flares to prevent an unsafe situation. The following maintenance and testing practices were identified in submitted FMPs to minimize flaring.

- **Implement a preventative maintenance program to predict failure in pipelines and stationary equipment (measure corrosion).** The gas going through pipelines and stationary equipment can be very corrosive. A predictive method such as using x-rays to measure pipe thickness is used to determine when to replace the equipment. This testing is performed on a periodic basis as dictated by the equipment type and the service it is in.

- **Install high-pressure alarms on process vessels**. Installation of alarms on process vessels can indicate a high pressure build-up (before pressure relief valves opens and directs gasses to flares) so that operators can intervene before flaring occurs.

- **Inspect pressure relief valves routinely to ensure proper operation**. If a pressure relief valve improperly seats or is otherwise defective, gases will leak and be combusted in the flare. In an attempt to reduce such occurrences, the pressure relief valves can be inspected periodically.

- **Maintain and calibrate flare gas control valves on a routine schedule**. Flare gas lines are typically equipped with control valves to regulate the volume of gas going to flares. Should these valves malfunction, it is possible that excessive gas would be directed to the flare. These valves could be calibrated on a routine schedule.

- **Retain spare parts onsite to minimize system downtime**. Quick and easy access to spare parts reduces equipment downtime and associated flaring. While the economic feasibility of purchasing and maintaining backup equipment will need to be considered on a case-by-case basis for each facility, some facilities maintained the following types of equipment onsite to minimize flaring:

    - **Compressors**. Compressors are ubiquitous in the gas and petroleum industry and play a critical role in many different stages of oil and gas production, processing/refining, and transmission.

    - **Sulfur scrubber components/media**. If the sulfur scrubber system is down, the fuel cannot be processed for onsite use and must be flared instead.

    - **Spare parts for primary combustion equipment (blowers, etc.)**. If the primary combustion equipment is down, the fuel cannot be utilized onsite and must be flared instead.

Procedures to Reduce Flaring during Maintenance and Shutdowns

Another effective flare minimization measure is to optimize and coordinate maintenance activities so that equipment failure and downtime is minimized to the extent feasible. A proactive and preventative maintenance program can greatly reduce downtime and thereby minimize flaring. However, during maintenance and shutdown events, operators can take additional measures to avoid or reduce flaring. The following procedures were identified in submitted FMPs.

- **Perform maintenance on one area without impacting other operations on site.** Designing a facility in a manner that allows maintenance to be performed in one area of a facility without affecting other operations can reduce flaring. This allows the other operations to continue normally without the need to flare excess gas.

- **Curtail oil/gas production during planned shutdown of sales line**. In the event of a planned shutdown of a sales gas pipeline, and/or major maintenance activities, oil/gas production can be curtailed. This could potentially result in lost revenue.

- **Close oil well casing vents during vapor control system maintenance**. Casing gas remains in reservoir instead of being flared, but this can potentially result in reduced oil production rate until vents are opened.

- **Store gas in bladder tank.** For waste water treatment plants, limited amounts of digester gas can be stored in bladder tanks during maintenance, testing, or process upsets and later be routed to combustion devices for beneficial use on-site.

- **Plan maintenance activities during optimal periods.** Scheduling maintenance during periods of minimum capacity needs and/or following planned process unit shutdowns has the potential of minimizing flaring activities.

- **Optimize planned shutdowns for major maintenance.** Most inspection, repair, and minor maintenance work can be performed while a facility is in operation. However, there are times when a facility has to shut down and flare process gas to conduct major maintenance work. The management of a facility shutdown is known as a “turnaround”. Scheduled facility shutdowns are expensive and labor intensive due to the loss of production and the expense of the turnaround itself. While turnaround procedures are primarily focused on minimizing downtime, the following specific procedures were identified in submitted FMPs to minimize flaring during plant turnaround.
  - Have extra personnel on site to re-start the plant as quickly as possible
  - Recycle discharge gas back to compressor inlets until minimum operating pressure is obtained
  - Prior to turnaround, identify critical equipment to be serviced to avoid refinery downtime and associated flaring
  - Phase equipment and process unit shutdowns to minimize fuel gas imbalances that may result in additional flaring
  - Identify alternate disposition of process gases to minimize flaring;
  - Identify key process unit operations such as fuel gas systems and sulfur recovery operations that must remain in operation to minimize flaring of sulfur-containing gases
  - Phase equipment and process unit start-ups to minimize start-up duration and the flaring associated with these transitional operations

Redundant Systems

Even with the most rigorous and proactive maintenance programs in place, there is always the potential for critical equipment failure. Installing redundant systems minimizes the potential of downtime by allowing operators to quickly switch from one system to another in the event of equipment failure or during maintenance. The following redundant systems were identified in FMPs to minimize flaring.

- **Redundant compressors.** Compressors can fail, and as a result the gas may need to be flared. Installation of a redundant secondary compressor can minimize flaring when the primary compressor is down.

- **Redundant gas treatment systems (sulfur scrubber).** This allows gas to continue to be treated and burned in combustion equipment when one unit is not available.

- **Redundant digester gas-fired turbines.** Some wastewater treatment plants have incorporated redundant digester-gas-fired turbines into their system design. The redundant system allows the turbines to be maintained without the need to flare. This has potential to reduce a considerable amount of flaring, as the turbines for these types of operations typically require frequent maintenance. In addition, a redundant system reduces downtime and extends the life of the turbines.

Procedures to Prevent or Mitigate the Effects of Power Outages to Reduce Flaring

A power outage has the potential to result in flaring as vapors are sent to flares to protect the facility from being over-pressurized. The following specific procedures were identified in submitted FMPs to mitigate the effects of power outages and reduce flaring.

- **Backup generators.** Install emergency IC engine/generators to power equipment during power outages.

- **Power outage alarm.** Send alarms to all operators when power outage occurs to ensure rapid response.

- **Infrared testing.** Implement infrared testing of electrical equipment on a routine basis to identify hot-spots that could result in a power outage.

- **Avian guards.** Install avian guarding in substations to deter birds from contacting energized equipment.

VI. FLARE CONTROL TECHNOLOGY EVALUATION

As a component of this further study, the District evaluated the feasibility of new ultra low NOx flare emission control technologies. While the modernization of flare technology will not reduce the frequency or volume of flaring activities, it can reduce the emissions from such activities, thereby accomplishing the same end goal.

The District has identified a new class of VOC destruction devices that are similar to enclosed flares but operate with mixing controls and are being put into practice in the petroleum industry as control devices. These devices offer ultra low NOx emissions of approximately 0.02 lb NOx/MMBtu (compared to existing District Rule 4311 requirement of 0.068 lb NOx/MMBtu). These devices may not considered flares by the Rule 4311 definition, but are an alternative method for VOC control. One Permit to Operate and at least eight Authority to Construct permits have been issued to facilities in the Valley for these new devices.

These new devices may not be a viable replacement for some emergency flares, particularly those with high intermittent gas volume capacity requirements. These devices appear suitable for use at sites with more predictable gas disposal needs. To further evaluate opportunities for emission reductions from flaring, the District will perform an exhaustive evaluation of NOx emission reduction control technologies in its upcoming 2016 ozone and PM2.5 attainment plans and propose potential rule amendments requiring the use of these technologies where technologically achievable and economically feasible.

VII. FURTHER STUDY FINDINGS AND RECOMMENDATIONS

As a result of this comprehensive study the District offers the following findings and recommendations:

1. **The District identified minimization practices currently performed at facilities that have the potential to be applied to other facilities.**

   a. **The District recommends conducting a thorough evaluation of the most effective flare minimization practices included in approved FMPs and requiring the implementation of these practices where technologically achievable and economically feasible**. Even though operators of flares in the Valley have already taken extensive measures to reduce flaring, through this study the District has identified effective minimization practices currently performed at some facilities that could be employed at other facilities to further reduce flaring. To further evaluate opportunities for emission reductions from flaring, the District will perform an exhaustive evaluation of these flare minimization practices in its upcoming 2016 ozone and PM2.5 attainment plans and propose potential rule amendments requiring the use of these practices where technologically achievable and economically feasible.

b. **The District recommends exploring options to further promote the implementation of the most effective flare minimization practices during the FMP submittal and review process.** Under Rule 4311, FMPs are required to be submitted and approved for existing, new, and modified flaring systems. For existing systems, an updated FMP is required to be submitted and approved every five years. Working with operators to identify potential flare minimization practices during the FMP review process provides operators the opportunity to incorporate feasible flare minimization practices when new and modified systems are proposed and during the ongoing review of FMPs.

2. **Ultra low NOx technologies with the potential to further reduce emissions from flaring have recently become available. The District recommends conducting a thorough evaluation of new ultra low NOx control technologies for flaring and requiring the implementation of these technologies where technologically achievable and economically feasible.** Through this further study, the District has identified new low NOx control technologies that may serve as suitable options for further reducing NOx emissions from flaring in the San Joaquin Valley. To further evaluate opportunities for emission reductions from flaring, the District will perform an exhaustive evaluation of NOx emission reduction control technologies in its upcoming 2016 ozone and PM2.5 attainment plans and propose potential rule amendments requiring the use of these technologies where technologically achievable and economically feasible.

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