air pollution control district
SANTA BARBARA COUNTY

Rule 364 Refinery Fenceline Monitoring Plan Guidelines

December 2019 – Draft

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1. Executive Summary

The Santa Barbara County Air Pollution Control District (District) is proposing to adopt District Rule 364 – Refinery Fenceline and Community Air Monitoring. The purpose of District Rule 364 is to require a real-time fenceline air monitoring system at the petroleum refinery in the District and to fund a refinery-related community air monitoring system that provides air quality information to the public and local response agencies about levels of various criteria air pollutants, volatile organic compounds, and other toxic air contaminants in the community.

Rule 364 requires that refinery operators submit a written fenceline air monitoring plan for establishing and operating a real-time fenceline air monitoring system. Therefore, District staff developed the Rule 364 – Refinery Fenceline Air Monitoring Plan Guidelines (Guidelines) as a written framework to be used by the Control Officer to evaluate the refinery's air monitoring plan. By design, these Guidelines will inform petroleum refinery operators about the elements necessary to complete an air monitoring plan. The plan should be tailored to the facility's size, operations, emission profile, specific location, and its surrounding receptors.

A fundamental requirement of Rule 364 is that a fenceline air monitoring plan must provide detailed information about the installation, operation and maintenance of a fenceline air monitoring system. A fenceline air monitoring system is defined as a combination of equipment that measures and records air pollutant concentrations at or near the property boundary of a petroleum refinery. An effective fenceline air monitoring system should be capable of measuring routine emissions from the refinery and detecting leaks, as well as unplanned releases from refinery equipment and other sources of refinery-related emissions. The fenceline air monitoring system would inform refinery operators and the public about air pollution impacts to the nearby communities.

Developing an air monitoring plan requires three important steps:

1) Identification of emissions sources and affected communities,
2) Deriving a fenceline air monitoring system that can provide real-time information about certain air pollutant levels, and
3) Effectively communicating this information using data management technology and displays.

An approvable fenceline air monitoring plan shall meet the following key objectives:

- Provide information about various air pollutant levels that are measured in real-time in durations short enough to adequately address significant emissions changes from refinery operations;
- Gather accurate air quality and meteorological data to identify both the time(s) and location(s) of various air pollutant levels near refinery operations and provide a comparison of these levels to other pollutant levels monitored in the area;

- Track long-term air pollutant levels, variations, and trends over time at or near the property boundaries of the petroleum refinery and in the nearby communities;
- Provide context to the data so that local communities can distinguish air quality in their location from other locations in the area and understand the potential health impacts associated with local air quality near petroleum refinery operations;
- Provide a notification system for communities near refineries when emissions exceed thresholds (e.g., RELs); and
- Provide quarterly reports summarizing the measurements, data completeness, and quality assurance.

Rule 364 sets-forth requirements for air monitoring plans. The air monitoring plan shall include detailed information for the following:

- An evaluation of routine emission sources at the refinery (e.g., utilizing remote sensing or other measurement techniques or modeling studies, such as those used for health risk assessments);
- An analysis of the distribution of operations and processes within the refinery to determine potential emission sources;
- An assessment of air pollutant distribution in surrounding communities (e.g., mobile surveys, gradient measurements, and/or modeling studies used for health risk assessments);
- A summary of fenceline air monitoring instruments and ancillary equipment that are proposed to continuously measure, monitor, record, and report air pollutant levels in real-time near the petroleum refinery facility perimeter (i.e., fenceline);
- A summary of instrument specifications, detectable pollutants, minimum and maximum detection limits for all air monitoring instruments;
- Proposed monitoring equipment siting and selected pathways (when applicable) for fenceline instruments, including the justification for selecting specific locations based on the assessments mentioned above;
- Operation and maintenance requirements for the proposed monitoring systems;
- An implementation schedule consistent with the requirements of Rule 364;
- Procedures for implementing quality assurance and quality control of data;
- A web-based system for disseminating information collected by the fenceline air monitoring system;
- Details of the proposed public notification system; and
- Demonstration of independent oversight.

This information will assist the Control Officer in determining the approval status of an air monitoring plan during the plan review process required by Rule 364.

2. *Fenceline Air Monitoring Systems*

A fenceline air monitoring system shall take into account the geospatial layout of the refinery site, potential release sources, local meteorology, atmospheric dispersion characteristics of the compounds of concern, the relative risk to likely receptors based on these criteria, and other considerations outlined in Table 1 below.

TABLE 1: FENCELINE AIR MONITORING PLAN CHECKLIST

	Fenceline Air Monitoring Coverage (or Spatial Coverage)
☑	Identify the facility's proximity to sensitive receptors affected by the refinery operation and provide the information below:
	Distance from facility to closest sensitive receptors
	Location of downwind and upwind communities
	Eminent sources of non-refinery emissions surrounding the facility
	Dispersion modeling *
☑	Describe historical facility emission patterns and pollutant hotspots based on the following:
	On-site location of operations and processes, and their level of emissions
	Facility plot plans and topography
	Dispersion modeling *
☑	Select sampling locations along the perimeter of the facility based on the information above. Also, provide the following:
	Locations where equipment will be sited (e.g., GIS coordinates) and measurement pathways
	Elevations of equipment and pathways
	A description of how the monitoring system will cover all nearby downwind communities
	Fenceline Air Monitoring Equipment Description
☑	Select fenceline air monitoring equipment that is capable of continuously measuring air pollutants in real-time and provide the following:
	Specifications for the fenceline instruments (e.g., detection limits, time resolution, etc.)
	Explanation of the operation and maintenance requirements for selected equipment
	Substantiate any request to use alternative technologies
☑	Monitor for the pollutants listed in Table 1 of Rule 364 and include the following:
	Specify pollutant detection limits for all instruments and paths measured
	Quality Assurance
☑	Develop a Quality Assurance Project Plan (QAPP) that describes the following:
	Quality assurance procedures for data generated by the fenceline air monitoring system (e.g. procedures for assessment, verification and validation)
	Standard operating procedures (SOP) for all measurement equipment
	Routine equipment and data audits

TABLE 1 (CONTINUED)

Data Presentation to the Public	
☑	Design a data display website that includes the following:
	Educational material that describes the objectives and capabilities of the fenceline air monitoring system
	A description of all pollutants measured and measurement techniques
	A description of background levels for all pollutants measured and provide context to levels measured at the fenceline
	Procedures to upload the data and ensure quality control
	Definition of QC flags
	Hyperlinks to relevant sources of information
	A means for the public to provide comments and feedback; Procedures to respond to the feedback
	Archived data that with data quality flags, explain changes due to QA/QC and provide chain of custody information
	Quarterly data summary reports, including relationship to health thresholds, data completeness, instrument issues, and quality control efforts
Notification System	
☑	Design a notification system for the public to voluntarily participate in, that includes the following:
	Notifications for activities that could affect the fenceline air monitoring system (e.g., planned maintenance activities or equipment failures)
	Notifications for the availability of periodic reports that inform the community about air quality
	Triggers for threshold exceedances (e.g. Acute Reference Exposure Levels (RELs))
	Communication methods for notifications, such as, website, mobile applications, automated emails/text messages and social media

* Dispersion modeling shall be conducted using U.S. EPA's Preferred and Recommended Air Quality Dispersion Model (e.g., Health Risk Assessment).

Details about each of these key considerations are explained below.

A. Multi-Pollutant Monitoring

Multi-pollutant monitoring is a means to broaden the understanding of air quality conditions and pollutant interactions, furthering capabilities to evaluate air quality models, develop emissions control strategies, and support research and health studies. Petroleum refineries and activities associated with them emit a wide range of air pollutants, including criteria pollutants (SOx and NOx), reactive organic compounds (ROCs), and toxic air contaminants (benzene, toluene, formaldehyde, and hydrogen sulfide).

Chemical compounds associated with health risk and those measured at other ambient air monitoring locations should be identified in the air monitoring plans. Identification of the health risk drivers can be informed by the health risk assessment studies performed at the refinery, as well as other information regarding potential health risk near the refinery. Additional chemicals may be of interest to monitor as a part of the fenceline air monitoring system and may be included in the reporting for additional public information.

The California Environmental Protection Agency's (CalEPA) Office of Environmental Health Hazard Assessment (OEHHA) is collaborating with the California Air Resources Board (CARB) and the Interagency Refinery Task Force to identify and develop information on chemicals emitted from refineries and their health effects in order to assist air agencies in developing plans for air monitoring at refineries in California. In March 2019, OEHHA published a report[1] that presents a comprehensive list of chemicals emitted from California refineries, including emissions that occur routinely in daily operations as well as accidental and other non-routine emissions. The list prioritizes the chemicals according to their emissions levels and toxicity, providing a list of chemicals that would be top candidates for air monitoring near refineries according to the volume of the chemicals emitted and their toxicity. The presence of a chemical on this comprehensive list does not necessarily mean it is released from all refineries at all times or in significant quantities.

The potential compounds emitted from refineries that pose the highest health risk in nearby communities should be identified along with the appropriate monitoring technologies selected to measure them. This assessment should be informed by the OEHHA report on Refinery Chemical Emissions and Health Effects Report. The chemical compounds of interest for Rule 364 are presented in Table 2 below.

Table 2- Refinery-Related Air Pollutants to be Addressed by Fenceline Air Monitoring Plans

Air Pollutants	
Sulfur Dioxide (SOx as SO_2)	**BTEX Compounds** (Benzene, Toluene, Ethylbenzene, Xylenes)
Nitrogen Oxides (NOx as NO_2)	
Total ROCs	**Hydrogen Sulfide** (H_2S)
Formaldehyde	**Carbonyl Sulfide**
Acetaldehyde	**Ammonia**
Acrolein	**Black Carbon or $PM_{2.5}$**
1,3-Butadiene	**Hydrogen Cyanide**
Styrene	

A brief description of the refinery-related air pollutants is listed below.

[1] Analysis of Refinery Chemical Emissions and Health Effects – Report. March 20, 2019 (https://oehha.ca.gov/air/analysis-refinery-chemical-emissions-and-health-effects)

i. Sulfur Dioxide (SOx as SO_2)

SO_2 is the criteria pollutant that is the indicator of SOx concentrations in the ambient air and can have direct health impacts and can cause damage to the environment. Heating and burning of fossil fuel releases the sulfur present in these materials and results in the formation of SO_2. The major sources of SO_2 at refineries are the fuel fired in process heaters and boilers, fluidized catalytic cracking (FCC) units, sulfur recovery units, and flares. As a result, measurement of this compound will help identify the potential contribution of a refinery to the ambient concentrations in nearby communities.

ii. Nitrogen Oxides (NOx as NO_2)

NOx is a group of highly reactive gases that contribute to the formation of ground-level ozone, as well as secondary particles such as $PM_{2.5}$. Scientific evidence links NO_2 exposures with adverse respiratory effects and is one of the criteria pollutants, making it a compound that is routinely measured in ambient air monitoring networks. Both gasoline and diesel-powered vehicles are the main source of onshore NOx emissions, however substantial emissions are also added by stationary sources such as petroleum refineries. NOx measurement will help determine if refineries add significant concentrations to nearby urban environments.

iii. Reactive Organic Compounds (ROCs)

ROCs include non-methane hydrocarbons (NMHC) and oxygenated NHMCs such as aldehydes. They are emitted by a large number of sources, but many hydrocarbons are associated with fuels and the production of fuels. ROCs originate from production processes, storage tanks, transport pipelines, and waste areas. High ROC measurements can indicate emission leaks from the refinery. As a result, measurement of these compounds is critical to determine the impacts that refineries have on nearby communities. Measurement of ROCs should be carried out continuously using open-path technologies at the fenceline of the refinery, unless it is demonstrated in the fenceline air monitoring plan that an alternative measurement technique (e.g. point monitors) can be effectively utilized.

Automated gas chromatographs (Auto-GCs) are the best point monitor option to measure specific ROC pollutant concentrations semi-continuously at a monitoring site. This technology has been developed by a number of manufacturers, and U.S. EPA has evaluated several commercially available auto-GCs in order to determine their suitability for use in air monitoring stations. The U.S. EPA has published the results in the Photochemical Air Monitoring Station (PAMS) Gas Chromatography Evaluation Study Report.[2] However, a substantial number of auto-GC units (or other point monitors) would need to be deployed to achieve sufficient spatial coverage along the property boundary or fenceline of a petroleum refinery. Other methods for continuous measurement of speciated ROCs include, but not limited to, Open-Path Fourier

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[2] RTI (2014). Gas Chromatograph (GC) Evaluation Study: Laboratory Evaluation Phase Report. Prepared for U.S. EPA PAMS Program. https://www3.epa.gov/ttnamti1/files/ambient/pams/labevalreport.pdf

Transform Infrared (OP-FTIR) systems that can effectively measure selected ROCs simultaneously with high time resolution. The use of these measurement techniques can potentially provide real-time and continuous air quality data.

In some cases, more traditional measurement techniques could be utilized if the air monitoring plan successfully demonstrates the effectiveness of the measurement technique. For example, ROCs could be measured by the collection of ambient air using evacuated canister sampling and subsequent analysis on a gas chromatograph (GC). This method relies on acquiring air samples that often require a considerable amount of time depending on the measured concentrations (e.g., several hours with canisters to several days with adsorption cartridges) and subsequent chemical analysis in a certified laboratory. The sample collection time can vary from instantaneous grab samples to averaging times of 24 hours. If this sampling technique is selected, periodic 24-hour samples (e.g., 1 in 6 days) and instantaneous grab samples (e.g., 5- or 10-minute samples) that are triggered by elevated readings of continuous NMHC are required. The continuous ROC measurement must achieve the temporal and spatial coverage requirements of the rule, while the periodic and triggered samples will provide information on the speciation of the measured ROCs.

iv. Aromatic Hydrocarbons – BTEX Compounds

While measurements of ROCs provide valuable information about potential refinery emissions, it is necessary to distinguish additional, well-defined ROCs to represent the health risk drivers associated with refinery emissions. BTEX compounds (referring to benzene, toluene, ethylbenzene, and xylenes) occur naturally in crude oil and are associated with the fugitive emissions from petroleum storage and transfer. BTEX is also a product of incomplete combustion from stationary equipment and motor vehicles. This group of aromatic ROCs are important because they pose a significant risk to human health.

Optical methods such as Ultraviolet Differential Optical Absorption Spectroscopy (UV-DOAS) and Open-Path Fourier Transform Infrared (OP-FTIR) monitors are advanced techniques that can measure BTEX compounds. However, the UV-DOAS instruments are able to detect BTEX compounds at lower concentrations compared to OP-FTIR instruments, so UV-DOAS is the preferred monitoring method. Additional analytical methods for BTEX compounds include absorption traps and subsequent separation by gas chromatography (GC) with detection by flame ionization optical absorption or mass chromatography, as well as auto-GC monitors.

v. Aldehydes

Aldehydes emitted into ambient air include, but are not limited to, formaldehyde, acetaldehyde, and acrolein. These pollutants are all identified as toxic air contaminants (TAC) that may cause respiratory symptoms and cancer. They can be emitted from a refinery as they are the products of incomplete combustion of natural gas. These compounds can be measured continuously at the fenceline of the refineries using open-path technologies. A more detailed listing of aldehydes with potential health concerns is provided by OEHHA.

vi. Other Toxic Air Contaminants (TACs)

Other ROC air toxics of concern that are often reported in a refinery's emission inventory include 1,3-butadiene and styrene. These pollutants have been detected in routine and non-routine refinery emissions and therefore must be measured and reported. A more detailed listing of potential ROCs of health concern is provided by OEHHA. Depending on emissions from each facility, measurement of other ROC air toxics may be appropriate. Such ROC compounds include, but are not limited to, methanol, phenol, naphthalene, and hexane.

vii. Hydrogen Sulfide (H_2S)

Hydrogen sulfide is a colorless, flammable, extremely hazardous gas with a "rotten egg" smell. It can result from the breakdown of organic matter in the absence of oxygen such as in swamps and sewers, occurs naturally in crude petroleum and natural gas, and is produced at oil refineries as a by-product of refining crude oil. As a result, low-level concentrations can occur continuously at petroleum refineries and its measurement will help identify potential leaks at refineries and address community odor concerns.

viii. Carbonyl Sulfide (COS)

Carbonyl sulfide is naturally found in crude oil and is a byproduct of oil refining with a distinct sulfide odor. It is classified as a TAC and a federal hazardous air pollutant (HAP). COS can be released into atmosphere as fugitive emissions from refineries. At high concentration levels, COS may cause narcotic effects in humans. COS can be measured using open-path technologies and should be measured and reported at the fenceline if the selected open-path monitors can detect it.

ix. Ammonia (NH_3)

While the main sources of ammonia are natural, primarily from the decay of organic matter, petroleum refineries can also emit considerable amounts, particularly from catalyst regenerator vent releases. Ammonia is colorless, pungent-smelling, and corrosive. Even though it is unlikely to have adverse effect on health at background levels, exposure to high concentrations following an accidental release or in occupational settings may induce adverse health impacts.

x. Black Carbon (BC) or $PM_{2.5}$

Black carbon (BC) is a product of incomplete combustion of fossil fuels, biofuels, and biomass, and it is emitted directly into atmosphere in the form of particles, mostly in the $PM_{2.5}$ size range. BC is a major component of "soot," a complex mixture that also contains some organic carbon. Although BC is often associated with emissions from heavy-duty diesel engines, a portion of all combustion emissions contains these constituents. BC has been routinely used to estimate the contribution of diesel particulate matter (DPM) to total PM. DPM is the major contributor to air toxic health risk, however it cannot be directly measured through atmospheric measurements and has to be estimated, usually based on BC measurements. In order to help determine if refineries add significant BC concentrations to nearby urban environments and discern the contribution of refineries to observed BC levels in the community, the refinery operators must determine potential BC hotspots on the facility fenceline (or within the facility) and perform BC measurements.

xi. Hydrogen Cyanide (HCN)

Hydrogen cyanide is colorless, highly flammable and can be explosive when exposed to air in high concentrations. It is released from various industrial activities, including refining. At high concentrations, such as from accidental releases, it is highly toxic. HCN can be effectively measured using open-path technologies and should be measured and reported at the fenceline if the selected open-path monitors can detect it at desirable levels.

B. Continuous and Real-Time Measurement of Air Pollutants

Continuous air monitoring at or near the property boundaries of a petroleum refinery can significantly improve rapid detection and communication of potential hazardous releases to refinery operators, responders, and the public in addition to providing long-term data be used to determine trends in emissions (e.g., diurnal, seasonal variations). Therefore, the fenceline monitoring shall be operated continuously with a required time resolution of five-minute averaging when feasible. High time resolution monitoring reduces the chance of pollutant hot spots being undetected over the measured area and can provide real-time emission information to refinery personnel and the nearby communities. If achieving the desired time-resolution is not feasible, refinery operators shall provide rationale in the air monitoring plan for any proposed time resolutions greater than five-minute averaging (e.g., based on the equipment employed, the number of paths covered by each open-path system, or other operational limitations).

C. Selection of Fenceline Air Monitoring Technologies

A fenceline air monitoring system is a combination of equipment that measures and records air pollutant concentrations at or near the property boundary of the facility. Multiple technologies may need to be employed to ensure adequate compound identification. Conventional fenceline air monitoring techniques rely on point monitors that only provide concentration information from a single point in the survey area, greatly increasing the chances of missing surface emission hotspots or emission plumes. Therefore, even after collecting data from multiple points in the survey area, the point sampling approach may lack the spatial or temporal data necessary to obtain a complete picture of the emissions from large permitted sources.

Open-path technology is a well-established method to measure path-integrated trace gas absorptions and concentrations in the open atmosphere, making it ideal for long-term fenceline monitoring for refineries. Open-path technology is a type of Optical Remote Sensing (ORS) that measures air pollutant concentration levels along an open-path, significantly improving the spatial coverage. ORS instruments use a light signal to continuously detect and measure concentrations of chemical compounds along the distance covered by the light signal in real-time.

As a result, open-path technologies can provide greater temporal and spatial resolution compared to conventional air monitoring techniques. For example, narrow pollutant plumes can be detected by an open-path fenceline air monitoring system that might otherwise be missed by point monitors. The light source emits light towards a detector either at the opposite end of the light path (bi-static configuration) or co-located with the light source (mono-static configuration) if the light is reflected back by a reflector, providing path-averaged concentrations of multiple pollutants. Although the open-path ORS techniques have been used for over 20 years and are well-established, they are constantly improving and gaining use for large monitoring applications that are not conductive to traditional point source methods. Improvements often include changes to technologies that improve detection limits or the type of compounds detected.

Due to the large number of potential leak sources that are scattered over a wide area at refineries and difficulties in detecting and repairing these leaks (which may become significant collectively), these fugitive emissions are best monitored over a large area or path using the open-path systems. Fugitive emissions are emissions of gases or vapors from leaks and other unintended or accidental releases of emissions. Leaks from pressurized process equipment generally occur through valves, pipe connections, mechanical seals, or related equipment, usually originating from the process area. Fugitive emissions also occur from storage tanks that are used to store crude oil prior to refining, intermediates between refining processes, and refined product streams.

U.S. EPA has published a comprehensive assessment of various open-path ORS technologies, outlining the advantages and limitations of each measurement method.[3] Based on the advantages that open-path technologies provide over conventional air monitoring techniques, District staff recommends the use of open-path technology for implementing a fenceline air monitoring system required by Rule 364. The air monitoring plan must provide specifications for the instruments selected for a fenceline air monitoring system, such as the detection limits of the equipment for each chemical and time-resolution capabilities. Also, the air monitoring plan must demonstrate that the instruments can measure all the pollutants identified in Rule 364. The selected open-path instruments should be able to record and store the measured spectral absorption and associated average concentrations of measured pollutants for retrospective investigations. Where open-path monitors are being operated, all factors that could affect air pollutant measurements, such as the maximum path length and potential interferences, must be discussed in the air monitoring plan.

i. Emerging Technologies

In comparing the costs of an ORS-based measurement approach with traditional point monitoring approaches for long-term fenceline measurements, an ORS-based approach is likely to be more cost-effective at this time. However, a refinery owner or operator may demonstrate

[3] https://www.epa.gov/sites/production/files/2018-08/documents/gd-52v.2.pdf

that other air monitoring techniques and/or technologies (e.g., emerging technologies) could be used in place of open-path technology depending on the pollutants that are monitored.

For example, low-cost sensors could allow cost-effective, real-time monitoring at numerous fixed locations along the perimeter of the petroleum refinery. Some of these commercially available low-cost sensors can provide measurements for criteria pollutants (e.g., $PM_{2.5}$, PM_{10}, ozone). However, the situation is different for gaseous air toxics, where sensors with sufficiently low detection limits for specific compounds (e.g., benzene) are generally not available at this time. Total ROC concentrations can be measured using Photon Ionization Detection (PID) sensors, although they do not provide ROC speciation and are not considered "low-cost." In the event of an equipment failure or during extended maintenance activities, the low-cost sensors can serve as a temporary measurement technique until the main fenceline air monitoring system is restored to normal operating conditions.

Despite substantial progress in these technologies, at this time, none of the low-cost sensors can provide the level of sensitivity and accuracy required to measure the pollutants required by Rule 364. However, gaseous sensors are expected to improve in the future and fenceline air monitoring plans could be augmented to employ these sensors. Therefore, the District may consider approving emerging technologies for future compliance with Rule 364. The petroleum refinery would submit a revised fenceline air monitoring plan if the changes to the fenceline air monitoring system are supported based on new information. This includes demonstrating that the proposed alternative air monitoring technology will meet the requirements of Rule 364 and provide adequate sensitivity and temporal and spatial coverage for the compounds identified in the rule.

D. Fenceline Sampling Locations and Coverage

Air monitoring plans must specify the following information related to the locations selected for the fenceline air monitoring equipment:

- Areas along the perimeter that are likely to detect compounds associated with petroleum refinery operations;
- Proximity of the proposed fenceline monitoring equipment to residences and other sensitive receptors, such as schools, hospitals, and community parks;
- Where equipment will be sited (e.g., GIS coordinates);
- Elevations at which equipment will be placed; and
- Length of each path that will be monitored with fenceline instruments.

The air monitoring plan must provide a discussion that explains the rationale for choosing the equipment siting specifications. The refinery operator must also address key considerations, such as the distance necessary to accurately measure emissions and critical transport areas around the perimeter of the refinery. To ensure that the monitoring system will attain a high level of accuracy, the following key factors should be discussed:

i. Local Meteorological Conditions

Meteorological conditions can significantly affect the concentration of air pollutants in a region. Therefore, it is important that the petroleum refinery operators consider the typical meteorological conditions (e.g., wind patterns, temperature, rainfall, cloud cover, etc.) of a site. For example, if a facility is in an area that is prone to fog, the facility operator should ensure the equipment for the fenceline air monitoring system is not sensitive or easily impeded by low-lying cloud cover produced by fog.

Evaluating historical meteorological data is imperative in air monitoring equipment site selection and in determining whether certain candidate equipment locations are likely to experience higher measured pollutant concentrations from an emissions source. Wind can be the most critical meteorological element for the transport of refinery emissions to the surrounding communities. Often, peak concentrations occur during stable, low wind speed conditions when pollutants can build up and meander in any direction. Frequency distributions of winds and associated graphic analyses (i.e., wind roses) can be analyzed to evaluate predominant wind patterns, as well as diurnal and seasonal variability.

ii. Topography

Concentrations of pollutants can be greater in valleys than for areas of higher ground. This is because, under certain weather conditions, pollutants can become trapped in low lying areas. Therefore, the topography of the petroleum refinery can affect the distribution and dispersion of pollutants from refinery operations. The petroleum refinery operator should design the fenceline air monitoring system to ensure fenceline air monitoring equipment is sited such that it captures the most critical transport and dispersion areas along the perimeter of the facility.

iii. Pollutant Hotspots

It is essential for the refinery operators to identify potential pollutant hotspots within the facility to ensure fenceline monitoring of these emissions and to provide effective information to the neighboring communities with sufficient spatial coverage. Therefore, in developing the air monitoring plan, the refinery operator should survey the facility with special attention to areas where emissions are most likely, such as tank storage, oil processing, wastewater treatment, and loading areas. Information gathered from the survey should be used to establish the facility’s overall emissions profile. The survey should also consider the elevation of potential pollutant hotspots.

iv. Spatial Coverage of Monitors

The fenceline monitoring system should be designed to ensure adequate coverage of the area along the facility perimeter, to the extent feasible. Considerations such as the proximity of refinery emissions sources to sensitive receptors and type of pollutants to be measured could require additional open-path monitors for a facility. Also, information available from dispersion modeling, gradient sampling, and mobile measurements should be taken into consideration when assessing adequate coverage.

Sampling locations should have an open, unobstructed path. Ideally, each air monitoring path should be at least 1 meter vertically and horizontally from any supporting structure and away from dusty or dirty areas. The air monitoring plan must also identify potential disruptions of airflow and the effect of obstacles or traffic on the measured concentrations. Potential interferences caused by meteorological (e.g., fog or rain) or process issues (e.g., process steam) associated with the selected location must be addressed. Furthermore, the air monitoring plan should describe how the proposed fenceline air monitoring system will effectively provide relevant information for all nearby downwind communities given the expected meteorological conditions. Due to the high prevalence of marine fog in the area, heaters and fans may be required to keep the instrument optics and reflector mirrors free of moisture to maximize data recovery.

3. Meteorological Measurements

Exposure to air contaminants within an urban area can vary greatly due to the proximity to emission sources, the magnitude and specific type of emissions, structures and terrain influences, and meteorological conditions. Variability in wind speed and direction pose significant challenges for the analysis of the data from air quality monitoring programs and exposure assessments. Therefore, an understanding and assessment of the general meteorological patterns in and around each facility is a critical component in not only the design of the measurement systems, but also interpreting the measurement results, including the transport and dispersion of air pollutants from the refinery to the community. Therefore, Rule 364 requires fenceline monitoring locations to continuously record wind speed and wind direction data.

In order to provide high quality data, the Air Monitoring Plan must provide information on siting considerations and equipment to be employed for real-time meteorological data collection at high resolution (at minimum, matching the time resolution of the air quality monitors). Wind sensor quality, siting, and quality assurance shall meet the specifications and guidelines that are typically required by air quality regulatory measurements and modeling purposes (for reference, see the U.S. EPA Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements).[4]

[4] https://www3.epa.gov/ttn/amtic/files/ambient/met/Volume_IV_Meteorological_Measurements.pdf

4. Quality Assurance / Quality Control (QA/QC)

The measurements from the fenceline air monitoring system shall reflect a commitment to quality data that is outlined in the air monitoring plan. The air monitoring plan shall address quality assurance, including training of personnel, routine maintenance and calibration checks, technical audits, data verification and validation, and data quality assessment.

The plan must also document the instrument manuals, Standard Operating Procedures (SOP), and a Quality Assurance Project Plan (QAPP). The QAPP provides a blueprint for conducting and documenting a program that produces quality results and outlines the specific goals of the monitoring network and instrumentation. The QAPP also summarizes how the data will be reviewed and managed by the refineries. The QAPP must outline a QA/QC plan that follows U.S. EPA guidelines[5] and should provide clear definitions and procedures for QA/QC that are necessary to indicate why some data may be missing, suspect, or invalid. The critical functions to be addressed in the QAPP are summarized below:

- **Project background and management:** The QAPP should provide background information and define the problems to be addressed and the general goals of the fenceline monitoring. The QAPP should describe project organization, quality objectives and acceptance criteria for measurement data, and plans for documentation, recordkeeping, and data dissemination.
- **Technical Approach:** The QAPP should demonstrate that the appropriate approaches and methodologies are employed for performing measurements, data handling, and quality control and address the design and implementation of the measurement systems.
- **Assessment/Oversight:** The QAPP should offer appropriate QA/QC steps for ensuring the effectiveness of the monitoring plan covering experimental design, representativeness of the data, instrument operation and data acquisition, calibration check procedures, data quality indicators, independent systems and performance audits, and peer-review.
- **Data Validation and Usability:** The QAPP should describe what steps will be taken to ensure that the individual data elements conform to the criteria specified in the monitoring plans.

All monitoring data must be collected, managed and archived in a standard electronic format after necessary data processing and validation. Processing the data involves collecting the data, assuring its quality, storing the data in a standardized format, and interpreting the data for communication to the public. The most critical steps in this process include:

- Automatically retrieving data from the fenceline monitors containing the measured levels of each air pollutant along with meteorological parameters;
- Validating data file completeness and integrity;

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[5] U.S. EPA (2002). Guidance for Quality Assurance Project Plans. EPA/240/R-02/009. https://www.epa.gov/sites/production/files/2015-06/documents/g5-final.pdf

- Transferring file contents to a database;
- Flagging data that do not meet pre-defined quality control limits;
- Copying quality assured data and indices into a database for use by the data display and dissemination program;
- Generating and recording logs to monitor system operation; and
- Notifications when measured concentrations are above pre-defined concentrations limits.

To ensure that the collected data meets the highest quality possible, each piece of monitoring equipment must be operated in strict accordance with an in-depth operating protocol. Standard Operating Procedures (SOPs) must be prepared for each specific measurement method to achieve the appropriate level of detail and standardization and to consequently ensure that the monitoring equipment provides high quality data. The SOPs should be informed by general operating instructions that are typically provided by the manufacturer of the equipment, by operational experience and audits, and by general operational guidelines and performance specifications that are available for U.S. EPA and State approved methods. The SOPs should address specific topics such as calibration procedures and quality control procedures (indicating standards and checks, acceptance criteria and schedule), as well as data reduction (indicating validation procedures, reporting and schedule).

Rule 364 requires that the measurements from the fenceline monitoring system be available to the public on a real-time basis with QA/QC measures implemented to provide confidence in the data collected. Publicly available quarterly measurement reports should reflect a higher level of data validation, including a manual review of the data by qualified personnel. The real-time and near-real-time disseminated measurement data should not be considered final, but it is important that the preliminary real-time measurement data distributed to the public be of an acceptable quality. Also, it is important that instrument failures are detected quickly to prevent grossly invalid data from being presented to the public. This can be accomplished by utilizing built-in status flags on the instrument operational parameters and by providing real-time data screening for outliers, impossible values, stuck values, negative values, rates of change, excessive short-term noise, etc.

5. Data Display and Dissemination

The primary goal of Rule 364 is to collect real-time emissions data and share that data with the community, local responders, and industry so that it can be used to evaluate and adaptively manage the impacts of refinery emissions on the community. Therefore, it is essential that the collected data is made available and displayed online in a relevant and understandable manner to the public in real-time or near real-time. The air monitoring plan must include information and examples of how the quality-controlled data will be displayed and the steps taken to provide context to the real-time measurements to the public. Also, the air monitoring plan shall address means for providing automated, reliable, useful, and understandable information, including, the intent and limitations of the data collected and an explanation of how background concentrations and/or contributions from other sources may affect measured concentrations.

In order to make the data provided in this outreach as accessible as possible, the project website should use data visualization tools to graphically depict information using maps and time series plots of measured pollutants and wind data. The website should not simply provide graphical information about current conditions. It needs to allow the public to access historical data directly and in a user-friendly manner. The archived data should include data quality control flags, explain changes, and provide information to identify data that should be removed or was removed after QA/QC.

All preliminary data from the fenceline monitoring system must be submitted to the District as quickly as practicable and in an approved format. The refinery operators must also publish quarterly reports written at a public-friendly level on the data dissemination website. The quarterly data reports shall include rigorous review of calibration data, data processing calculations (such as conversion calculations of instrument signal to pollutant concentration), data consistency, field data sheets and logbooks, instrument performance checks, and equipment maintenance and calibration forms. All changes to the reported real-time data must be explained in quarterly reports. The major goals of the outreach program include:

- Developing multiple communication venues to ensure widespread access to environmental information and to appeal to the various communication preferences (e.g., text messages, email, website, etc.) among the end users;
- Promoting access to and awareness of the measurements and use of the real-time air pollution data through an active outreach and education program;
- Developing contextual material to assist interpretation and understanding of the real-time data and its limitations;
- Designing an effective public outreach program (e.g., informational meetings, workshops, etc.) that informs the public about the health impacts associated with emissions levels detected by the fenceline air monitoring system and informs decision related to reducing community exposure; and
- Identifying designated personnel to address District and public questions about monitoring equipment and readings.

In order to provide context to this complex data set for the public, the designed website should contain information regarding the species measured and the measurement techniques, discussion of levels of concern for each measured species, typical background levels, potential non-refinery sources that could contribute to measured concentrations, and definitions of data QC flags. This should be written at a public-friendly level with clarity and thoroughness and with links provided to additional sources of information. In addition, the air monitoring plan and the data website should include details of how the public can report experiences and provide comments and feedback for improvement of the website and other data dissemination tools, and the monitoring activities in general.

6. Notification System

A. Reference Exposure Level (REL) Notifications

A Reference Exposure Level (REL) is an airborne concentration level of a chemical in which no adverse health effects are anticipated for a specified exposure duration. They are designed to protect the most sensitive individuals in the population by the inclusion of margins of safety. Therefore, an air concentration that exceeds the REL does not automatically indicate an adverse health impact. However, levels of exposure above the REL levels may have an increasing but undefined probability of resulting in an adverse health impact, particularly in sensitive individuals (e.g., children, the elderly, pregnant women, and those with acute or chronic illnesses).

The website should offer an opt-in notification system that is integrated with the data collected by the air monitoring network that automatically generates and issues notifications to subscribers when each of the pollutant levels exceed the corresponding RELs, or other lower thresholds pursuant to the approved air monitoring plan. Resources that should inform the thresholds include the National Ambient Air Quality Standards (NAAQS), California Ambient Air Quality Standards (CAAQS), and the acute, chronic or carcinogenic RELs as assessed by the Office of Environmental Hazard Assessment (OEHHA).[6]

OEHHA has developed acute RELs for assessing potential non-cancer health impacts for short-term, one-hour peak exposures to air pollutants and chronic RELs for assessing non-cancer impacts from long-term exposure. If the one-hour average concentration of any of the measured pollutants exceed its corresponding acute REL, notifications should be sent out to the subscribers. Whereas long-term exposures are typically assessed by their annual emissions. Therefore, chronic RELs and cancer risk must be compared to annual average concentrations of measured toxic pollutants and be reported in the periodic reports once one year of data is available.

B. Notification Methods & Emergency Response

The notification system should be designed to provide information to the public via email, text message or other communication venues with the ability to be notified regarding: (1) data availability and release of periodic reports; (2) exceedances of REL thresholds; and (3) monitoring system status. The timely notifications will inform the public when certain pollutants exceed those concentration thresholds or may pose a potential health concern, allowing the public to consider further actions to protect their health. The notifications would also provide information to refinery operators to rapidly identify and mitigate any undetected

[6] OEHHA: http://www.oehha.ca.gov/air/allrels.html

and/or accidental emissions. This can have a significant impact on the reduction of refinery fugitive emissions.

The air monitoring plan should also identify alternative methods of accessing periodic reports for those members of the community who may not have internet access (e.g., automated phone systems for dial-in information, public displays, hard copies of periodic reports in libraries or community centers, etc.). Based on the needs of the community, providing information in other languages should be strongly considered. Some examples of methods for communicating the data to the public include the following:

- Website data displays;
- Mobile application;
- Automated email/fax/text notification system;
- Social media feeds;
- Public data displays in community locations;
- Automated call-in phone system;
- Television and radio reports; and
- Published quarterly data summary reports.

As provided by state law, emergency response agencies, such as local fire agencies, have the primary responsibility for scene management during an accidental release of emissions or other emergency incidents. The refinery operator must identify the primary local agency that provides emergency preparedness and response services. The refinery must also coordinate with the first responders to integrate with and augment the existing public alert systems. Communication mechanisms are necessary to provide the public with access to public safety information during refinery upsets and accidental releases of pollutants and not to conflict or duplicate the first response alert systems in case of an accidental release of emissions.

The California Air Resources Board (CARB) Monitoring and Laboratory Division and the California Air Pollution Control Officers Association (CAPCOA) have completed the first two volumes of the Refinery Emergency Air Monitoring Assessment Report. The Objective 1: Delineation of Existing Capabilities report, released in May 2015, provides a comprehensive inventory of emergency air monitoring assets and capabilities located in and around California's major oil refineries. The Objective 2: Evaluation of Air Monitoring Capabilities, Gaps, and Potential Enhancements became available in March 2019. Also in March 2019 OEHHA released a related report: Analysis of Refinery Chemical Emissions and Health Effects. These are available from the CARB Refinery Air Monitoring website.[7]

[7] https://www.arb.ca.gov/fuels/carefinery/crseam/crseam.htm

7. Future Updates to the Monitoring Plan Guidelines

Revisions and updates to this guidance are expected and will be required as new instrumentation, methodologies and monitoring strategies are developed.