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Petroleum Refinery Emissions Reduction Strategy:

Staff Report

Prepared by the staff of the

Bay Area Air Quality Management District

October 2015

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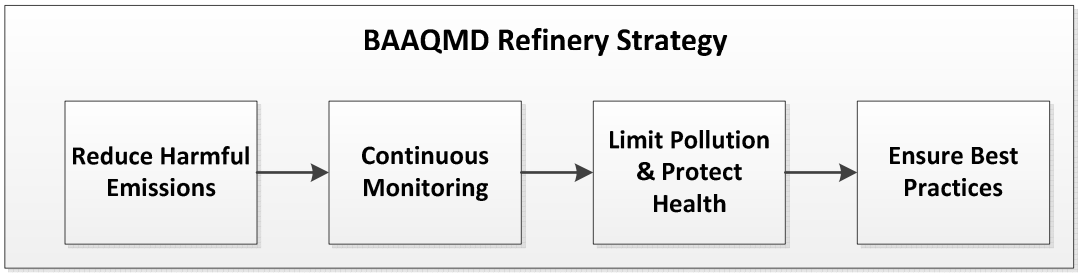
Petroleum Refinery Emissions Reduction Strategy: Staff Report

I. EXECUTIVE SUMMARY

The Bay Area Air Quality Management District (Air District) has developed a four-part strategy for addressing air pollution from Bay Area petroleum refineries. This strategy stems from a Board of Directors' resolution (2014-17) adopted in October 2014, in which the Board instructed staff to develop a regulatory strategy that would further reduce emissions from petroleum refineries, with a goal of an overall reduction of 20 percent (or as much as feasible) no later than 2020. The strategy targets a spectrum of criteria pollutants, including volatile organic compounds (VOC), particulate matter (PM), sulfur dioxide (SO_2), and oxides of nitrogen (NOx). Figure 1 below provides an overview of the entire strategy. The remainder of this document provides more detail about the first component –Reduce Harmful Emissions.

Figure 1.



The four elements of the Refinery Strategy are described as follows:

Reduce Harmful Emissions: The first set of these rules, designed to reduce harmful emissions, will be considered by the Board in December 2015 and is expected to reduce overall emissions from refineries by approximately 16 percent. This first set of rule actions would reduce sulfur dioxide (SO_2) from coke calcining and reduce smog-forming and toxic emissions from equipment leaks and cooling towers. These rules also would limit ammonia emissions from fluid catalytic cracking (FCC) units, which will reduce associated formation and emission of fine particulate matter ($PM_{2.5}$).[1] In mid-2016, the second set of regulations will be developed to further reduce $PM_{2.5}$ emissions from fluid catalytic cracking units (if needed) and SO_2. The second set of regulations also would reduce SO_2 from other refinery sources and smog-forming emissions from turbines. The development of these sets of regulations is also known as the Petroleum Refinery Emission Reduction Strategy.

Continuous Monitoring: Proposed Regulation 12, Rule 15, Petroleum Refining Emissions Tracking (Rule 12-15), would require that continuously updated, state-of-the art methods be used to calculate and report the total pollution from the refineries every year. It also would require extensive air quality monitoring to validate those pollution calculations and ensure surrounding communities are not

[1] $PM_{2.5}$ is the portion of particulate matter with an aerodynamic diameter of less than 2.5 micrometers.

subjected to unhealthy levels of pollution. Proposed Rule 12-15 also includes other requirements that will enable the Air District to have a more complete understanding of the sources of pollution at the refineries. These requirements include providing information on the physical characteristics of crude oil to determine when significant changes in feedstock occur that might lead to higher emissions. The information also will include energy efficiency data needed to understand opportunities to reduce emissions of climate pollutants. Additionally, Rule 12-15 will require new Health Risk Assessments (HRAs) be performed to determine the health risk from toxic air pollutants at the refineries using the best available estimates of pollution emission rates and newer, more protective assumptions about how that pollution impacts nearby communities.

Limit Pollution & Protect Health: Proposed Regulation 12, Rule 16, Petroleum Refining Emissions Limits and Risk Thresholds (Rule 12-16), would limit refinery pollution to levels that minimize the health burden for the surrounding communities. The rule would limit toxic emissions by restricting the overall health burden caused by those pollutants, as demonstrated in Health Risk Assessments. This method accounts for relative toxicity of various air contaminants and how they are dispersed across the community. To determine the progress toward minimizing the health burden, the Air District will review new emissions data every year and require updated Health Risk Assessments as necessary.

$PM_{2.5}$ and SO_2 are two federally regulated pollutants that have not been classified as "toxic" but still have negative health impacts on nearby communities. For these pollutants, the rule will impose a limit on emission rates and also will require refineries to demonstrate that emissions of these pollutants will not exceed federal health standards.

Ensure Best Practices: Air District staff is developing changes to the Air District permitting regulations to ensure that when refineries modernize or make significant changes to the type of crude oil they use they will be required to use the best available control technology to reduce smog-forming, toxic, and climate pollutants. Over time, these changes to the permitting regulations will ensure the refineries use best practices and operate as efficiently and cleanly as possible.

Overview of Proposed Rules and Rule Amendments

In this first phase of the Refinery Strategy, staff has developed four regulatory proposals: two new rules, and proposed amendments to two existing Air District rules.

- New draft rule, Rule 9-14: Petroleum Coke Calcining, to address emissions of SO_2 and the formation of $PM_{2.5}$ from two coke calcining kilns, this rule is addressed in detail in a stand-alone staff report;
- New draft rule, Rule 6-5: Fluidized Catalytic Cracking Unit (FCCU), to address emissions of ammonia and also to minimize PM2.5 emissions from FCCUs at the five refineries;
- Draft amendments to Rule 8-18: Equipment Leaks, to address fugitive emissions of ROG and toxic compounds from equipment in heavy liquid service; and
- Draft amendments to Rule 11-10: Toxic and ROG emissions from Cooling Towers, to address reactive organic gases (ROG) and toxic compounds from cooling towers.

Combined, these rules and rule amendments are expected to achieve an overall emission reduction of 16 percent from the affected refineries and associated facilities. These emissions reductions would make substantial progress toward not only achievement and maintenance of the state and federal

ambient air quality standards, but also toward the achievement of the 20 percent reduction goal adopted by the Air District Board of Directors.

II. BACKGROUND

The Petroleum Refinery Emissions Reduction Strategy specifically addresses the first part of the overall Refinery Strategy – Reduce Harmful Emissions. It is intended to reduce emissions of criteria pollutants and their precursors (SO_2, oxides of nitrogen (NO_X), particulate matter, $PM_{2.5}$, organic gases, and toxic compounds) from the five Bay Area refineries and associated facilities. The Air District plans to accomplish these refinery emissions reductions by amending several Air District rules affecting petroleum refineries and developing additional rules aimed at specific refinery processes.

The Air District is moving these individual actions through the rulemaking process as a package. This enables the Air District to use its staff resources more efficiently, streamlines coordination and consultation with the public and the regulated community and responds to requests by the public. There should be no inference that this approach creates dependencies between these rule actions. Each rulemaking action is independent from the others and will be individually evaluated and considered for adoption according to the requirements of the California Health and Safety Code (H&SC).

The purpose of this staff report and its appendices (individual rule-specific reports and proposed rule language) is to inform the public and the regulated community of the Air District's plans for implementing the Petroleum Refinery Emission Reduction Strategy through rulemaking. This report and the draft regulatory language reflect the input of stakeholders as a result of the Request for Comment on the Initial Report released in May 2015, open houses conducted in refinery communities in September and internal staff deliberations. Staff will consider the input received in drafting the proposed rules and the final staff report. The final proposed rules and staff report will be presented to the Air District Board of Directors before the end of 2015.

Goals: On December 17, 2014, the Air District's Board of Directors approved the following overall goals for the Petroleum Refinery Emission Reduction Strategy:

1. Strive to achieve a 20 percent reduction in emissions of criteria pollutants and precursors in the next five years.
2. Strive to achieve an additional 20 percent reduction in health risk from the emission of toxic compounds.

Criteria pollutants are pollutants for which federal or state air quality standards have been established, such as SO_2, ozone, and $PM_{2.5}$. Precursors are pollutants that interact in the atmosphere to form criteria pollutants. For example, NO_X, and reactive organic gases (ROG) when exposed to sunlight combine to form ozone.

A. Regulatory Context

The Air District is currently engaged in developing regulatory measures to reduce emissions of air pollutants from a wide variety of stationary and area sources. As part of the ongoing development of the Air District's 2016 Clean Air Plan, staff evaluated many of these sources and determined that some of

the largest stationary sources of air pollutants include landfills, refineries, chemical manufacturers, and publically owned treatment works (POTW).

The 2011 Bay Area Emissions Inventory for stationary sources indicates that although landfills are the largest sources of total organic gases (TOG) in tons per day (tpd), refineries are the largest individual stationary source emitters of reactive organic gases (ROG).[2] Refineries are also the predominant source of SO_2 emissions. (See Table 1)

Table 1: Criteria Pollutant and Precursor Emissions by Industrial Sector

Industrial Sector	TOG (tpd)	ROG (tpd)	$PM_{2.5}$ (tpd)	NOx (tpd)	SO_2 (tpd)	CO (tpd)
Petroleum Refining and Related Facilities	12.1	10.0	2.7	10.0	8.8	5.6
Landfills	191.2	1.7	0.33	0.5	0.3	1.6
POTWs	3.0	0.4	0	0	0	0
Chemical Manufacturing Facilities	1.6	1.6	0.4	0.1	0	0.1

Further, the five Bay Area refineries rank among the top ten facilities in the Bay Area for risk-weighted emissions of toxic air contaminants (TAC), based on an evaluation of emissions from stationary sources in 2012 and using risk factors for cancer and chronic hazard index.

Based on assessments of emissions of criteria pollutants and TAC from refineries, and to ensure the attainment and maintenance of the NAAQS and California Ambient Air Quality Standard (CAAQS)[3] and ensure protection of the public from toxic air contaminants, the Air District has made emissions reductions from these facilities a high priority and intends to reduce refinery emissions by 20 percent by 2020, if feasible. To this end, staff is engaged in several rulemaking efforts to further reduce emissions of all air pollutants (including criteria and toxic pollutants) from the five Bay Area refineries, plus five associated facilities that either support refinery operation (two sulfuric acid plants and two hydrogen plants), or process a refinery by-product (one coke calcining plant). This emissions reduction effort is part of an overall refinery strategy to address refineries and their impact on neighboring communities. An overview of the rest of this strategy is provided in Section I at the beginning of this document.

B. Air District Board Direction

On October 15, 2014, the Air District Board of Directors adopted Resolution Number 2014-07, instructing staff to develop a strategy based on an evaluation of approaches that would further reduce emissions from petroleum refineries, including:

- The “community-worker” approach outlined in a September 26, 2014 letter;
- Approach(es) proposed by industry;
- Approach(es) to require each refinery to develop a refinery emissions improvement plan to implement a suite of measures to demonstrate compliance with all applicable requirements of the strategy to further reduce emissions from petroleum refineries and to identify any

[2] TOG includes methane, while ROG does not.

[3] The Bay Area is designated as a non-attainment area for the State 8-hour and 1-hour standard and the National 8-hour standard for ozone; and the State standards for fine particulate matter ($PM_{2.5}$). [http://www.baaqmd.gov/research-and-data/air-quality-standards-and-attainment-status]

additional feasible measures to achieve best practices with respect to minimizing emission and to assure continuous improvement in minimizing emissions; and
- Other approaches deemed appropriate by Air District staff.

The resolution also instructed Air District staff to prepare and present to the Board of Directors by December 2014, a strategy to achieve further emissions reductions from petroleum refineries that would include as a goal a 20 percent reduction in refinery emissions, or as much emissions reductions as feasible. The resolution also provided that the strategy must include a schedule to implement regulations or other enforceable mechanisms as expeditiously as possible.

On December 17, 2014, the Board of Directors approved the staff-proposed approach that would blend the best of the evaluated approaches. This approach has the following components:

- Identify specific source categories with opportunities for cost-effective controls (this is also known as a Best Available Retrofit Control Technology review, or BARCT review);
- Adopt requirements identified in the U.S. Environmental Protection Agency (EPA) Refinery Risk and Technology Review;
- Include the quantitative goals from the Community-Worker proposal;
- Include continuous improvement as a goal for regulations;
- Retain compliance with the Health and Safety Code and the process transparency advocated by industry.

The Board of Directors also approved the following overall goals for the Petroleum Refinery Emissions Reduction Strategy:

1. Strive to achieve a 20 percent reduction in criteria pollutants and precursors within the next five years; and
2. Strive to achieve an additional 20 percent reduction in health risk from toxics.

C. Targeted Pollutants

The Petroleum Refinery Emission Reduction Strategy is intended to reduce emissions from the five Bay Area refineries and the five associated facilities of the following pollutants:

- Particulate matter (PM), including directly emitted filterable PM and condensable PM, as well as precursor compounds that form $PM_{2.5}$ as a result of chemical reactions in the atmosphere. Condensable PM is particulate matter that forms after the hot emissions from the stack cool to ambient temperatures. These emissions are not quantified by traditional particulate testing methodologies because the sampling system does not operate at atmospheric temperatures and the condensable PM is a vapor at higher temperatures.
- ROG, a precursor in the formation of ground-level ozone.[4]
- NO_x, an ozone precursor and a contributor to fine PM formation.

[4] Methane is not part of ROG because it has a low reactivity for ozone formation, although it is a potent greenhouse gas (GHG). The Air District expects some methane reductions as a co-benefit of ROG reductions. However, methane is not currently a targeted pollutant in this Petroleum Refinery Emission Reduction Strategy. It will be addressed through other measures in the Clean Air Plan.

- SO_2, a contributor to fine PM formation.
- Ammonia (NH_3), also a contributor to fine PM formation.

Each of the ten facilities mentioned above has high emissions of one or more of these targeted pollutants.

D. Phased Approach

Air District staff recommends a two-phase approach to complete the rulemaking for the Petroleum Refinery Emission Reduction Strategy:

1. Phase 1 is scheduled to be completed in the fourth quarter of 2015; and
2. Phase 2 is scheduled to be completed in the third quarter 2016.

The first set of proposed regulations, Phase 1, focuses on regulatory efforts for which staff has developed enough background information—such as emissions inventory, emissions reductions, control technology evaluation and cost estimates, cost effectiveness, and preliminary environmental impact review—to proceed relatively quickly. Phase 1 includes the following regulatory actions:

- New proposed rule, Rule 9-14: Petroleum Coke Calcining, to address emissions of SO_2 and the formation of $PM_{2.5}$;
- New proposed rule, Rule 6-5: Fluidized Catalytic Cracking Unit (FCCU), to address emissions of ammonia and also to address condensable PM formation;
- Proposed amendments to Rule 8-18: Equipment Leaks, to address fugitive emissions of ROG and toxic compounds from equipment in heavy liquid service; and
- Proposed amendments to Rule 11-10: Toxic and ROG emissions from Cooling Towers, to address reactive organic gases (ROG) and toxic compounds from cooling towers.

The second set of regulatory actions, Phase 2, would focus on regulatory development for which staff has developed initial information, such as emissions inventory and cost estimates, but for which staff is currently in the process of gathering additional information needed for the regulatory development process, including environmental and socioeconomic information. Phase 2 would cover the following regulatory actions:

- Draft amendments to new Rule 6-5: FCCU to address emissions of SO_2 and condensable PM;
- Draft amendments to Regulation 9, Rule 1: Sulfur Dioxide, to further reduce emissions of SO_2 and the formation of $PM_{2.5}$ from refinery fuel gas combustion and from sulfuric acid plants, and to address emissions of SO_2 from sulfur plants; and
- Draft amendments to Rule 9-9: Stationary Gas Turbines, to address emissions of NO_X.

This report covers the regulatory actions for following rules: 6-5, 8-18, and 11-10. It also provides a summary of the costs and benefits of all the rules. Rule 9-14 is covered in detail in a separate report , which is also available from the Air District's website.[5] The Air District is soliciting feedback on all four rulemaking projects in Phase 1.

[5] See "2015 Rules Workshops" at the following URL: http://www.baaqmd.gov/rules-and-compliance/rule-development/meetings-and-public-hearings

E. Affected Facilities

There are five petroleum refineries in the Bay Area that may be affected by the emission reduction strategy:

1. Chevron Products Company (Richmond);
2. Phillips 66 Company – San Francisco Refinery (Rodeo);
3. Shell Martinez Refinery (Martinez);
4. Tesoro Refining and Marketing Company (Martinez); and
5. Valero Refining Company – California (Benicia).

There are also five associated support facilities that may be affected:

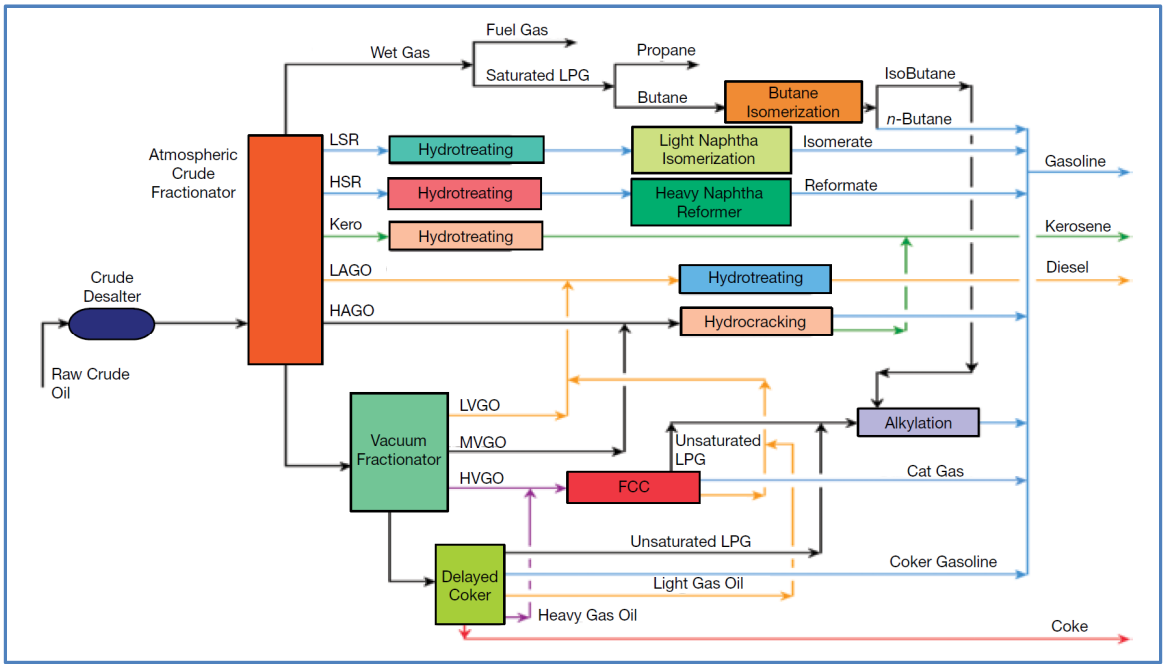
1. Chemtrade West (sulfuric acid plant that supports Chevron);
2. Eco Services (formerly called Solvay; sulfuric acid plant that supports Shell and Valero regularly, and Tesoro as needed when its acid plant is down for maintenance);
3. Air Products (hydrogen plant that supports Tesoro);[6]
4. Phillips 66 Carbon Plant; and
5. Air Liquide (hydrogen plant that supports Phillips 66).

F. Petroleum Refining Processes

These facilities process crude oil into a variety of products such as gasoline, aviation fuel, diesel and other fuel oils, lubricating oils, and feedstocks for the petrochemical industry. The diagram in Figure 2 illustrates how various process units at petroleum refineries convert raw crude oil (petroleum) into fuels and other products.

[6] There is also an Air Products plant that supports only the Shell Refinery. The emissions from that plant were included in the baseline inventory.

Figure 2: Refinery Flow Diagram



Legend: LSR = light straight-run naphtha; HSR = heavy straight-run naphtha; Kero = kerosene; LAGO = light atmospheric gas oil; HAGO = heavy atmospheric gas oil; LVGO = light vacuum gas oil; MVGO = medium vacuum gas oil; HVGO = heavy vacuum gas oil.

The processing of crude oil occurs in various process units or plants; some of the primary process units include:

- Crude Desalter: Crude oil is mixed with water to separate the salt and sediments from the crude.
- Crude Unit: The incoming desalted crude oil is heated and distilled into various fractions for further processing in other units.
- Gas Concentration Unit: Light hydrocarbons from the top of the crude unit are separated and distributed in the refinery fuel gas (RFG) system for use as fuel for heaters and boilers.
- Vacuum Distillation Unit: The residue oil from the bottom of the crude oil distillation unit is further distilled under heavy vacuum.
- Hydrotreater: Naphtha, kerosene, and gas oil are desulfurized from the crude unit by using hydrogen and converting the organically bound sulfur into hydrogen sulfide (a toxic compound).
- Fluidized Catalytic Cracker Unit: Longer chain, higher boiling hydrocarbons such as heavy oils are broken (or "cracked") into lighter, shorter molecules at high temperatures and moderate pressure in the presence of a catalyst. This process is so named because the catalyst is so fine that it behaves like a fluid.
- Butane Isomerization Unit: Isobutene (a lighter hydrocarbon) is combined with olefins (heavier hydrocarbons) to form larger molecules known as alkylates, which are used in blending gasoline to boost the octane rating. Alkylates are considered one of the highest quality refinery products.
- Light Naphtha Isomerization Unit: Benzene is saturated and short, straight-chain hydrocarbons are isomerized into branched-chain hydrocarbons.
- Heavy Naphtha Reformer and Hydrotreater: Low-octane linear hydrocarbons (paraffins) are converted into aromatics using a catalyst. The process also forms hydrogen - used in the refinery's hydrocracking and hydrotreating units - and benzene, toluene, and xylene (BTX) feedstocks, used in other process units.

- Hydrocracker Unit: Hydrogen is used to upgrade heavier fractions into lighter, more valuable products, such as diesel and jet fuel, in a high pressure system.
- Alkylation Unit: Butene and propene are reacted with isobutane into alkylate, a high octane gasoline component.
- Delayed Coker: Very heavy residual oils are converted into end-product petroleum coke as well as naphtha and diesel oil byproducts.
- Claus Sulfur Plant: A two-step (thermal and catalytic) process for recovering sulfur from gaseous hydrogen sulfide (H_2S) derived from refining crude oil. In the thermal step, H_2S laden gas is combusted to form elemental sulfur and sulfur dioxide (SO_2). In the catalytic step, a catalyst is used to boost the sulfur yield. In this step H_2S reacts with SO_2 to form elemental sulfur.

These primary process units, minor process units, auxiliary equipment (boilers, turbines, heat exchangers, etc.), and other refinery activities (such as truck and loader traffic) emit a variety of criteria pollutants, toxic air contaminants, and greenhouse gases. Other sources of emissions include waste water treatment, tanks, leaking equipment, pressure release devices, flares, marine terminals, and product loading, which are collectively subject to at least ten different Air District regulations.

III. PROPOSED RULES AND RULE AMENDMENTS

Air District staff has begun developing the following control measures that would comprise the Petroleum Refinery Emissions Reduction Strategy. Table 2 lists these individual control measures and rule development efforts.

Table 2: Description of Rule Changes

Title	Proposal Description
PHASE 1	
Rule 6-5: FCCU (Part 1)	Establish emission limits on fluid catalytic cracking units in oil refineries for ammonia, which is a $PM_{2.5}$ precursor. It is expected that limiting ammonia from the FCCU would also reduce emissions of condensable PM.
Rule 8-18: Equipment Leaks	Reduce fugitive emission of organic gases and toxic compounds through the following: • Include identification and monitoring of heavy liquid service equipment; • Amend the non-repairable equipment standard to reduce the allowable amount of equipment placed on non-repairable list; • Require quantification of leaks for all equipment placed on the non-repairable list; • Add a maximum leak concentration (10,000 ppm) that would apply to all equipment placed on the non-repairable list; and • Add a maximum mass emissions rate (five pounds per day) that would apply to any individual piece of equipment subject to monitoring by Rule 8-18. Administrative changes to rule language will be drafted to clarify and enhance enforceability of the rule.
Rule 9-14: Petroleum Coke Calcining	Reduce SO_2 emissions from the coke calcining facility through improvements to the emission control system.
Rule 11-10: Toxic and ROG Emissions from Cooling Towers	Reduce emissions of toxic organic gases and ROG from cooling towers by testing for and repairing heat exchanger leaks.
PHASE 2	
Rule 6-5: FCCU (Part 2)	Reduce SO_2 and condensable PM emissions.
Rule 9-1: Sulfur	Reduce SO_2 emissions by the following:

Title	Proposal Description
Dioxide (Part 1)	1. Limit the sulfur content of refinery fuel gas to no more than 40 ppm; 2. Limit SO_2 emissions from sulfuric acid plants to no more than 0.20 lb. SO_2 per ton of acid produced; and 3. Reduce SO_2 emissions from refinery sulfur plants to the extent that it is feasible.
9-9: Stationary Gas Turbines	Require the installation of selective catalytic reduction control on turbines with heat input greater than 100 MM BTU/hr. (The scope of this change may be expanded to include smaller turbines, if staff finds that there may be cost-effective opportunities for emission reductions on these smaller turbines.)
FURTHER STUDY MEASURES	
Rule 8-8: Industrial Wastewater	Review industrial wastewater collection, separation, and treatment system operations to develop an overall strategy to reduce air toxics and TOCs.
8-44: Marine Vessel Operations	Reduce organic gas emissions from marine loading operations that are within the Air District's authority in consideration of overlapping authority of the Coast Guard and other agencies.
9-10: Refinery Boilers, Steam Generators and Process Heaters	The majority of NO_X emissions at the refineries come from these sources. Recent updates to Rule 9-10 have tightened standards, but those reductions have not yet been reflected in the emissions inventory. Substantial work will be required to determine whether there are opportunities for additional controls.

Phase 1 items listed in the above table are the rules and amended rules that are being proposed for adoption.

A. Regulation 6, Rule 5: Particulate Emissions from Refinery Fluidized Catalytic Cracking Units

Staff proposes the major provisions in new proposed Rule 6-5 listed in Table 3.

Table 3: Major Provisions in Proposed Rule 6-5

Rule Section	Description
§ 6-5-301	Establish a new 10 ppmvd (at 3% oxygen concentration, daily average basis) ammonia emission limit from FCCUs effective January 1, 2018.
§ 6-5-401	Require submission of a control plan to comply with Section 6-5-301 and permit applications to perform required equipment modifications by January 1, 2017.
§ 6-5-402	Require submission of a monitoring plan to ensure continuous compliance monitoring for Section 6-5-301 by January 1, 2017.
§ 6-5-403	As an alternative to compliance with Section 6-5-301, an FCCU operator may perform an optimization study leading to a new ammonia emission limit (presumably higher than the limit in Section 6-5-301) that is demonstrated to result in the greatest reduction in PM2.5 emissions from the FCCU that is achievable given other existing requirements on the FCCU.

B. Regulation 8, Rule 18, Equipment Leaks

Staff proposes the general changes to Rule 8-18 (**Table 4**), which would become effective January 1, 2016.

Table 4: Major Amendments in Proposed Rule 8-18

Rule Section	Description
§ 8-18-113	Require identification and monitoring of heavy liquid service equipment and subject heavy liquid service equipment to leak minimization and repair requirements.
§ 8-18-200	Additions to and clarification of definitions
§ 8-18-306	Reduce the allowable amount of equipment placed on non-repairable list.
§ 8-18-306.1	Require mass emission monitoring for all equipment placed on the non-repairable equipment list.
§§ 8-18-306.1 & 311	Establish a maximum mass emissions limit for fugitive equipment subject to the rule.
§ 8-18-401.11	Require the identification of the cause of any background reading greater than 50 ppmv.

In addition, proposed administrative changes to rule language have been included to improve clarification and enforceability of the rule.

C. Regulation 9, Rule 14: Petroleum Coke Calcining Operations

Staff proposes the major provisions in new proposed Rule 9-14 listed in Table 5**: Major Provisions in Proposed New Rule 9-14**

Table 5: Major Provisions in Proposed New Rule 9-14

Rule Section	Description
§ 9-14-200	Creation of definitions for the new rule especially with respect to standards, administrative requirements and monitoring requirements.
§ 9-14-301	Requires the Carbon Plant to meet an SO_2 emission limit of 144 pounds per hour for each kiln and to either meet an annual emission limit of 770 tons per year or SO_2 or demonstrate and 80% control of SO_2.
§ 9-14-401	Requires the Carbon Plant to commission a study with an independent engineering firm to determine the technical means and cost to upgrade their control system to achieve 80% control of SO_2. Study to be completed by January 1, 2017.
§ 9-14-402	Sets a schedule for phasing in the increased control requirements on each of the two kilns.
§ 9-14-501	Emissions and Monitoring Recordkeeping Requirements
§ 9-14-502	Dry Sorbent Injection Rate Recordkeeping Requirements
§ 9-14-503	Annual Recordkeeping requirements for demonstration of 80 percent SO_2 control.
§ 9-14-601	Emissions monitoring requirements

D. Regulation 11, Rule 10: Cooling Towers

Staff proposes the general provisions in new Rule 11-10 listed in Table 6.

Table 6: Major Provisions in Proposed Rule 11-10

Rule Section	Description
§ 11-10-200	Addition of new definitions for the new THC leak monitoring and leak repair

	provisions.
§ 11-10-304	THC leak monitoring requirements provide refineries three options.
§ 11-10-305	Progressive steps for leak action repair requirements.
§ 11-10-400	Leak reporting requirements and "Best Modern Practices" requirements.

In addition, proposed administrative changes to rule language have been included to improve clarification and enforceability of the rule.

IV. EMISSIONS AND EMISSION REDUCTIONS

The Air District has established a baseline emissions inventory for estimating emissions reductions from the new rules and proposed amendments to current rules in the Petroleum Refinery Emission Reduction Strategy. This inventory shows baseline emissions for pollutants targeted by the proposed regulations: PM (including directly-emitted filterable PM and condensable PM), TOG,[7] NO_x, and SO_2. It includes emissions from petroleum refinery processes (e.g., feedstock and product handling, petroleum separation, and conversion and treating processes) as well as from auxiliary facilities such as hydrogen production, sulfur recovery, and power plants. Reporting year 2013[8] was chosen as the baseline year because it is the most recent year for which the Air District has complete emissions data. However, equipment leak and cooling tower TOG emissions are based on reporting year 2014 because the calculation methodology for these source categories have been significantly improved in this reporting cycle.

Table 7: Baseline Emissions from the Refineries and Associated Facilities

Facility Name	Average Annual Emissions (tons/year)				
	PM (filterable)	PM (cond.)[9]	TOG	NO_X	SO_2
Chevron	173	255	2,129	910	339
Phillips 66	53	—	337	266	409
Shell	409	98	1,812	971	1,084
Tesoro	80	91	1,200	763	572
Valero	123	—	494	1,142	111
Chemtrade West	4	—	55	2	127
Eco Services	18	—	1	13	362
Air Products	10	—	9	3	2
Phillips 66 (Carbon Plant)	29	—	0	239	1,242
Air Liquide	16	—	29	2	2
Total Emissions	**915**	**444**	**6,066**	**4,311**	**4,250**

The baseline emissions inventory shown in Table 7 will be replaced with the Petroleum Refinery Emissions Profile (PREP), an emissions inventory that would be required from relevant facilities by proposed Rule 12-15. The PREP will be used as a reference with which to compare ongoing emissions inventories to monitor emissions changes. It will have a breadth similar to the baseline inventory

[7] The Air District's emissions reporting system does not consistently differentiate between TOG and ROG emissions. Because TOG is the more inclusive category, it is being used for the development of the baseline.
[8] The 2013 reporting year emissions correspond to emissions from calendar year 2012.
[9] Condensable PM emissions are estimated based on a very small number of non-standard tests on FCCUs. These numbers will change as more testing is completed at the refineries.

provided in Table 7 because it will include emissions from both refineries and their auxiliary facilities. However, it will not include emissions that exceeded regulatory or permitted limits, or emissions from accidental air releases.

At this point, the Air District has estimated the following emission reductions and costs for the regulatory actions under consideration (Table 8). More details may be found in the appendices to this document. The Air District is seeking ongoing input on the accuracy of these estimates throughout its rule making process.

Table 8: Estimated Emissions Reductions and Costs for Rule Changes in Phase One

Title	PM (tons/year)	TOG (tons/year)	NO_X (tons/year)	SO_2 (tons/year)	Costs (million $/yr)
Rule 9-14: Petroleum Coke Calcining				372	$2.0
Rule 6-5: FCCU (Part 1)[10]	TBD				$0
Rule 8-18: Equipment Leaks		1,227			$6.8
Rule 11-10: Cooling Towers		997			$1.3
Totals for Phase 1	**TBD**	**2,224**	**0**	**372**	**$10.1**

Table 8 shows that the Air District has identified significant opportunities for SO_2 and TOG reductions. As sources of filterable PM at the refineries are already cost-effectively controlled, the key opportunity for emissions reductions is from condensable PM. The Air District plans to address condensable PM by regulating emissions from FCCUs.

The total combined baseline emissions from the refineries are 15,986 tons per year. The emissions reductions from Phase 1 of the Petroleum Refinery Emission Reduction Strategy are estimated to be 2,596 tons per year, which means this initial phase is projected to reduce emissions from these sources by 16 percent. Air District staff is still developing emissions reductions estimates for Phase 2, but expects the combined emission reductions to meet or exceed the 20 percent goal set by the Board.

Twenty Percent Reduction in Risk from Toxic Emissions

Another of the goal of the Petroleum Refinery Emission Reduction Strategy is to reduce the risk from emissions of toxic compounds by at least 20 percent. Several of the rule development efforts undertaken in the strategy would reduce toxic emissions and risk. Specifically, amendments to Rule 8-18 would reduce VOCs, including toxic compounds, from leaking components, and amendments to Rule 11-10 would expand the scope of this airborne toxic control measure to included toxic organic gases from refinery cooling towers (see Table 2).

The "Limit Pollution and Protect Health" components of the overall Refinery Strategy (Draft Rules 12-15 and 12-16) will specifically address the risk from toxic emissions. Staff expects that the revised requirement for Health Risk Assessments in 12-15 and the stringent Action Levels in 12-16 will significantly impact the risk from toxic emissions. Once the impact of these rules is fully understood, Air District staff will determine whether additional toxic emission reductions are feasible.

[10] Part 1 of this rule change would reduce ammonia emissions. There is reason to believe that this would also reduce emissions of condensable PM, but it is not possible to quantify condensable PM reductions at this time. Therefore, the estimated PM reduction is listed as "to be determined" or TBD.

V. ECONOMIC IMPACTS

Pursuant to the California Health & Safety Code (H&SC), the Air District is required to perform two different types of economic analysis for rule development activities. The two required analyses are (1) a socioeconomic analysis under Health and Safety Code section 40728.5, and (2) an incremental cost analysis under H&SC section 40920.6. The California Health & Safety Code states, in part, that air districts shall endeavor to achieve and maintain state ambient air quality standards for ozone, carbon monoxide, sulfur dioxide, and nitrogen dioxide by the earliest practicable date. In developing regulations to achieve these objectives, air districts shall consider the cost effectiveness of their air quality programs, rules, regulations, and enforcement practices in addition to other relevant factors, and shall strive to achieve the most efficient methods of air pollution control. However, priority shall be placed upon expeditious progress toward the goal of healthful air.

Since these economic analyses are specific to the particular rules, they are not addressed in the main body of this document. The cost effectiveness analysis for Rule 9-14: Petroleum Coke Calcining, may be found in the Staff Report for that proposed rule. The cost effectiveness analyses for Regulation 6, Rule 5 and amendments to Regulation 8, Rule 18 and Regulation 11, Rule 10 may be found in the appendices specific to those rules.

VI. SOCIOECONOMIC IMPACTS

Section 40728.5 of the California Health and Safety Code requires an air district to assess the socioeconomic impacts of the adoption, amendment or repeal of a rule if the rule is one that "will significantly affect air quality or emissions limitations". Applied Development Economics of Walnut Creek, California has prepared a socioeconomic analysis of proposed new Regulation 6, Rule 5 and amendments to Regulation 8, Rule 18 and Regulation 11, Rule 10. This analysis is based on the costs of compliance with the proposed regulations, and is attached to this report as Appendix E. The analysis concludes that the socio-economic impacts of compliance with the requirements of these rules are less than significant. Moreover, because affected sources are not small businesses, small businesses are not disproportionately impacted by the proposed rule changes.
Rule 9-14 impacts a coke calciner, which operates in a different economic context from the refineries. Therefore, it was evaluated in its own, separate socioeconomic report. Rule 9-14 would have a significant impact on the effected facility.

VII. ENVIRONMENTAL IMPACTS

Pursuant to the California Environmental Quality Act, the District has had an initial study prepared by Environmental Audit, Inc. of Placentia, California for the proposed new Regulation 6, Rule 5, Regulation 9, Rule 14 and amendments to Regulation 8, Rule 18 and Regulation 11, Rule 10. The initial study concludes that there are no potential significant adverse environmental impacts associated with these proposed amendments. A negative declaration is proposed for approval by the District Board of Directors. The negative declaration and initial study are available to the public for comment (see Appendix F).

VIII. REGULATORY IMPACTS

Section 40727.2 of the California Health and Safety Code requires an air district, in adopting, amending, or repealing an air district regulation, to identify existing federal and air district air pollution control requirements for the equipment or source type affected by the proposed change in air district rules. The air district must then note any differences between these existing requirements and the requirements imposed by the proposed change. The regulatory impacts analysis for Rule 9-14: Petroleum Coke Calcining, may be found in the Staff Report for that proposed rule. The regulatory impacts analyses for Regulation 6, Rule 5 and amendments to Regulation 8, Rule 18 and Regulation 11, Rule 10 may be found in the appendices specific to those rules.

IX. RULE DEVELOPMENT AND PUBLIC CONSULTATION PROCESS

During this multi-phased rule development effort staff endeavored to engage all interested stakeholders, including affected industry, nearby community members, environmental organizations, other governmental agencies, the media, and other interested parties. There are several aspects to this public engagement, including:

- Development of conceptual versions of draft rules with discussions of those concepts;
- An advanced Call for Comments, released May 26, 2015, which included:
    - Petroleum Refinery Emissions Reduction Strategy: Initial Report
    - Concept Papers addressing each of the draft rules and rule amendments
    - Draft rule and rule amendment language
- Hosting a series of Refinery Rules Open House Workshops to solicit public input / comment on the Petroleum Refinery Emissions Reduction Strategy: Workshop Report, and revised concept papers for each of the draft new rules and draft rule and rule amendments. The Open Houses were held in the following locations:
    - Martinez on September 15, 2015,
    - Benicia on September 17, 2015, and
    - Richmond on September 28, 2015;
- Meetings and consultations (community meetings, phone conversations, emails, letters) with interested stakeholders in less formal settings to discuss concerns and issues;
- Preparation of a regulatory package for the consideration of the Air District Board of Directors, including:
    - Proposed regulatory language;
    - A Staff Report presenting the staff's findings, such as descriptions of the refining industry, regulatory history, summary and explanation of the proposal, emissions and emission reductions estimates, costs, cost effectiveness and incremental cost effectiveness, environmental and socioeconomic impacts, a schedule of implementation (when the provisions of the rule become effective if adopted), and staff recommendations to the Board of Directors;
    - An environmental analysis report;
    - A socioeconomic analysis report;
    - A discussion of and responses to comments received on the proposed rule, staff report, and environmental and socioeconomic analyses; and
- Public Hearing, where the staff's presentation is made and stakeholders may provide testimony to the Board of Directors on the staff proposal and at which the Board would consider the adoption of the proposal.

Appendix F of this document contains a summary of the comments received during the advanced call for comments and the workshop phases of the rulemaking effort along with Staff's responses to those comments.

X. PRELIMINARY SCHEDULE OF THE PETROLEUM REFINERY EMISSION REDUCTION STRATEGY REGULATORY DEVELOPMENT

Table 9 provides a preliminary schedule for the development of each of the two phases of the regulatory effort. It should be noted that these are only rough estimates of the schedule and the dates may change as the effort proceeds.

Table 9:
Schedule of the Petroleum Refinery Emission Reduction Strategy Regulatory Development

Milestone	Phase 1	Phase 2
Concepts	April 2015	April 2015
Workshops	3rd Quarter 2015	2ND Quarter 2016
Public Hearing	4th Quarter 2015	3RD Quarter 2016

XII. COST RECOVERY

The Air District has the authority to assess fees to regulated entities for the purpose of recovering the reasonable costs of implementing and enforcing applicable regulatory requirements. On March 7, 2012, the Air District's Board of Directors adopted a Cost Recovery Policy that specifies that newly adopted regulatory measures should include fees that are designed to recover increased regulatory program activity costs associated with the measure (unless the Board of Directors determines that a portion of those costs should be covered by tax revenue).

In accordance with the adopted Cost Recovery Policy, Air District staff is developing a new fee schedule to be included in Regulation 3, Fees.

XIII. CONCLUSION

Pursuant to Section 40727 of the California Health and Safety Code, the proposed new rules must meet findings of necessity, authority, clarity, consistency, non-duplication, and reference. Proposed new Regulation 6, Rule 5 and amendments to Regulation 8, Rule 18 and Regulation 11, Rule 10 are:

- Necessary to ensure the attainment and maintenance of the NAAQS and California Ambient Air Quality Standard (CAAQS)[11] and ensure protection of the public from toxic air contaminants

[11] The Bay Area is designated as a non-attainment area for the State 8-hour and 1-hour standard and the National 8-hour standard for ozone; and the State standards for fine particulate matter ($PM_{2.5}$). [http://www.baaqmd.gov/research-and-data/air-quality-standards-and-attainment-status]

given the size and impact of the refineries;
- Authorized under Sections 40000, 40001, 40702, 40725 through 40728, and 44391 of the California Health and Safety Code;
- Written or displayed so that their meaning can be easily understood by the persons directly affected by them;
- Consistent with other Air District rules, and not in conflict with state or federal law;
- Non-duplicative of other statutes, rules or regulations; and
- Implementing, interpreting or making specific the provisions of the California Health and Safety Code Sections 40000, 40702, and 44391.

The proposed new rules have met all legal noticing requirements, have been discussed with the regulated community, and reflect consideration of the input and comments of many affected and interested parties. Air District staff recommends adoption of proposed new Regulation 6, Rule 5 and amendments to Regulation 8, Rule 18 and Regulation 11, Rule 10.

APPENDICES

Appendix A: Rule 6-5: Fluidized Catalytic Cracking Units (FCCU)
Appendix B: Changes to Rule 8-18: Equipment Leaks
Appendix C: Changes to Rule 11-10: Toxic and ROG emissions from Cooling Towers
Appendix D: California Environmental Quality Act, Negative Declaration
Appendix E: Socio-Economic Analysis
Appendix F: Comments Received and Staff Responses

Appendix A:
Concept Paper for Rule 6-5: Fluidized Catalytic Cracking Units (FCCU)

Rules to Be Amended or Drafted

District staff proposes new Regulation 6, Rule 5, *Particulate Emissions from Refinery Fluidized Catalytic Cracking Units* (Regulation 6-5) to reduce emissions of fine particulate matter (PM) from fluidized catalytic cracking units (FCCUs) at petroleum refineries.

Goals

The goal of this rulemaking is to achieve emission reductions of fine PM ($PM_{2.5}$ and $PM_{2.5}$ precursors) from FCCUs at Bay Area refineries. The Air District plans to do this in two actions as described in the staff report. The first action will be a new ammonia emission limit at FCCUs. Ammonia is primarily a concern because of its role as a precursor to the formation of fine, condensable PM at the FCCU exhaust. This occurs when ammonia in the FCCU exhaust reacts with compounds such as NOx and SOx, and the resulting compounds condense into fine PM once emitted from the FCCU exhaust. Thus, the proposed ammonia emission limit is an indirect limit on the emission of fine, condensable PM.

The second action will be a later amendment of Regulation 6-5 to directly address emissions of condensable PM and emissions of another fine PM precursor: SO_x. The specific measures to be proposed in the second action depend on the emission reductions achieved by the first action.

Background

FCCUs are complex processing units at refineries that convert heavy components of crude oil into light, high-octane products that are required in the production of gasoline. This conversion reaction is promoted with the use of a fine, powdered catalyst in the FCCU reactor vessel. During the reaction phase, the catalyst becomes coated with petroleum coke, which is burned off in the FCCU regenerator vessel so that the catalyst can be reused. This process and equipment are shown in Figure 1.

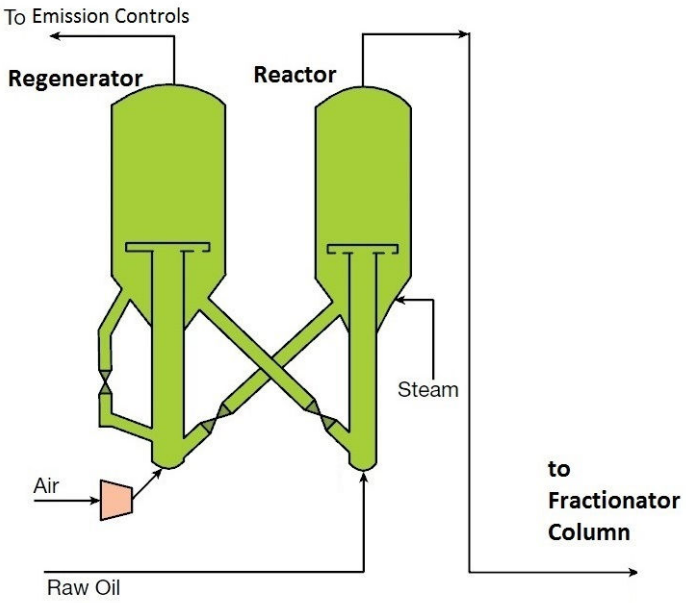


Figure 1 – FCCU Process

The emission stream from the FCCU results from the combustion gas created in the regeneration vessel exhaust. In addition to the pollutants that originate in the regeneration process—particulate matter (PM), sulfur dioxide (SO_2), carbon monoxide (CO), oxides of nitrogen (NO_x), and volatile organic compounds (VOC)—other pollutants, such as ammonia and additional NOx, are introduced or created downstream of the regeneration vessel. Most of the ammonia that is ultimately emitted from the FCCU exhaust is introduced downstream of the regenerator either to suppress NOx formation or to increase the effectiveness of electrostatic precipitators (ESPs) in removing PM from the FCCU exhaust.

The Bay Area has five petroleum refineries. Four of these, Chevron, Shell, Tesoro and Valero, operate FCCUs. The Valero refinery has recently retrofitted its FCCU with a wet scrubber and therefore has lower $PM_{2.5}$ and SO_2 emissions than the other refineries. The Chevron and Tesoro FCCUs use ammonia to control filterable particulate matter emissions in ESPs, resulting in unreacted ammonia being emitted to the atmosphere (*ammonia slip)*. The Shell FCCU uses ammonia or urea injection to control NO_x emissions, as well as to improve ESP operation. Valero would be exempt from the proposed rule because the rule includes an exemption for FCCUs that are controlled by wet scrubbers that have been determined to be "best available control technology" (BACT).

Regulatory History and Context

There are currently no Air District regulations that apply to ammonia emissions from FCCUs. There are two federal standards in part 60 that may apply to FCCUs, depending on the year of construction, reconstruction, or modification, but neither one applies limits to ammonia emissions.[1]

Emissions

Based on recent source tests, ammonia concentrations at the FCCU catalyst regeneration outlet (post-control) are 29 parts per million by volume (ppmv) at the Chevron refinery and 23 ppmv at the Shell refinery. Test data are not available for the Tesoro refinery, but Tesoro is permitted to inject twice as much ammonia as the Chevron refinery actually uses. Also, District staff estimates the following condensable PM emissions from FCCUs:

Facility	2013 Condensable PM FCCU Emissions (tpy)
Chevron	255
Shell	98
Tesoro	91

Regulatory Concepts and Proposed Regulations

In 2003, South Coast AQMD adopted an ammonia emission limit of 10 ppmv, corrected to 3 percent oxygen, for FCCUs in their Rule 1105.1. Air District staff is proposing the same limit in Regulation 6, Rule 5. Staff is also proposing a continuous emission monitoring system (CEMS), whereas the South Coast AQMD requires annual source tests. An emission limit of 10 ppmv, also corrected to 3% oxygen, was recently imposed at the Bay Area Valero refinery FCCU in an Air District permit. The South Coast limit in Rule 1105.1 and Valero's FCCU limit appear to be the most stringent ammonia emission limits imposed on refinery FCCUs.

[1] 40 CFR part 60, subpart J, *Standards of Performance for Petroleum Refineries* and 40 CFR part 60, subpart Ja, *Standards of Performance for Petroleum Refineries for which Construction, Reconstruction, or Modification Commenced after May 14, 2007*

Although District staff is proposing a stringent ammonia emission limit, they recognize that ammonia and urea injection are used to promote PM control at FCCUs with electrostatic precipitators (ESPs) and that these ESPs are subject to District and federal PM emission limits. Staff also recognize that fine PM, rather than ammonia itself, is the FCCU emission of greater concern. Therefore, and as suggested by WSPA in response to an earlier draft of Regulation 6-5, the proposed rule includes an exception to the 10 ppmv ammonia limit for a refinery that successfully performs an ammonia optimization to establish the level of ammonia and/or urea injection that will minimize overall fine PM emissions at the FCCU which still complying with other, existing FCCU emission limits, and that also accepts an enforceable ammonia emission limit at this optimized injection rate.

Control Mechanisms

Staff believes that the three refineries that operate FCCUs that would be subject to the 10 ppmv ammonia emission limit will all elect to perform an ammonia optimization because this approach has the potential to achieve significant reductions in ammonia, and in related emissions of condensable PM, with no capital expenses or significant new operating costs.

Costs and Emissions Reductions

Although there will be one-time optimization costs, reduced use of ammonia and urea could result in long-term cost savings.

Emission reductions are based on current emission rates of 29 ppmv (Chevron) and 23 ppmv (Shell) being reduced to 10 ppmv, then applying the resulting percentage reduction to the associated mass emissions of ammonia at each refinery. Because of a lack of test data, the Tesoro emission reduction is assumed to be the same as at Shell. For the ammonia optimization option, reduction are assumed to be half of those that would result from compliance with the 10 ppmv limit. For condensable PM, the goal of either a simple reduction in ammonia injection to achieve 10 ppmv ammonia slip, or an optimization of ammonia use is a 50% reduction in total condensable PM emissions.

Facility	Ammonia Reduction (tpy)		Condensable PM Reduction (tpy)	Capital Cost ($ M)	Total Annualized Cost ($ M)
	10 ppmv limit	Optimization			
Chevron	58	29	128	0*	0*
Shell	15	7.5	49	0*	0*
Tesoro	15**	7.5	46	0*	0*

*The optimization option in Regulation 6-5 should not require capital investment or significant additional operating costs.

**Assumed to be the same as Shell refinery from reduced use of ammonia injection.

Regulatory Impacts

Section 40727.2 of the California Health and Safety Code requires an air district, in adopting, amending, or repealing an air district regulation, to identify existing federal and air district air pollution control requirements for the equipment or source type affected by the proposed change in air district rules. The air district must then note any differences between these existing requirements and the requirements imposed by the proposed change. Appendices E and F identify the federal and air district

control requirements that affect the sources potentially impacted by draft Regulation 12-15 and 12-16, respectively.

Economic Impacts

The California Health and Safety Code generally requires two different economic analyses for proposed regulations by an air district. The first (H&S Code §40728.5) is a socioeconomic analysis of the adverse impacts of compliance with the proposed regulation on affected industries and business. The second analysis (H&S Code §40920.6) is an incremental cost effectiveness analysis when multiple compliance approaches that have been identified by an air district. These analyses are discussed below:

Socio-Economic Analysis (H&S Code §40728.5)

Section 40728.5 of the California Health and Safety Code requires an air district to assess the socioeconomic impacts of the adoption, amendment or repeal of a rule if the rule is one that "will significantly affect air quality or emissions limitations". Applied Development Economics of Walnut Creek, California has prepared a socioeconomic analysis of draft Regulation 6-5. This analysis is based on the costs of compliance with the draft regulation discussed above, and is attached to the staff report. The analysis concludes that the socio-economic impact of compliance with the requirements of Regulation 6-5 is less than significant.

Incremental Cost Evaluation (H&S Code §40920.6)

Section 40920.6 of the California Health and Safety Code requires an air district to perform an incremental cost analysis for any proposed Best Available Retrofit Control Technology rule or "feasible measures" rule when the air district has identified more than one potential control option to achieve the emission reduction objectives of the rule. Because District staff believes that the three affected refineries will elect to perform an ammonia optimization, with no capital expenses or significant new operating costs, there is no basis to calculate incremental cost-effectiveness.

Appendix B:
Changes to Rule 8-18: Equipment Leaks

Rules to Be Amended or Drafted

Regulation of equipment leaks at oil refineries requires amendments to Regulation 8, Rule 18, *Equipment Leaks* (Rule 8-18).

Goals

The goal of this rulemaking is to achieve further reductions in fugitive emissions of volatile organic compounds (including toxic organics) at refineries.

Background

Oil refineries, chemical plants, bulk plants, bulk terminals, and other facilities that store, transport, and use volatile organic liquids lose some organic material as fugitive emissions wherever there is a connection between two pieces of equipment. Valves, pumps, and compressors can also leak organic material. Rule 8-18 requires such facilities to maintain a leak detection and repair (LDAR) program. The purpose of the LDAR program is to ensure that all equipment is inspected regularly and, if a leak is found to exceed the leak threshold, the equipment must be repaired, replaced, or placed on limited list of non-repairable equipment. Currently, equipment in heavy liquid service[1] is only subject to the applicable leak standards in Section 8-18-300. However, these components are not subject to the routine inspection requirements contained in Section 8-18-400. Without routine inspections of equipment in heavy liquid service, leaks may not be found and repaired.

Process and Source Description

Component leaks commonly occur at the joints or connections between sections of piping, at valves, at pumps or from barrier fluid contained between seals, and at leaking pressure relief devices (PRDs).

Regulatory History and Context

The Air District originally adopted Rule 8-18 in 1980 and has amended it twice, first in 1992 and again in 2004. In addition, some minor changes were made to the rule in 1998 and 2002. The original intent of the rule was to control fugitive organic gas leaks from valves and connectors at refineries, chemical plants, bulk plants, and bulk terminals. Rule amendments adopted in 1992 significantly lowered the allowable leak concentration limits to the lowest levels in the country and required more effective inspection and repair programs in order to reduce emissions and promote self-compliance. The 1992 amendments reduced emissions by an estimated 1.2 tons per day (tpd).

The allowable leak standard is 500 parts per million volume (ppmv) for pumps, compressors, and PRDs.[1] For valves and other equipment, the allowable leak standard is 100 ppmv. Leaks are detected using a portable combustible gas indicator.

The U.S. Environmental Protection Agency (EPA) has promulgated LDAR standards for facilities in the synthetic organic chemical manufacturing industry but not for petroleum refineries. The EPA's standards in 40 CFR parts 60 and 63 include LDAR provisions for monitoring and repairing equipment in heavy liquid service and do not rely on instrumental monitoring, but instead rely on "visual, audible, olfactory, or any other detection method."

[1] PRDs are also subject to the requirements of Air District Regulation 8, Rule 28, *Episodic Releases from Pressure Relief Devices at Petroleum Refineries and Chemical Plants*.

Emissions

There are five large refineries operating within the jurisdiction of the Bay Area Air Quality Management District (Air District). Table B-1 summarizes the total equipment inventory regulated under Air District Regulation 8-18 at the five major refineries in the Bay Area for the calendar year 2013.

Table B-1: Fugitive Equipment Component Counts[1]

Valves	Pumps & Compressors	Pressure Relief Devices[2]	Connectors[3]	Total TOG (TPY)[4]
273,239	2,705	1,142	1,016,636	2,402

[1]Counts do not include components in heavy liquid service.

[2]The count includes atmospheric PRDs only.

[3]Connector counts are not required to be identified per Section 8-18-402.1 nor monitored per Section 8-18-401 unless refineries desire the repair period allowance of Section 8-18-304.2. Only two Bay Area refineries record all connector measurements, while three refineries record only connectors with leaks that exceed the standard. An average multiplier (3.5 x total valve inventory) was used to determine the total connector count for facilities that did not record all connector counts.

[4]Total organic emissions from the 2013 BAAQMD Emissions Inventory.

Regulatory Concepts and Proposed Regulations

The Air District is considering the following changes to Regulation 8, Rule 18, which would:

- Become effective January 1, 2018:
  - Include identification of all equipment in heavy liquid service,
  - Monitoring of heavy liquid service valves, pumps and PRDs; and
  - Subject heavy liquid service valves, pumps and PRDs to leak minimization and repair requirements;
- Amend the non-repairable equipment standard to reduce the allowable amount of equipment placed on non-repairable list;
- Identify the cause of any background reading greater than 50 ppmv;
- Require mass emission monitoring for all equipment placed on the non-repairable equipment list; and
- Add a maximum leak concentration and/or mass emissions limit for fugitive equipment subject to the rule.

In addition, administrative changes to rule language will be made to improve clarification and enforceability of the rule.

Monitoring of Equipment in Heavy Liquid Service

Based on the Air District's 2013 emissions inventory, fugitive emissions from the heavy liquid equipment listed above are estimated at 1,476 tons per year (excluding methane). However, equipment in heavy liquid service is not currently subject to routine inspection and repair under Air District Regulation 8, Rule 18.

Table B-2 summarizes equipment in heavy liquid service at the five major refineries.

Table B-2: Heavy Liquid Service Equipment Fugitive Component Counts

Facility	Valves	Pumps	Pressure Relief Devices[1]	Connectors[2]
Chevron	32,228	1,859	62	127,977
Phillips 66	6,655	293	6	27,350
Shell	12,734	337	20	37,361
Tesoro	10,976	250	70	38,416
Valero	15,570	193	0	56,596
Total	**78,163**	**2,932**	**158**	**287,700**

[1] The count includes atmospheric PRDs only.

[2] An average multiplier (3.5 x total valve inventory) was used to determine the total connector count for facilities that did not provide an accurate connector count.

Effective January 1, 2018, the Air District will require all facilities subject to the rule to identify, routinely monitor heavy liquid equipment within their current LDAR program. A main issue mentioned by the regulated community was their belief that it was not necessary to monitor equipment in heavy liquid service (initial boiling point greater than 302^{o}F) because these produce minimal emissions. A similar issued was raised by industry was amended in 1992. The Air District's response to industry still applies today.

This suggests that organic compounds larger than C_9 do not emit. However, these are the organic compounds that the majority of the current District rules control. Currently, the Air District coating rules regulate the organic compounds called mineral spirits. Based upon the comments above from industry, mineral spirits are considered a heavy organic compound. The current rule does not exempt heavy liquid equipment from the applicable emission standards in the rule which implies the potential of this equipment to emit. The Air District believes the facility should be held responsible to inspect and maintain all equipment subject to the standards of the rule.

Reducing the Amount of Equipment on Non-Repairable List

The Air District established the non-repairable list to allow sources to delay repairs of essential equipment for five years or until the next scheduled turnaround, whichever comes first.[2] Essential equipment is defined as any equipment that cannot be removed from service unless the process unit is shut down and the component is isolated. This activity would likely create more emissions than the actual fugitive leaks.

The five refineries in the Bay Area currently have an average of 24 pieces of equipment, mostly valves and connectors, on their non-repairable equipment lists.[3] The average percentage of valves and connectors on a non-repairable list is 0.04 percent (allowable percentage of valves including connectors is 0.30 percent), which indicates the LDAR programs implemented at the five refineries can achieve a much lower fraction of equipment placed on a non-repairable list than the fraction currently allowable by the rule.

[2] BAAQMD Regulation 8, Rule 18, Section 306.1.

[3] Average non-repairable equipment count calculated with each connector counted as two valves pursuant to Section 8-18-306.3.

In addition, the Air District has accounted for the increased equipment inventory with the inclusion of heavy liquid equipment monitoring. If the heavy liquid equipment produces the minimal emissions claimed by industry, then the added heavy liquid equipment inventory will compensate for the lowered non-repairable percentages by affording each facility additional equipment allowed on the non-repairable list.

Further efforts in eliminating equipment from the non-repairable list may enable LDAR programs to approach the point where non-repairable equipment lists would no longer be necessary and the issue of non-repairable equipment could be addressed by other means.

Mass Emissions Determination for Equipment on Non-Repairable List
Because all equipment placed on the non-repairable list is allowed to leak above the applicable leak standard for up to five years, the mass emission rate of any equipment placed on the non-repairable equipment list should be determined and should not exceed a mass emissions limit. A mass emissions limit on non-repairable equipment provides an incentive to replace or repair the high emitting equipment as soon as possible, which is better than allowing equipment to remain on the non-repairable list up to five years, regardless of its emission rate.

Addition of a Fugitive Mass Emission Limit
Leak standards are expressed as concentration-based limits rather than mass-based limits to better allow field staff to quickly determine compliance. Mass emissions are determined by quantifying both the concentration and the flow rate of a leak. It is possible that low concentration leaks may have a high flow rate resulting in significant emissions. Currently, monitoring of mass emissions is only required for those valves that leak organic compounds greater than 10,000 ppm (a “major leak”) for more than 45 days. No Bay Area refinery has triggered this requirement to date, and therefore, no mass emissions monitoring has been done.

Clarification of the Leak Repair Definition
The current rule requires any leak discovered by the operator and not repaired within 24 hours to be minimized within the first 24 hours following leak discovery. The minimization must be done using best modern practices to reduce the leak to the lowest achievable level, regardless of whether the leak is ultimately repaired within the allowed seven days or placed on the non-repairable equipment list.

Many facility owner/operators incorrectly believe cleaning leaking equipment with soap and/or water complies with the best modern practice requirement. As stated in the Air District’s September 2013 Compliance Advisory, leak minimization should include some type of repair attempt, which may include tightening bolts, replacing bolts, tightening packing gland nuts, and injecting lubricant into packing. The Air District intends to clarify what is required for leak minimization by amending the definition language to identify specific types of minimization methods. Also, the definition will state that cleaning, scrubbing, or washing equipment alone is not considered best modern practice.

Identification of High Background Readings
Leak limits are expressed as “above background” where *background* is defined as, “The ambient concentration of total organic compounds determined at least three meters (10 feet) upwind from the equipment to be inspected and not influenced by any specific emission point as indicated by a hydrocarbon analyzer specified by Section 8-18-501.” A review of 2013 monitoring data from the five refineries identified numerous instances of high background concentrations, including a case with a

background of 500 ppmv (five times the existing leak standard for equipment other than a pump or pressure relief device and equal to the limit for pumps and pressure relief devices). To address high background concentrations, the Air District is considering a new requirement that would require identification of the cause of any background reading greater than 50 ppmv (half the existing leak standard). Identification of a cause for elevated background concentrations may identify other equipment in need of repair or replacement.

Control Mechanisms

The Air District proposes no new control mechanisms, only expansion and improvement of the existing LDAR program.

Costs and Emissions Reductions

Table B-3 shows VOC emission reductions and costs associated with improvements to the LDAR program.

Table B-3: Emissions Reductions and Costs

Facility	Emission Reduction (tpy)	Capital Cost ($ M)	Total Annualized Cost ($ M)
Chevron	641	$0.11	$2.6
Phillips 66	117	$0.02	$0.70
Shell	156	$0.04	$0.90
Tesoro	143	$0.03	$1.4
Valero	170	$0.05	$1.2
Total	**1,227**	**$0.25**	**$6.8**

Incremental Cost

Under Health and Safety Code section 40920.6, the District is required to perform an incremental analysis when adopting a Best Available Retrofit Control Technology (BARCT) rule or feasible measure required by the California Clean Air Act. To perform this analysis, the District must (1) identify one or more control options achieving the emission reduction objectives for the proposed rule, (2) determine the cost effectiveness for each option, and (3) calculate the incremental cost effectiveness of each option.

Option 1

The Air District considered the option of monitoring piping connectors quarterly, rather than annually. Monitoring costs increase by $12.00 per connector, or $3.45 M annually. Expected emission reductions from this increased monitoring frequency is estimated to be approximately 40 tons per year, so the incremental cost effectiveness of this option is more than $86,000 per ton.

Option 2

The Air District considered the option of continuing to allow each refinery to monitor heavy liquid equipment using the "visual, audible, olfactory, or any other detection method" approach. This option was not considered adequate because the emission factor studies done to quantify emissions from heavy liquid equipment were conducted in facilities where equipment with significant leaks were found undetected using the visual, audible, olfactory methods.

Other Impacts

Regulatory Impacts

California Health and Safety Code section 40727.2 requires the District to identify existing federal air pollution control requirements for the equipment or source type affected by the proposed rule or regulation. The District must then note any differences between these existing requirements and the requirements imposed by the proposal.

Regulation 8, Rule 18: Equipment Leaks applies to fugitive emissions from valves, pumps, compressors, pressure relief devices, connection and any other component that may have fugitive leaks. The proposal expands the applicability or the current rule to equipment in heavy liquid service.

Numerous federal requirements apply to fugitive emissions at the facilities subject to Regulation 8, Rule 18. New sources are subject to New Source Performance Standards found in 40 CFR Part 60, Subpart VV/VVa (Equipment Leaks of VOC in the Synthetic Organic Chemicals Industry) and Subpart GGG/GGGa (Equipment Leaks of VOC in Petroleum Refineries). Other sources are subject to National Emission Standards for Hazardous Air Pollutants (NESHAPS) found in 40 CFR Part 61, Subpart V (National Emission Standards for Equipment Leaks (Fugitive Emission Sources)), and to 40 CFR Part 63, Subpart CC (National Emission Standards for Petroleum Refineries). Table 1 below is a simplified comparison between BAAQMD and federal requirements.

Table 1 - **Comparison of the Basic Provisions of the Fugitive Emissions Rules of Federal and BAAQMD**

BAAQMD Regulation 8 Rule 18	40 CFR 60 VV/VVa & GGG/GGGa 40 CFR 63 CC
Applicability	
Components at petroleum refineries, chemical plants, bulk plants and bulk terminals.	Affected equipment in petroleum refineries, synthetic organic chemicals manufacturing facilities, and onshore natural gas processing plants.
Requirements	
LDAR program including quarterly inspection of equipment in light liquid/gas/vapor. Connectors in light liquid/gas/vapor service and inaccessible equipment inspected annually.	Pumps and valves inspected monthly. Valves in light liquid/gas/vapor service inspected monthly. After two monthly inspections without leaks, equipment may be inspected quarterly until a leak is detected.
Leak threshold at 100 ppm for any general	Leak threshold at 10,000 ppm for pumps and

BAAQMD Regulation 8 Rule 18	40 CFR 60 VV/VVa & GGG/GGGa 40 CFR 63 CC
equipment, valves and connectors. Leak threshold of 500 ppm for any pumps, compressors and PRDs.	valves in heavy liquid service.
Leaks detected by operator minimized within 24 hours and repaired within 7 days Leaks detected by BAAQMD repaired within 24 hours A percent of non-repairable equipment may delay repair until unit turnaround.	Pump, valves, PRDs and connectors in light liquid service/gas/vapor service leak threshold at 10,000 ppm. Compressors required to have a seal system with barrier fluid. PRDs in gas/vapor service leak threshold at 500 ppm
	Leaks > 10,000 ppm 15 days repair maximum, first attempt at repair with 5 days.
Recordkeeping and Reporting	
Submit quarterly reports of non-repairable equipment and their leak rates. Submit equipment inventory report annually	Submit semiannual reports containing the number of equipment by type that were repaired and for which repair was delayed and the reason for delay
Test Methods	
U.S. EPA Method 21 for leak screening, ASTM Method D-86 for VOC content of liquids and EPA Protocol for Equipment Leak Emissions Estimates, Chapter 4 or monitoring for mass emission sampling.	U.S. EPA Method 21 for leak screening, ASTM E-260, E-168, E-169 for the VOC content, ASTM Method D-2879 for vapor pressure.
Exemptions	
Pressure vacuum valves on storage tanks not exempt from District Regulation 8 Rule 5	Components operating under negative pressure, pumps with closed vent system, PRDs vented to a control device.
Controlled seal systems and PRDs vented to a vapor recovery system or disposal system which reduces emissions of organic compounds by 95% or greater.	
Equipment in vacuum service	

This proposal is not duplicative of any current requirements for equipment in heavy liquid service.

Appendix C:
Changes to Rule 11-10: Cooling Towers

Rules to Be Amended or Drafted

Regulation of organic gases and toxic air contaminants from cooling towers at refineries requires amendment to Air District Regulation 11, Rule 10, *Hexavalent Chromium Emissions from Cooling Towers* which will be renamed *Hexavalent Chromium from All Cooling Towers and Total Hydrocarbon Emissions from Petroleum Refinery Cooling Towers*.

Goals

The goal of this rulemaking is to achieve technically feasible and cost-effective total hydrocarbon (THC) and toxic air contaminant emission reductions from cooling towers at Bay Area refineries by requiring more rapid detection of heat exchanger leaks.

BACKGROUND

The Bay Area has five large-scale petroleum refineries which operate a total of 34 permitted cooling towers. These cooling towers are large, industrial heat exchangers that are used to dissipate significant heat loads to the atmosphere through the evaporation of water. When heat exchanger leaks go undetected for long periods of time, significant quantities of organic compounds can be stripped from the cooling tower water and emitted to the atmosphere. The following table (Table C1) provides the distribution of cooling tower throughout the five refineries.

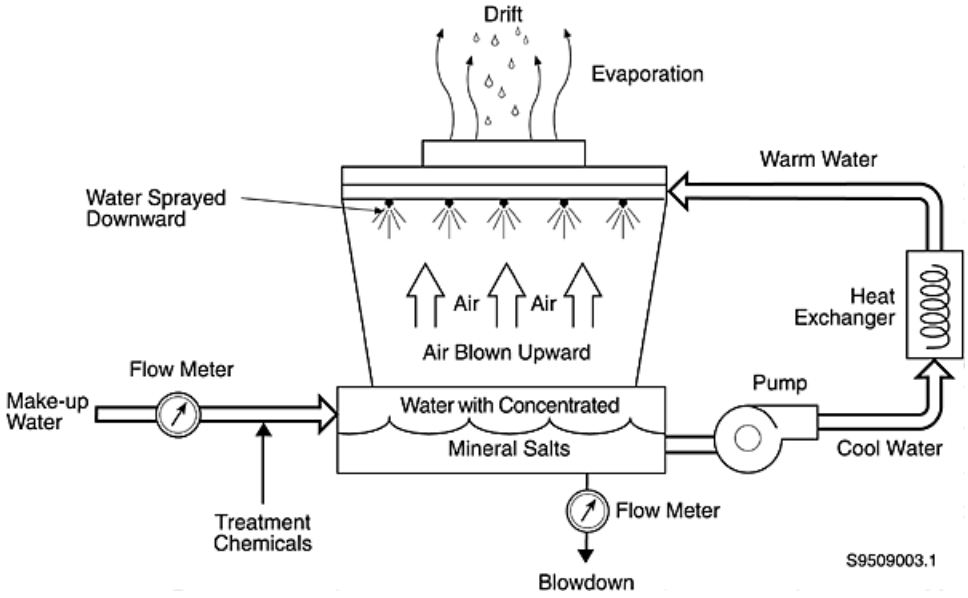
Table C1
Number of Affected Cooling Towers at Each Refinery

Facility	Number of Cooling Towers
Chevron	8
Shell	5
Tesoro	13
Phillips 66	7
Valero	1
TOTAL	**34**

Process and Source Description

Cooling towers are part of a heat exchange system consisting of a device or a collection of devices used to transfer heat from process fluids to water without intentional direct contact of the process fluid with the water and to transport and/or cool the water in a closed-loop system (cooling tower system). Figure C1 (below) depicts a basic cooling tower structure.

Figure C1 – Cooling Tower



Cooling towers can be designed as either natural draft or mechanical draft devices. Natural draft cooling towers are large hyperbolic structures that look similar to those found at nuclear power plants. They use natural convection of warmed air to create air to cool the water. Mechanical draft cooling towers use large fans to force air either through or across the water to cool it.

Regardless of the design, a small proportion of the cooling water is entrained in the updraft as mist, commonly called *drift*. When the water in the droplets evaporates, any dissolved solids in the cooling water form particulate matter.[1]

When heat exchanger leaks occur (from process fluids leaking into cooling water), the volatilization of hydrocarbons and/or Toxic Air Contaminants (TACs) in the contaminated cooling water lead to emissions. Such leaks tend to occur when heat exchanger tube sheets fail or when tubes rupture as a result of corrosion or the use of inferior materials during the exchanger construction process.

Emissions resulting from leaks can become significant if heat exchanger leaks go undetected for long periods of time. In 2010 a heat exchanger leak at a Bay Area refinery resulted in emissions of at least 52 tons of VOC over a recorded period of a few weeks. The total magnitude of emissions from the leak event was greater; emissions from the event were only estimated once the leak was detected, which was likely weeks if not months after the leak began.

Regulatory History and Context

District Regulation 11, Rule 10 was developed in 1989 to reduce hexavalent chromium emissions from cooling towers.

In 2009, The U.S. Environmental Protection Agency (EPA) promulgated, and in 2013 amended, 40 CFR part 63, subpart CC, *National Emission Standards for Hazardous Air Pollutants from Petroleum Refineries*

[1] Cooling tower water frequently contains additives such as biocides, anti-foaming agents and anti-scaling agents, any of which could be emitted as particulate matter

(MACT[2] CC). Section 63.654 in MACT CC requires periodic monitoring (monthly or quarterly) of heat exchangers in organic hazardous air pollutant (HAP) service within the heat exchange system for leaks of organic gases, unless:

- the minimum pressure on the cooling water side is at least 35 kilopascals (5.1 psi or 10 inches of mercury) greater than the maximum pressure on the process side, or
- if an intervening fluid containing less than 5 percent by weight of organic HAP is employed between the process fluids and cooling water (provided the intervening fluid is used solely to isolate the process fluids & cooling water and is not is not sent through the cooling tower or discharged).

MACT CC requires leaks to be repaired as soon as practicable after they are discovered.[3] But, not all cooling towers are subject to the monitoring, leak, and repair requirements of MACT CC.[4]

PROPOSED AMENDMENTS

Cooling Tower Emissions have been addressed by the Texas Commission on Environmental Quality (TCEQ). The TCEQ developed Chapter 115 – Control of Air Pollution from Volatile Organic Compounds, SUBCHAPTER H: HIGHLY-REACTIVE VOLATILE ORGANIC COMPOUNDS to address Highly Reactive Volatile Organic Compound (HRVOCs) emissions from industrial cooling towers. As part of its strategy to better control HRVOC emissions, the TCEQ modified a water sampling technique known as the Texas El Paso Method, now referred to as the Modified El Paso Method (MEPM), and required Texas petroleum refineries to use the MEPM to detect strippable hydrocarbons from leaking cooling tower heat exchange systems.[5]

The Texas El Paso Method, developed in the 1970's employs a "dynamic" or "flow-through" system for air stripping a sample of cooling tower water and analyzing the resultant off-gases for VOCs using a common flame ionization detector (FID) analyzer. The TCEQ developed the MEPM to concentrate on the measurement of strippable hydrocarbons, compounds with lower molecular weights and boiling points that are generally lost when sampled for purge/trap analyses. When the MEPM is applied, a continuous stream of cooling water is sampled directly into an air stripping column apparatus. Air flowing countercurrent to the cooling water strips HRVOCs from the water for analysis.

The Air District's staff is concerned about the MEPM sampling method's ability provide representative hydrocarbon emissions data on a consistent basis. The Air District will allow the MEMP sampling method to be used as one of three possible THC detection methods provided the petroleum refineries follow the Air District's Manual of Procedures methodology that will update the MEPM by July 1, 2016, the effective date for Regulation 11, Rule 10. A second method of THC detection Regulation 11, Rule 10 will allow is via water sampling for lab analysis. It is a very accurate THC detection method providing water samples are taken properly to protect the integrity of the sample and providing the correct EPA lab analysis methodologies (8260 and 8270) are used. The third method that petroleum refineries may use to detect THC in cooling tower water is via the use of a continuous hydrocarbon analyzer.

[2] "MACT" stands for Maximum Achievable Control Technology, which is the level of control that the emission standards regulation is intended to achieve.
[3] … but no later than 45 days after detecting the leak, unless the repair is not feasible.
[4] Applicability criteria can be found in Section 63.654.
[5] The MEPM is the basis for the monitoring required by U.S. EPA in § 63.654.

Regulation 8, Rule 2, Section 114 states that "Emissions from cooling towers, railroad tank cars, marine vessels and crude oil production operations are exempt from this Rule, provided best modern practices are used." Regulation 1, Section 207 defines *best modern practices* in general as **"**The minimization of emissions from equipment and operations by the employment of modern maintenance and operating practices used by superior operators of like equipment and which may be reasonably applied under the circumstances."

Regulation 11, Rule 10 is now proposing a cooling tower-specific definition. In the draft rule, Staff has compiled examples of best practices from several sources.

Elements to be added to Regulation 11, Rule 10 are as follows:

1. THC leak monitoring, repair and minimization requirements for petroleum refinery cooling towers will be incorporated into an existing regulation that was adopted in 1989 to limit hexavalent chromium emissions from all Bay Area cooling towers that were subject to the provisions of the rule. The regulation's description will be modified to include THC emissions from petroleum refinery cooling towers.
2. Regulation 8, Organic Compounds, Rule 2: *Miscellaneous Operations* exempts cooling tower emissions provided Best Modern Practices are used. Regulation 11, Rule 10 will define Best Modern Practices and will require refinery staff to take steps to ensure heat exchanger equipment is kept corrosion free and in good working order; to make visual and odor inspections on a regular basis; to perform surrogate testing, such as residual chlorine measurements every shift, and to track the amount of biocide added to cooling tower water on a daily basis to maintain water chemistry.
3. The regulation will require each cooling tower to use one of three options to monitor cooling tower water hydrocarbon concentrations on a daily basis. Cooling towers that circulate less than 2,500 gallons per minute of cooling water will be allowed to monitor weekly, and any cooling towers that circulate less than 500 gallons per minute of cooling water will be allowed to monitor once every 14 days.
4. The regulation will include a THC concentration standard of 84 ppb (by weight) when cooling tower water is sampled for lab analysis. The THC concentration standard will be 6 ppm (by volume) when cooling tower water is monitored by a continuous analyzer or the use of an APCO approved alternative monitoring method. When the THC standard for any of the three allowable monitoring methods is exceeded, a leak action response will be required.
5. The refinery shall be required to minimize the leak within 5 calendar days and shall repair the leak within 21 days.
6. For leaks that cannot be repaired within 21 calendar days, the refinery would have to speciate and quantify THCs associated with the leak in order to ensure mass emissions are below 15 pounds per calendar day and the hourly & annual (if applicable) TAC emissions are below their corresponding acute and/or chronic trigger levels in Table 2-5-1 of Regulation 2, Rule 5.
7. Regulation 11, Rule 10 would also include detailed recordkeeping requirements.

Staff proposes that the new requirements in Regulation 11, Rule 10 go into effect on July 1, 2016

Control Mechanisms

No add-on controls are proposed, only frequent monitoring and rapid leak detection, minimization, and repair.

EMISSIONS AND EMISSIONS REDUCTIONS

Emissions

There are five large-scale petroleum refineries within the Air District's jurisdiction that operate a total of 34 permitted cooling towers. The number of cooling towers per facility varies. One refinery has only one cooling tower while another has 13 permitted cooling towers. Based on the 2014 Air District emissions inventory, the cooling towers collectively emitted approximately 3.0 tons per day (TPD) of organic gases (1,128 tons per year), estimated using AP-42 emission factors.[6]

Emissions Reductions

Estimated emission reductions are based on implementing a total hydrocarbon concentration standard (for hydrocarbons in cooling tower water) equivalent to the EPA controlled emission factor of 0.7 lbs of hydrocarbons emitted for every million gallons of recirculated water. Table C2 lists the estimated emissions reductions from the implementation of the proposed amendments to Rule 11-10.

Table C2
Potential Emissions Reductions

Facility	Emission Reduction (tpy)
Chevron	298
Shell	228
Tesoro	313
Phillips 66	84
Valero	74
TOTAL	**997**

Staff estimated that the overall, VOC emissions would be reduced by about 88 percent.

ECONOMIC IMPACTS

District staff anticipates that affected sources would meet requirements stemming from the proposed amendments to Rule 11-10 in one of three ways.

Option 1: Affected sources may pursue involves daily water sampling, which costs $300 a day for each cooling tower.

Option 2: Installation and operation of a "continuous analyzer"; each of which costs $75,000. Each analyzer requires a shelter costing in the range of $500,000 to $1,000,000.

Option 3: Implementation of the "APCO approved alternative monitoring method", the cost of which is $50 per tower per day. Petroleum refineries that choose to use an APCO approved alternative monitoring method of detecting THC leaks, and have four or more cooling towers, may have to hire a full-time employee at an anticipated cost of $85,000 per year to operate detection equipment on a daily basis. This figure was factored into Option 3 for those refineries operating four or more cooling towers that service heat exchangers circulating organic compounds.

[6] AP-42, *Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources*, Fifth Edition, April 2015, Table 5.1-3

Based on the three options listed above, staff developed the following compliance cost analysis. The table below (Table C3) lists the estimated total amortized cost (over ten years), total annual cost (capital plus operating), and emission reductions for each petroleum refinery to purchase and install continuous hydrocarbon analyzers for their cooling towers.

Table C3
Annualized Costs

Facility	Option 1: Daily Water Sampling	Option 2: Continuous Analyzer (Low)	Option 2: Continuous Analyzer (High)	Option 3: APCO approved alternative monitoring method
Chevron	$876,000	$282,900	$528,900	$231,000
Shell	$547,500	$212,175	$396,675	$176,250
Tesoro	$1,423,500	$495,075	$925,575	$322,250
Phillips 66	$766,500	$285,900	$528,900	$212,750
Valero	$109,500	$70,725	$132,225	$18,250
Overall	**$3,723,000**	**$1,343,775**	**$2,512,275**	**$960,500**

Cost Effectiveness

Cost effectiveness for these rule amendments are expected to range less than $50 per ton to about $4,500 per ton. The emission reductions, annualized costs, and cost effectiveness are presented in the table below (Table C4).

Table C4
Emissions Reductions, Annualized Costs, and Cost Effectiveness

Facility	Emission Reduction (tpy)	Total Annualized Cost Range ($)	Cost Effectiveness Range ($/ton)
Chevron	298	$231,000 – $876,000	$776 – $1,129
Shell	228	$176,250 – $547,500	$773 – $2,402
Tesoro	313	$322,250 – $1,423,500	$1,031 – $4,553
Phillips 66	84	$212,750 – $766,500	$2,533 – $9,125
Valero	74	$18,250 – $132,225	$246 – $1,780
Overall	**997**	**$960,500 – $3,723,000**	**$963 – $3,734**

Incremental Cost Effectiveness

Under Health and Safety Code section 40920.6, the District is required to perform an incremental analysis when adopting a Best Available Retrofit Control Technology (BARCT) rule or feasible measure required by the California Clean Air Act. To perform this analysis, the District must (1) identify one or more control options achieving the emission reduction objectives for the proposed rule, (2) determine the cost effectiveness for each option, and (3) calculate the incremental cost effectiveness of each option.

Three options were considered for the cost analysis, and incremental cost effectiveness analysis. Option 1 is for daily water sampling and testing, and is the highest cost. Option 2 is for installation and use of continuous monitoring was considered with two sensitivity cases – one where a typical analyzer shelter is required, and a second where the shelter is twice the cost because of a unique location and/or utilities

may not be readily accessible. Option 2 is based on one analyzer and shelter being located where it can effectively monitor two cooling towers. If this is not always possible, the Option 2 costs may be slightly more than the daily water sampling and testing costs. Option 3 is the lowest cost – using a simple APCO approved monitoring device to monitor for total hydrocarbons.

All three options are found to be cost effective. The cost effectiveness of the highest cost daily sampling and testing is well within typical cost effectiveness guidelines. The other two options are equally will within typical cost effectiveness guidelines. However, incremental cost effectiveness analysis of either daily sampling or continuous analyzers for small cooling towers were found to not be cost effective. This analysis resulted in proposing weekly sampling for cooling towers with less than 2,500 gallons per minute circulation rates, and sampling every 14 days for cooling towers with less than 500 gallons per minute circulation rates.

Socioeconomic Impacts

As required by the California Health and Safety Code, a thorough socioeconomic analysis of the impacts of the proposed amendments to Rule 11-10 is presented in Appendix E.

REGULATORY IMPACTS

Section 40727.2 of the California Health and Safety Code requires an air district, in adopting, amending, or repealing an air district regulation, to identify existing federal and air district air pollution control requirements for the equipment or source type affected by the proposed change in air district rules. The air district must then note any differences between these existing requirements and the requirements imposed by the proposed change. The following table (Table C5) provides a comparison of the proposed amendments to related provisions from other air quality regulations affected cooling towers at refineries.

Table C5
Regulation 11, Rule 10, Section 40727.2 Analysis

Section	**Description** (paraphrased)	Comparable State/District Rules	Comparable Federal Rules	Discussion
101	Purpose	NA	NA	No applicable requirements
103	Exemption for certain pieces of equipment	NA	NA	No applicable requirements
201 - 215	Definitions	NA	NA	No applicable requirements
301	Standards: Effective March 1, 1990, prevents the use of Cr6 chemicals		40 CFR 63, Subpart Q	Prevents the use of chromium-based water treatment chemicals in Industrial Process Cooling Towers
304	Standards: Effective July 1, 2016, provides Bay Area refinery owner/operators with the following three monitoring options at the cooling tower return lines to check for total hydrocarbon (THC) leaks in cooling towers (closed-loop recirculation systems): • Continuous THC analyzer monitoring; or • Direct grab sampling and lab analysis of THC in cooling water; or • APCO approved alternative THC monitoring method		40 CFR 63, Subpart CC (MACT CC) - 63.654 Provides owners/operators of heat exchange systems (closed-loop recirculation and once-through) the option of monitoring for total strippable volatile organic compounds (VOC) concentration via the Modified El Paso (MEP) on a monthly or quarterly basis. Heat exchange (HEX) systems constructed/reconstructed after August 18, 1995and before September 4, 2007 are considered "existing" sources and are required to come into compliance with applicable requirements on/before October 29, 2012. HEX systems constructed on/after September 4, 2007 are considered "new" sources and are required to come into compliance upon initial startup or October 28, 2009 whichever is later.	Reg. 11-10 vs. MACT CC: • Addresses THC leaks from all cooling towers regardless of if they are in organic HAP service or not. • More frequent monitoring: Continuous/weekly vs. monthly/quarterly • Concentration of THC in cooling water determined via Method 8260/8270 vs. Concentration of total strippable VOC in stripped air determined via MEP. • Delay of repair action level: None in Reg. 11-10 vs. 62 ppmv in MACT CC.

Section	**Description** (paraphrased)	Comparable State/District Rules	Comparable Federal Rules	Discussion
305	Standards: Effective July 1, 2016, Bay Area refinery cooling tower owners/operators that exceed the THC leak action levels of 84 ppbw (existing) or 42 ppbw (new/modified) will have to minimize the leak within 5-calendar days and repair/remove the defective piece of equipment from service within 21-calendar days.		MACT CC – 63.654: Requires the leak to be repaired within 45-days if technically feasible; if technically infeasible allows repair to be delayed until next scheduled heat exchange system (HEX) shutdown; if technically feasible but parts/personnel not available, allows repair to be delayed for 120-days.	Reg. 11-10 vs. MACT CC: • Unlike MACT CC, Reg. 11-10 does not contain a delay of repair action level. Therefore, the leak has to be minimized/repaired ASAP. • Though not explicitly stated in the rule, Bay Area refinery cooling tower owners/operators can request reprieve (variance, Compliance & Enforcement Agreement, etc.) if leaks cannot be fixed due to technically infeasibility and/or if parts/personnel are unavailable. • If reprieve is granted, Bay Area refinery cooling tower owners/operators will have to demo compliance with Reg. 8-2-301 by ensuring mass emissions from the THC leak are below 15 pounds/day.
401	Reporting: Requires Bay Area refinery cooling tower owners/operators to follow notification procedures if continuous/weekly/alternative monitoring determines the THC leak action of 84 ppbw (existing) or 42 ppbw (new/modified) is exceeded as discussed below.		MACT CC – 63.655	See more detailed sections below
401.1	Requires Bay Area refinery cooling tower owners/operators to notify the APCO within 1-calendar day if THC leak action levels of 84 ppbw (existing) or 42 ppbw (new/modified) is exceeded	NA	MACT CC – 63.655	Reg. 11-10 requires notification to be substantiated with info on: • pH, iron, and chlorine concentration in cooling water associated with leak; • date and time when leak was discovered; • list of all HEXs served by the cooling tower.
401.2	Requires Bay Area refinery cooling tower owners/operators to notify the APCO within 5-calendar days if THC leak action levels of 84 ppbw (existing) or 42 ppbw (new/modified) is exceeded	NA	MACT CC – 63.655	Reg. 11-10 requires notification to be substantiated with info on: • Leak specifics (extent, repairs, re-inspection, further actions/potential delays in repairs)
402	Best Modern Practices (BMP): Requires Bay Area refinery cooling tower owners/operators to minimize THC leaks from cooling towers by employing BMP		NA	No similar existing requirement
402.1	Continuously measure THC concentration in cooling water with District approved analyzer. .	NA	NA	If implemented, Bay Area refinery cooling tower owners/operators could avail themselves of reprieve from other BMP requirements discussed below via a proposed limited exemption in the rule.
402.2	Backflush all HEX during turnaround and check HEX's for corrosion/damage.	NA	NA	No similar existing requirement

Section	**Description** (paraphrased)	Comparable State/District Rules	Comparable Federal Rules	Discussion
402.3	Re-passivate steel within HEX's during turnaround.	None	None	No similar existing requirement
402.4	Seal tubes within HEX's if pitted/corroded.	None	None	No similar existing requirement
402.5	Perform visual observations once per shift to detect changes in cooling water appearance and algae growth.	None	None	No similar existing requirement
402.6	Monitor cooling tower decks once per shift for odors.	None	None	No similar existing requirement
402.7	Equip each HEX with a District approved telltale THC leak indicator and perform visual observations once per shift.	None	None	No similar existing requirement
402.8	Measure residual chlorine (~biocide) in cooling water once per shift.	None	None	No similar existing requirement
402.9	Monitor the air above cooling water once per shift with District approved hand-held monitors (~FIDs, etc.).	None	None	No similar existing requirement
402.10	Measure ORP in cooling tower water once per shift.	None	None	No similar existing requirement
402.11	Track and record the quantities of biocide added every day.	None	None	No similar existing requirement
402.12	Measure pH and iron concentration in cooling tower water with hand-held monitors once per shift.	None	None	No similar existing requirement
504	Monitoring and Records: Requires Bay Area refinery owners/operators to retain cooling tower operating records collected per Sections 301, 304, 305, 401, 402, and 602 for at least five years from the date of entry.	Regulation 2-6-501, 503	40 CFR 70.6(a)(3)(ii)	This requirement is similar to the recordkeeping requirement in the Air District's Major Facility Review (~Title V permit) Reg. 2, Rule 6 which is based on 40 CFR Part 70 "State Operating Permit Programs".
602	Manual of Procedures: Effective July 1, 2016, requires Bay Area refinery cooling tower owners/operators to install District approved THC analyzers at specific District approved locations (cooling tower return line or HEX exit line) in conformance with certain requirements (such as analyzer sensitivity, analyzer maintenance & operational requirements, etc.). Bay Area refinery cooling tower owners/operators are also given the opportunity to request for an alternative THC monitoring system (MEP, etc.) if they can demo equivalency to the APCO's satisfaction.	NA	NA	Administrative requirement

Section	Description (paraphrased)	Comparable State/District Rules	Comparable Federal Rules	Discussion
603	Specifies EPA methods to be used if Bay Area refinery cooling tower owners/operators choose to monitor for THC in cooling water by direct grab sampling followed by lab analysis to demo compliance with the THC leak action level.	NA	NA	Administrative requirement
604	Specifies sampling location (cooling water return line) to be used if Bay Area refinery cooling tower owners/operators choose to monitor for THC in cooling water by direct grab sampling followed by lab analysis to demo compliance with the THC leak action level.	NA	NA	Administrative requirement

Review of this information concludes that the proposed regulation is necessary to achieve the emission reductions anticipated, and is not duplicative of existing requirements.

ENVIRONMENTAL IMPACTS

As required by the California Health and Safety Code, a thorough analysis of the environmental impacts of the proposed amendments to Rule 11-10 is present in Appendix F. No environmental impacts beyond reduction of hydrocarbon emissions from cooling towers is expected, so a Negative Declaration is recommended.

CONCLUSION

The proposed amendments to Regulation 11, Rule 10 will result in significant reduction of THC emissions. The CEQA analysis found there to be no additional significant environmental impacts expected from these requirements, and the Socio-Economic analysis found no significant impact on refineries or other processing plants with cooling towers in hydrocarbon service.