Bay Area Air Quality Management District

939 Ellis Street
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Proposed Amendments

Regulation 8 Rule 18: Equipment Leaks

Control Measure SS-16

Staff Report

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EXECUTIVE SUMMARY

Regulation 8, Rule 18 requires refineries to develop and implement a Leak Detection and Repair (LDAR) program to control fugitive emissions from valves, pumps, compressors, pressure relief valves, flanges, connectors, piping, and other equipment components. The rule, which includes the most stringent leak standards in California, also applies to chemical plants, bulk plants and bulk terminals.

The proposed amendments to Regulation 8, Rule 8 ensure that best available control technologies are used for valves. The proposed amendments would:

- Reduce the number of valves allowed on a non-repairable list;
- Limit the number of valves on the non-repairable list with leaks of 10,000 parts per million (ppm) or more and ensure that emissions from each of these valves is less than 15 pounds per day; and
- Allow connections to be placed on a non-repairable list at a ratio of one connection per two valves.

The proposed amendments are intended to implement Control Measure SS-16 from the Bay Area 2001 Ozone Attainment Plan. That measure called for amendments to Regulation 8, Rule 18 that would require that replacement valves meet Best Available Control Technology requirements or that they be "leakless" valves.

To implement the control measure, staff conducted numerous site visits to the Bay Area refineries and reviewed specific valve technologies to determine short-term and long-term emission performance. Staff found that no single valve type offered superior performance for the wide range of valve sizes and operating conditions encountered in a refinery, and that specifying valves for the many different situations encountered would be a complex undertaking with no clear benefits beyond those that come from the current rule.

Staff determined that the existing valve leak standard of 100 ppm provides the best means to ensure that refineries use the best technology available for valve replacements. The 100 ppm standard is the most stringent in California (the South Coast AQMD leak standard for valves is 500 ppm) and is set at a level just above typical background concentrations. The amendments therefore implement the control measure by limiting the number of valves allowed on the non-repairable list, thereby ensuring the broadest possible application of the 100 ppm standard.

During the rule development process for the amendments, refineries requested flexibility for connections that are very difficult to repair. Currently, connections must be repaired at any cost irrespective of emissions. To address this concern without increasing emissions, the proposed amendments would allow connections leaking below 10,000 ppm to be placed on the non-repairable list at a ratio of one connection per two valves. The total number of valves and connections allowed on the list would continue to be determined strictly by the total number of valves in use at the refinery as documented annually.

These amendments will reduce emissions of organic and other pollutants, including toxic compounds. Staff has identified an emission reduction of 0.2 ton per day of precursor organic compounds. The expected total cost for all five Bay Area refineries to implement the proposed amendments is $23,500 to $118,000 per year. The cost effectiveness is approximately $320 to $1600 per ton of precursor organic compound emissions reduced. An analysis of the socioeconomic impacts of the proposal was prepared by Applied Development Economics of Berkeley, California. The analysis concludes that the economic and employment impacts to the Bay Area from the proposal would not be significant.

A California Environmental Quality Act (CEQA) analysis for the proposed amendments has been prepared by Environmental Audit, Inc. of Placentia, California, concluding that the proposed amendments would not have any significant adverse environmental impacts. A Negative Declaration has been prepared for the proposed amendments pursuant to Public Resources Code § 21080(c) and CEQA Guidelines 15070 et seq. and was circulated for public review. No comments were received.

The proposed amendments were developed through a workgroup that included District and ARB staff and representatives from environmental groups, the affected refineries, and the Western States Petroleum Association. The workgroup met six times in various locations. In addition, the proposal was discussed at a public workshop on October 28, 2003 in Crockett.

BACKGROUND

There are five petroleum refineries within the jurisdiction of the District with approximately 233,000 total valves. The population of connections is estimated to be five times greater. The rule also applies to chemical plants, bulk plants and bulk terminals that have more than 100 valves or more than 10 pumps and compressors. The proposed amendments are not expected to significantly impact these smaller facilities.

Regulatory History

Rule 8-18 was first adopted in 1980 and was amended in 1992, with minor changes in 1998 and 2002. Rule amendments adopted in 1992 significantly lowered the allowable leak concentration limits to the lowest in the country and required more effective inspection and repair programs in order to reduce emissions and promote self-compliance. The 1992 amendments have reduced emissions by an estimated 1.2 tons per day.

Rule 8-18 was last amended in November 2002 to address minor deficiencies identified by US EPA in their limited approval/disapproval of the rule. The U.S. Environmental Protection Agency (US EPA) fully approved the current rule in June 2003.

Rule Development Process

During the process to develop this proposed amendment to Rule 8-18, staff has worked extensively with the affected industry, interested public, and other air pollution control

agencies, such as the California Air Resources Board (CARB), US EPA and other air pollution control districts.

Site Visits

Staff conducted numerous site visits to the Bay Area refineries to accompany both facility and district inspectors during Rule 8-18 inspections and learn how refinery staff carry out their leak detection and repair programs. These tours and the time spent in communication with both the inspectors and the representatives of the refineries were invaluable to the development of a balanced understanding of operations and technologies associated with the implementation of Rule 8-18.

Literature Review and Information Requests
Staff reviewed various sources of information regarding fugitive emissions, including bellow sealed valves, hermetically-sealed valves, fugitive emission rules of other California air districts, and reports provided by the refineries regarding their non-repairable lists and leak detection and repair programs.

Workgroup Meetings

During this rule development process, six workgroup meetings were held in various locations in the District. These workgroup meetings provided a forum in which technical and regulatory issues concerning this rule could be discussed in a effort to ensure that all participants had ample opportunity to voice their concerns and present comments and related information. In attendance at these meetings were industry representatives, environmentalists, CARB staff members, and district staff.

Workshops

Staff hosted one workshop on October 28, 2003 in Crockett, to discuss draft amendments to the rule in a public forum. In attendance at the meeting were industry representatives, members of the public, environmentalist, and CARB staff members.

ARB Review

The proposed rule amendments and draft staff report were transmitted to CARB on December 22, 2003. CARB reviewed the proposed amendments and submitted written comments on January 13, 2003. Responses to the CARB comments are included in this staff report (see pp. 20-22).

Current Rule Requirements

Each of the five refineries within the District has a leak detection and repair (LDAR) program. These programs function to ensure that all components are inspected regularly and, if a leak is found, the equipment is repaired, replaced, or placed on a list to be repaired. Under the current rule, there are four options under which a facility may comply with the rule:

Option 1 – Leak Concentration Standard: This option allows the facility to inspect affected equipment for leaks; 100 ppm for valves and connections, and 500 ppm for pumps, compressors and pressure relief devices. All equipment with leaks discovered by the facility must be minimized within 24 hours and repaired within seven days. All leaks discovered by the District must be repaired within 24 hours. All equipment not subject to an LDAR program discovered to be leaking by District staff is a violation of this rule.

A fraction of the equipment that cannot be repaired may be placed on a non-repairable list for up to five years or the next scheduled turnaround for that plant, whichever date comes first. The maximum fraction of components on the facility-wide turnaround list cannot exceed 0.5 percent for valves and 1.0 percent for pumps, compressors and pressure relief devices. Currently, connections are not allowed to be placed on a turnaround list.

Option 2 – Mass Emissions Standard: This option allows the facility to use the concentration standards as trigger levels and measure any non-repairable component for mass emissions. Using the above Option 1 leak concentration standards as trigger levels, any non-repairable component can be measured for mass emissions. If the mass emission rate is greater than 15 pounds per day, the component must be repaired. If the mass emission rate is less than 0.1 pounds per day for valves or 0.2 pounds per day for any other component, no further action is required. The number of components leaking above their respective mass emission limit cannot exceed a small percentage of the total number of components at the facility.

Option 3 – Reduced Inspection Frequency: Using the above Option 1 leak concentration standards as trigger levels, facilities can increase the interval between inspections for components that do not leak. This option reduces the cost of inspection and maintenance plans. The inspection frequency for equipment, except pumps and compressors, may be changed from quarterly to annually provided the equipment has been operated leak free for five consecutive quarters and records are submitted and approved by the District. If a leak is discovered, the frequency reverts back to quarterly inspections for that component.

Option 4 – District Approved Inspection and Maintenance Plan: The final option allows facilities to implement an alternate program to reduce emissions from leaks. This option requires a written plan approved by the District and EPA. To date, no Bay Area refinery has elected to use this option.

Other Air District Rules

Several other air pollution control districts in California have rules that address fugitive emissions from refineries and chemical plants. These districts include the South Coast Air Quality Management District (Rule 1173), the San Joaquin Valley Unified Air

Pollution Control District (4451 & 4452), and Ventura County Air Pollution Control District (Rule 74.7). In addition to these districts' rules, the federal New Source Performance Standards affect emissions from equipment leaks. The table in Appendix A provides a simplified comparison of the major provisions of these rules with the provisions of the District's current rule. The BAAQMD rule is the most stringent leak rule in the State of California with leak standards that are significantly more stringent than those in all other rules.

Overview of Current Leak Detection and Repair (LDAR) Programs

Each LDAR program functions to ensure that all components are:

- Identified;
- Labeled (except connections);
- Inventoried;
- Inspected for leaks; and
- If found leaking, tagged, repaired, replaced, or placed on a non-repairable list.

Identification: Each piece of equipment is uniquely identified in association with the plant at which it is located, the type of equipment, and a unique identification number.

Labels: In addition, this identity is also placed on a label that is attached to each component or group of components. Labels contain varying degrees of information, but most will at least include the identification number.

Inventory: Each piece of equipment is inventoried in a database that contains information on the equipment such as type, location, installation date, dates of inspection, leak concentration, and repair history.

Inspections: Each refinery employs an inspection team that consists of either in-house employees or contractors.[1] The inspection team calibrates their VOC detector, which is typically either a flame or photo ionization detector, and proceeds with the inspection. A member of the inspection team carries a monitoring device that reads and records information from a barcode or identifier attached to the component being inspected. If a leak is detected, a team member or another facility employee will attempt to minimize the leak as required by the rule. If the leak cannot be minimized, a team member will identify the component with a waterproof, indelible tag, upon which information regarding the leak is recorded and the component is identified for repair or replacement. Once the inspection is completed, the recorded information is uploaded into an LDAR data base.

[1] Three of the five Bay Area refineries employ independent contractors to conduct leak detection and repair inspections, and the remaining refineries utilize in-house employees. All refineries have a separate group dedicated to the task of leak detection and repair.

Technology Review

The District reviewed equipment that could represent Best Available Control Technology for valves.

Bellows Seal Valves

Bellows seal valves normally operate in a leak free manner because the moving components of the valve are hermetically sealed from the ambient air. Bellows seal valves function by replacing the packing and sliding or rotating seals with bellows (accordion-like tubing). This replacement eliminates the opportunity for emissions from the sliding of rotating seals and packing. However, failure of the bellows can result in significant emissions.

The bellows are sealed in two different ways. In one approach, the bellows are welded to the valve stem at the top and the valve body at the bottom. The process fluid is contained inside the bellows. In the approach, the bellows are welded to the valve stem at the bottom and the body on the top. The process fluid is contained in the annular region between the valve bonnet and bellows.

Bellows valves are available only in a relatively narrow size range and could be used as replacements in only a small subset of all refinery applications.

Solenoid-Actuated Valves

Solenoid-actuated valves are a departure from the standard air- or motor-operated valve design typically used for process fluid storage and handling of hydrocarbons. These valves are solenoid-actuated. They do not use stem, packing, or bellows. Further, solenoid-actuated valves isolate all moving parts within the process pressure areas. Because the actuator of these valves is completely sealed from the atmosphere and is actuated via magnetism, the potential for emissions due to the failure of seals surrounding dynamically moving parts is eliminated. However, failure of the isolation, such as a crack in the valve body can result in significant emissions. And, as with bellows valves, solenoid-activated valves could only be used in a limited range of refinery applications.

"BACT" Standard of the Control Measure

After reviewing specific valve technologies to evaluate short-term and long-term emission performance, staff concluded that the petroleum refineries must use the best technology available for replacements to consistently achieve the stringent emission standards of the rule – the 100 ppm leak limit for valves and 0.5 percent of the total number of valve allowed on a non-repairable list. Consequently, the strict emission standard combined with the limit placed on the non-repairable list constitutes a "best available control technology" standard.

As long as the refineries consistently meet this standard, the regulation need not dictate which technologies should be used. Rather, refineries should be allowed to use their expertise to determine the technology best suited for the conditions of use that will ensure

compliance with the requirements of the rule. This approach will allow the introduction of improved technology that may "cross over" from other industrial application without requiring an exhaustive review process to maintain a BACT list.

PROPOSED RULE AMENDMENTS

The proposed amendments:

- Reduce the number of valves that are allowed on the non-repairable list;
- Limit the number of valves leaking in excess of 10,000 ppm;
- Require mass emission rate determinations for valves leaking in excess of 10,000 ppm and control those with excess emissions; and
- Allow connections with leaks that do not exceed 10,000 ppm to be placed on the non-repairable list at a ratio of one connection per two valves.

The amendments are made possible by improvements in the ability of the refineries to locate and repair leaking components and improvements in valve technology, such as hermetically sealed valves and advancements in valve stem packing materials. These improvements, which are already being implemented in some areas, have led to emission reductions that have not yet been credited to this rule. By implementing the improvements across the board, additional emissions reductions will be achieved. Finally, the amendments will ensure that the components that are believed to be responsible for the greatest emissions are examined and if found to have excessive emissions, controlled.

Reducing the Number of Components on the Non-Repairable List

The non-repairable list was established to provide a mechanism to address essential components. Essential components are those pieces of equipment that cannot be repaired or replaced unless the process unit is shutdown and the component is isolated. This activity would likely create more emissions than the actual fugitive leaks. The rule allows a certain percentage of each type of equipment to be placed on the list. Table 1 indicates the current allowable fractions of each component on the non-repairable list.

Table 1
Current Allowable Limits for Components Awaiting Repair or Replacement

Equipment	Fraction of Non-repairable Equipment Allowed	Maximum Duration
Valves	0.5%	5 years or next turnaround
Pressure Relief Devices	1 %	5 years or next turnaround
Pumps/Compressors	1 %	5 years or next turnaround

Data collected from the refineries indicate that the current LDAR programs implemented at some refineries result in a much lower fraction of leaking equipment being placed on a

non-repairable list than the fraction allowable by Rule 8-18. This suggests that it is possible to reduce the percentage of equipment allowed on the non-repairable list or address non-repairable equipment in a different manner.

Staff proposes to modify the allowable fractions according to the table below.

Table 2
Proposed Revisions to the Allowable Limits for Components Awaiting Repair or Replacement

Equipment	Number of Non-repairable Pieces of Equipment Allowed	Maximum Duration
Valves (including valves with major leaks) and connectors	0.3% of total number of valves	5 years or next turnaround
Valves with major leaks	0.025% of the total number of valves	5 years or next turnaround
Pressure Relief Devices	1.0% total number of PRVs	5 years or next turnaround
Pumps/Compressors	1.0% total number of pumps and compressors	5 years or next turnaround

In this proposal, the fraction of valves (including valves with major leaks) allowed on the non-repairable list would be reduced from 0.5 percent to 0.3 percent.

Concentration Limit for Non-repairable Components

The proposal will also limit the number of valves leaking in excess of 10,000 ppm to 0.025 percent of the total number of valves in operation at the facility; these valves would be included in the number that make up the 0.3 percent allowed for all valves. Before a valve with a major leak (one that leaks in excess of 10,000 ppm) can be placed on the non-repairable list, its mass emission rate must be determined and found to be below 15 pounds per day. In addition, the mass emission rate must be determined at least once per year to ensure that the leak does not exceed the 15-pound limit. This provision is intended to prevent a component from leaking an indefinite amount of mass emissions for up to five years.

The amendments will require refineries to take action on valves that are found leaking in excess of 10,000 ppm (50 to 100 times the allowable limits). If a component is found to leak in excess of 10,000 ppm, the operator must do one of the following: (1) minimize the leak below 10,000 ppm within 24 hours and repair the component within seven days, or (2) measure the mass emission rate of the leak and place the component on the non-repairable list only if the mass emission rate is less than 15 pounds per day. If the valve leaks in excess of the allowable mass emission rate, then the operator must either repair or replace that component or capture and vent those emissions to a control device. Additionally, the refiner must notify the District of each mass emission rate determination at least 96 hour prior to the determination. This will allow the District to review the process of the emission rate determination and also allow concurrent testing of the leaking component for methodology evaluation.

Connections on the Non-repairable List

The refineries have long asserted that regulatory flexibility is needed for connections that pose difficulty in repair. To address this concern, staff proposes allowing connections with leaks less than 10,000 ppm to be placed on the non-repairable list in a very limited fashion that would not result in a relaxation of the rule. To ensure that any emissions associated with a connection being placed on the non-repairable list are offset, the amendments would require that each connection placed on the list counts as two pieces of equipment. The number of components allowed on the list is strictly limited to the number of valves located at the refinery multiplied by the allowed fraction. For example, if a refinery has 50,000 valves and the fraction of valves allowed on the non-repairable list is 0.3 percent, then the number of valves allowed on the list could not exceed 150. Additionally, for each connection allowed on the list, two spaces of the 150 allotted for valves would no longer be available.

EMISSION INVENTORY AND EMISSION REDUCTIONS

Emission Inventory

Emission inventory data collected over the past several years indicate that fugitive emissions have been constantly decreasing. Table 3 details these emissions and reductions. There was a significant emissions reduction between the 2001 inventory and the current modified 2002 inventory. This emission reduction is due mostly to the adoption of new correlations factors from the EPA that are published in the ARB's "California Implementation Guidelines for Estimating Mass Emissions of Fugitive Hydrocarbon Leaks at Petroleum Facilities." However, notwithstanding the change in correlation factors, there has been a general downward trend to fugitive emissions over the last several years. This trend is largely due to improvement in the leak detection and repair programs over time.

TABLE 3
Estimated Emissions Inventories for All Fugitives Components[1]

	SIP (Modified 1999 Inventory)[1]	2000 Inventory[2]	2001 Inventory[2]	Current (Modified 2002 Inventory) [2,3,4]
Refinery	**(organic emissions - pounds/day)**			
Chevron	7 ,821	7,821	7,773	2,294
Shell	352	352	351	381
ConocoPhillips	1,543	1,543	1,473	1,474
Valero Asphalt	35	35	35	22
Valero	1,969	530	257	332
Tesoro	1,690	1,690	1,688	128
Total (tons/day)	**6.71**	**5.99**	**5.79**	**2.32**

1. These are the estimated fugitive emissions from all components affected by Rule 8-18, including valves, pumps, compressors, pressure relief devices, and connections.
2. The annual emission inventories are based on equipment counts provided to the District by each refinery.
3. The values in this column reflect the use of modified correlation factors for each component category, as published in the ARB's "California Implementation Guidelines for Estimating Mass Emissions of Fugitive Hydrocarbon Leaks at Petroleum Facilities."
4. These values are currently under review and may not reflect the final emission inventory for 2002.

Emission Reductions

The emission reductions for the proposed amendments are presented in Table 4. These emission reductions are based on the assumption that all leaking components other than connections will be discovered at the five Bay Area refineries.

TABLE 4
Emission Reduction Estimates[1].

	Rule 8-18 Emissions[2] (lbs/day (TPD))	Amended Rule 8-18 Emissions[3] (lbs/day (TPD))	Emission Reductions (lbs/day (TPD))
Valves	706 (0.35)	303 (0.15)	403 (0.20)

1. Assumes a total of 233,000 valves at all five Bay Area refineries (see Table 5).
2. Assumes that the total number of valves leaking is 0.50 percent of all valves.
3. Assumes that the total number of valves leaking is 0.30 percent of all valves and that fraction leaking above 10,000 ppm is 0.0025 percent.

Staff estimates that there are approximately 233,000 total valves at the five Bay Area refineries. Table 5 presents the inventory for valves, pump and compressors, pressure relief devices, and connections.

TABLE 5
Estimated Inventories[1] of Various Components Subject to Rule 8-18 at the Bay Area Refineries

Refinery	Components		
	Valves	Pumps and Compressors	Connections
Chevron	71,000	800	355,000
ConocoPhillips	27,000	250	134,000
Shell	52,000	360	217,000
Tesoro	33,000	1500	156,000
Valero	50,000	300	250,000
TOTALS	**233,000**	**2110**	**1,112,000**

1. These values are based on quarterly reports and direct quotes from industry representatives.

OTHER AREAS FOR POTENTIAL EMISSION REDUCTIONS

During this rule development process, staff examined other strategies that have some potential for achieving emission reductions. These strategies are not included in this rulemaking because they require further study. Each potential strategy examined by staff is discussed briefly below.

Maximum Leak Limit for All Components

District staff examined whether a maximum leak standard should be established and whether it would reduce emissions. The BAAQMD rule and many other air district fugitive rules allows repair to be deferred for a small number of valves that exceed leak limits. These allowances are intended to avoid the potentially significant emissions that could come from shutting down a unit to make repairs. On the other hand, emissions from components with significant leaks awaiting repair could be potentially significant.

There is limited data available to determine whether a focus on leaks with concentrations over an established maximum is warranted. For individual components, the available data suggests that the correlation between mass emissions and concentration is poor. It may be more appropriate to focus on a mass emission approach. The proposed amendments will require the facilities to measure mass emissions on leaking valves over 10,000 ppm leak concentrations. This data will help determine if a mass emission or a maximum concentration is warranted. Additionally, an initial assessment of data reported by the Bay Area refineries indicate that less than one in 5000 valves leak in excess of 10,000 ppm, which is less than ten at any one refinery. Only a very small fraction of these components are expected to have mass emissions rates in excess of the preset limits. Emission reductions may therefore be quite limited and need further examination.

Violations for Leaks Detected During District Inspections

The current rule allows refineries 24 hours to repair leaks found by District inspectors and seven days to repair leaks discovered by refinery. An alternative would be to treat as a violation the detection of leaks by District inspectors in a specified percentage of the components inspected. The South Coast fugitives rule uses such an approach. This might encourage more thorough inspections by refinery personnel. On the other hand, refiners expressed concerns that even with good LDAR programs, it is possible to find leaks, particularly if a District inspector chooses to inspect an area that is due for inspection but has not yet inspected under the refinery LDAR program. Refiners felt that this might be perceived as unfair and might not improve the refinery program.

Accelerated Replacement of Equipment with Frequent Leaks/Repairs

Some specific components appear to be more prone to leaks and to require more repair. The rule could require a component to be replaced if the number of leaks within a specified time period exceeds a threshold specified in the rule. The South Coast and Ventura rules use this approach. On the other hand, it may be true that more frequent repair is required for certain demanding types of service, and any replacement component will have the same failure rate.

Replacement of Inaccessible Equipment with Superior Technologies

Replacement of inaccessible equipment with superior technologies could reduce the potential for emissions. Regulation 8, rule 18 requires less frequent inspection for these components. This reduced inspection frequency results in a longer average time period before a leak is detected and repaired. It is unclear whether superior technologies can be readily identified.

Control Emissions from Heat Exchangers

Heat exchangers are potential sources of VOC emissions through leakage of VOCs into cooling liquid and subsequent emission at cooling towers. A first step would be to measure VOC emissions at cooling towers over an entire cycle to determine whether emissions are significant. To determine if a leak exists in a heat exchanger, the VOC concentrations of cooling water at the inlet and outlet to the heat exchanger could be compared. A higher VOC concentration at the outlet would indicate a leak. This work would have to be done to determine whether there is any potential for emission reductions.

Quantification of Mass Emissions and Emission Caps

If mass emissions for leaking components can be reliably determined, a cap could be placed on total emissions from equipment placed on the non-repairable equipment list. Leaking equipment could be added to the list, but only if the total fugitive emission cap is not exceeded. If adding a leaking component would cause the cap to be exceed, emissions from equipment already on the non-repairable list would have to be reduced.

This approach would provide an incentive to replace high-emitting equipment on the list as soon as possible and would provide a facility flexibility to make the most cost effective choices that results in the least emission consequence. On the other hand, a mass emission cap could be overly complex and difficult to administer.

Increase Inspection Frequencies

Increasing the frequency of inspections would reduce the time that a leaking component goes undetected, and could decrease emissions. To implement increased inspection frequencies, additional staffing would be required. Staff would have to further assess potential emission reduction benefits from increased inspection frequencies.

Smart LDAR

The U.S. EPA and API have jointly worked on a project called "Smart LDAR" through the U.S. EPA's Common Sense Initiative for the Petroleum Refining Sector. Research indicates that a small subset of all leaking components is responsible for most of the emissions. Rather than focus efforts on controlling minor leaks, the Smart LDAR project is examining the use of remote sensing methods that would allow quick identification and repair of leaks causing large emissions. It is unclear when those methods will become available for routine use in refinery LDAR programs.

ECONOMIC IMPACTS

Costs

The costs associated with the proposed amendment are primarily the costs of determining the mass emission rates of valves leaking in excess of 10,000 ppm and the cost of controlling component with emissions above the 15-pound limit. There are two methods that were identified as reliable methods of determining mass emissions: high volume collection system (HCVS) and the US EPA vacuum method. These methods are described and compared in Appendix B.

Table 6 compares the cost of each of these methods. The cost values in Table 5 have been inflated from 1995 values using inflation factor of 1.2 obtained from the US Department of Labor, Bureau of Statistics (www.bls.gov).

TABLE 6
Cost Estimates for Mass Emission Rate Determinations

	HCVS	Vacuum Method
Total time required for ONE sample[1]	4 hours	Two days
Labor Cost per sample ($450/day)	$225	$900
Lab Cost per sample	$0	$400
TOTAL COST per sample	**$225**	**$1300**

1. This represents the time needed to sample one valve and not a population of valves. This value is based on the assumption that valves leaking in access of 10,000 ppm would be found individually and, therefore addressed individually. Further, it is expected to take at least a half day to prepare the

instrumentation (calibration and flow rate determination) for the high volume sampler and two days to enclose the leaking component and prepare for sampling (calibration and flow rate determination).

Based on current inspection data, it was estimated that a total of 60 valves may need mass measurements. Using the cost estimates from Table 6, the cost of sampling 60 valves annually was estimated between $13,500 and $78,000. The cost to capture, vent and control emissions from a valve with excess emissions can range from $5,000 to $20,000[2] each depending on the valve size, location (accessible or inaccessible, proximity to a vent for flare or fire box, spatial proximity to other components, etc.). It was estimated that 2.5 percent of valves leaking in excess of 10,000 ppm will have emissions of 15 pounds per day or greater,[3] or 2.5 percent. That is approximately two valves District-wide that could potentially be required to be controlled. This would result in a potential cost of $10,000 to $20,000 to reduce 5.5 tons of emissions or a cost effectiveness that range between $1,800 and $3,600 per ton reduced. The annual costs associated with these proposed amendments are presented in Table 7.

TABLE 7
Costs of the Proposal

Requirement	**Annual Costs**
Mass Emission Rate Determinations	$13,500 -$78,600
Control of Valves with Excessive Leaks	$10,000 to $40,000
TOTAL COSTS	**$23,500 to $118,000**

The emission reduction that will result from this proposal is estimated to be approximately 74 tons per year. This results in a potential cost effectiveness range of $320 to $1,600 per ton of precursor organic compounds District-wide.

Incremental Costs

Under Heath 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. To determine incremental costs, the District must "calculate the difference in dollar cost divided by the difference in the emission reduction potentials between each progressively

[2] This cost range is based on personal conversations between District staff and staff members of the California Air Resources Board and refinery personnel.

[3] Emissions estimates provided by WSPA.

more stringent potential control option as compared to the next less expensive control option."

This regulatory development process was initiated to examine the feasibility of drafting amendments to Regulation 8, Rule 18 that would implement Control Measure SS-16 from the Bay Area 2001 Ozone Attainment Plan. To implement Control Measure SS-16, staff evaluated requiring replacement valves that meet BACT requirements or that they be "leakless" valves. Staff has concluded the performance standard in the current rule combined with the limit placed on the non-repairable list constitutes the "best available control technology" and that no additional provisions are necessary or appropriate to ensure that refineries meet that standard of the rule.

In addition, during this rule development process, staff examined various alternatives to achieve the emissions reduction required under the 2001 Ozone plan. The first option considered was to require all valves placed on the non-repair list to be repaired or replaced with hermetically-sealed valves. This option would be extremely expensive. Bellow seal valves cost approximately $12,000, which is about $7000 more than a typical valve. Two tenths of a percent of the total number of valves (233,000), could be placed on the non-repairable list for up to five years (46,600 valves). It is expected that about half of these valves would need to be replaced with bellow seal valves or 23,300 valves. Because the valves can remain on the list up to five year, 20 percent of the valves would be cycled out each year (4660 valves). This type of an approach would result in an annual cost of $32 million. The second option considered is outlined in this proposal. A comparison of the alternative and this proposal is summarized in Table 8.

TABLE 8

Incremental Cost Analysis

	Annual Emissions Reductions	**Annual Costs**	**Cost Effectiveness**
Replace Valves with Hermetically-Sealed Valves	Negligible[1]	$32 million	Indeterminate
The Proposal	74 tons	$23,500 to $118,000	$320 to $1,600 per ton

1. Specific emission reductions cannot be credited to the replacement of valves with bellow seal valves because all valves must meet the 100 ppm standard and limits on the non-repairable list.

Socioeconomic Impacts

Section 40728.5 of the 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 Economic Development of Berkeley, California, has prepared the required cost analysis. (Appendix

D). That analysis concludes that the proposed amendments would have no significant socioeconomic impacts.

OTHER IMPACTS

Environmental Impacts

The District's environmental consultant, Environmental Audit, Inc., prepared an initial study for the proposed rule amendments to determine whether rule adoption would result in any significant environmental impacts. In general, the initial study concludes that the proposed amendments would result in environmental benefits by reducing the number and magnitude of leaks for which repairs can be deferred under existing rule provisions. The complete environmental document is attached as Appendix C. A Negative Declaration for the proposed amendments has been prepared and is proposed for adoption. The document was circulated for public comment during a comment period from December 22, 2003 to January 12, 2004. No comments were received.

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 does not expand the applicability or the current rule.

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 (Equipment Leaks of VOC in the Synthetic Organic Chemicals Industry) and Subpart GGG (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). A comparison between BAAQMD and federal requirements follows.

BAAQMD Reg. 8, Rule 18	40 CFR60 VV, GGG, 40 CFR63 CC
Applicability	
Components at petroleum refineries, chemical plants, bulk plants and bulk terminals.	Affected equipment in petroleum refineries, synthetic organic chemicals manufacturing facilities, onshore natural gas processing plants.
Requirements	
LDAR program for components in light liquid/gas/vapor. Quarterly inspections. Inaccessible components inspected annually.	Pumps and valves inspected monthly. Valves in light liquid/gas/vapor service inspected monthly. After two monthly inspections without leaks, they may be inspected quarterly until a leak is detected.
Leak threshold at 100 ppm for valves, connectors, 500 ppm for pumps, compressors and PRDs in gas/vapor/light liquid service.	Leak threshold at 10,000 ppm for pumps and valves in heavy liquid service.
Leaks detected by operator minimized within 24 hours and repaired within 7 days. A percent of non repairable components may delay repair until unit turnaround. Leaks detected by BAAQMD repaired within 24 hours.	Pumps, valves, PRDs and connectors in light liquid/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 > 10K ppm 15 days repair maximum, first attempt at repair within 5 days.
Recordkeeping and Reporting	
Submit quarterly reports of non repairable components and their leak rates.	Submit semiannual reports containing the number of components, 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 D86 for VOC content of liquids.	U.S. EPA Method 21 for leak screening, ASTM E-260, E-168, E-169 for the VOC content, ASTM Method D-2879 for the vapor pressure.

Exemptions	
Components handling liquids with an initial boiling point greater than 302^0 F.	Components that present a safety hazard
Components operating under negative pressure or enclosed systems and PRDs vented to vapor recovery or disposal system.	Components handling fluids with less than 10% by weight VOC.
Pressure vacuum valves on storage tanks.	Components operating under negative pressure, pumps with a closed vent system, PRDs vented to a control device.
PRDs installed for thermal protection of liquid lines provided they are vented to a drain or back in the line	
Administrative requirements for equipment handling organic liquids with an initial boiling point greater than 302^0 F.	

District Staff Impacts

Implementation of the proposal will have a negligible impact on the resources of the District. Staff will need to review reports regarding mass emission rate determinations and, occasionally, conduct site visit to witness of those determinations.

CONCLUSIONS

The proposed amendments to Regulation 8, Rule 18, Equipment Leaks will meet the commitment made during the adoption of the 2001 Ozone Attainment Plan for Control Measure SS-16. The proposal is intended set stringent standard and performance requirements that when implemented, will represent the best current industry practices and abilities and allow the District to account for any associated emission reduction. Pursuant to the Health and Safety Code section 40727, new regulations must meet necessity, authority, clarity, consistency, non-duplicity and reference. The proposed regulation is:

- Necessary to protect public health by reducing volatile organic compounds that contribute to ozone formation and to carry out the commitment in control measure SS-16 in the Bay Area 2001 Ozone Attainment Plan; and to protect public health by reducing exposures to toxic air contaminants.
- Authorized by California Health and Safety Code section 40702.
- Clear, in that the new regulation specifically delineates the affected industry, compliance options and administrative requirements for industry subject to this rule.
- Consistent with other District rules, and not in conflict with state or federal law.
- Non-duplicative of other statutes, rules or regulations.

- The proposed regulation properly references the applicable District rules and test methods and does not reference other existing law.

The proposal has met all legal noticing requirements and has been discussed with all interested parties. District staff recommends adoption of Regulation 8, Rule 18, Equipment Leaks.

COMMENTS AND RESPONSES

The following comments were received during the rule development process for the proposed rule amendments.

1. **The rule references EPA in several instances. To improve enforceability of the rule, we recommend that the acronym U.S. EPA be used when referencing the United States Environmental Protection Agency. There are several states with environmental protection agencies (e.g. California, Illinois, Ohio). There are also other countries with environmental protection agencies. <Rump, California Air Resources Board (ARB). E-mail. 1/13/04>**

   In over 40 years of enforcement of BAAQMD rules, many of which refer to "EPA," no enforceability issues have arisen from the use of this acronym. Among the EPAs cited, only U.S. EPA has any direct regulatory authority over the sources regulated by BAAQMD Regulation 8, Rule 18. Given the widespread use of the acronym in District rules, it may be more appropriate for the District to amend its Regulation 1 to include a definition of "EPA" if any real enforceability issues arise.

2. **Based on discussions with southern California refinery representatives and the SCAQMD, we believe that the amendments to BAAQMD Rule 8-18 do not achieve the equivalent of "all feasible measures."…The proposed rule includes a 5-year non-repairable provision. For comparison, South Coast AQMD Rule 1173 does not have a non-repairable provision. ARB staff consulted with refineries in the SCAQMD and found that these refineries comply with Rule 1173 by taking necessary efforts (such as using clamps and enclosures to contain process leaks without shutting down the operations) to control leaks, and all leaks must be repaired within 2 to 14 days and variances are seldom used. Therefore, BAAQMD should consider eliminating the 5-year provision in proposed Rule 8-18. <Rump, California Air Resources Board (ARB). E-mail. 1/13/04>**

   The BAAQMD rule is the most stringent leak rule in the State of California, with leak standards that are significantly more stringent than those in all other rules.

   In addition, the South Coast rule appears to include a non-repairable list and to allow non-repairable components at higher percentages than the Bay Area rule, though South Coast rule language is unclear on this point. The Bay Area rule includes an explicit non-repairable list which, with the proposed amendments, limits the number of valves allowed to exceed leak standards to 0.3% of all valves but with additional limits on mass emissions. The South Coast rule allows 0.5% of leaking valves inspected by air district inspectors to exceed leak standards (Section (d)(1), Table 1). It is unclear whether these

valves are then subject to requirements that operators repair valves within specified repair periods (Section (g)(1), Table 2), particularly where the operator has already inspected and repaired a valve. We are aware that ARB staff believe that these leaking components are subject to the repair requirements based on conversations with a single SCAQMD staff member.

If South Coast operators are required to repair these valves, it is unclear what this means. The South Coast rule defines "repair" as "…corrective action for the purpose of eliminating or reducing leaks…" while the Bay Area rule defines "leak repair" as "…tightening, adjustment, or addition of material, or the replacement of the equipment, which reduces the leakage to the atmosphere below the applicable leak standard…." In addition, the South Coast rule refers to repeated "repair actions" (Section (g)(2)), which may indicate that "repair" does not mean "reduce leaks below the standards." The South Coast rule also allows inspection frequencies to decrease if an operator keeps the percentage of components found leaking below the thresholds in Table I (Sections (e)(2) and (e)(3). So even if repair is required, it is implicit in the rule that there is no rule violation if the percentage of leaking components remains below the threshold.

Even if, despite rule language to the contrary, the South Coast rule does not include the equivalent of a non-repairable list, this does not make the South Coast rule more stringent than the BAAQMD rule. The BAAQMD non-repairable list affects a very small number of components. On the other hand, the more stringent leak standards in the BAAQMD rule apply to all components. The emission reductions that come from looking at a broader range of leaks must be weighed against potential emission increases from a non-repairable list. In addition, if we assume that there is such a thing as a non-repairable component, then it is inevitable that, in the South Coast district, variances will have to be granted or heroic measures with unknown cost effectiveness will have to be undertaken, and ARB has not weighed these consequences in its analysis. BAAQMD staff believe that, in making All Feasible Measure determinations, it is simply not appropriate to pick and choose provisions from a comparator rule. Each of the two rules being compared must be treated as wholes rather than as collections of interchangeable provisions. BAAQMD staff believe the BAAQMD rule is more stringent than the SCAQMD rule. ARB has provided no data to the contrary.

3. **The proposed amendments still allow for a 1 per cent exemption level under the non-repairable provision. This represents from 2 to 15 pumps/compressors per refinery. The representatives from the SCAQMD refineries said that for critical operations they have spare pumps that they can use while the main pumps are being repaired. Furthermore, in the SCAQMD, any occurrences over one leaking pump or compressor (>10,000 ppm) or pressure relief device (>200 ppm) is a violation. The District should consider eliminating this provision. <Rump, ARB. E-mail. 1/13/04>**

Although it may be true for the two refineries consulted by ARB that spare pumps are available, these spares are available, as ARB notes, only for "critical" operations. A non-repairable leak in a non-critical pump (and perhaps in any pump for the refineries not consulted) will require either a variance application or shutdown and subsequent startup with attendant emissions. ARB has provided no data to suggest that the SCAQMD approach would reduce emissions. It is just as reasonable to suppose that the rule provisions will result in shutdowns and subsequent startups that produce overall emission increases. In addition, the BAAQMD questions whether it is good public policy to write provisions that will almost certainly have to be addressed through extra-rule procedures like variances or enforcement discretion.

4. **The CAPCOA correlation equation includes a mass flow rate of 0.064 kg/hr for valves with readings between 10,000 and 100,000 ppm. This corresponds to 3.4 lb/day. For concentrations over 100,000 ppm the mass flow rate is 0.138 kg/hr, which corresponds to 7.3 lbs/day. The District should determine if a lower threshold (<15 lb/day) is warranted based on relevant data.. <Rump, ARB. E-mail. 1/13/04>**

   The correlation equations will tell you what emissions from an average valve leaking at a specified concentration would typically be and are used in constructing inventories. The correlations are derived from populations of valves and tell you nothing useful about an individual case. A valve going on the non-repairable list is not likely to be an average valve, and the cutoff was based on the BAAQMD's determination about what level of emissions is significant and should require immediate action, given the small number of components to which the non-repairable list applies. The District believes the 15-pound cutoff to be reasonable.

5. **Appendix A includes a table comparing the BAAQMD proposed rule with other district rules. Under SCAQMD non-repairable list, the leak thresholds are listed. Leak thresholds cannot be compared to non-repairable provisions. Leak thresholds pertain to trigger levels for violations and the non-repairable provision pertains to limited term exemptions. The District should indicate that the SCAQMD does not have a non-repairable provision. <Rump, ARB. E-mail. 1/13/04>**

   The BAAQMD disagrees with the view that the SCAQMD leak thresholds do not, in effect, constitute a non-repairable list. In addition, even if the SCAQMD provisions do not have the same effect as a non-repairable list, this does not make the SCAQMD rule more stringent than the BAAQMD rule, given the greater stringency of the BAAQMD leak standards, which apply to far more components than any provisions for non-repairable components. For a more detailed discussion of this issue, see the response to comment 2 above.

Appendix A

Comparison of the Basic Provisions of the Fugitive Emissions Rules of Four California Air Districts

Comparison of the Basic Provisions of the Fugitive Emissions Rules of Four California Air Districts

	BAAQMD Rule 8-18		South Coast AQMD Rule 1173	SJVUAPCD Rules 4451 & 4452	Ventura Co. APCD Rule 74.7
Minimum Leak Limits	§§8-18-211, 301→305		§1173 (d)(1)	§4451.3.9.1.1; §4451.3.9.2; §4452.3.6.1	§§74-7 L.18→L.20, L.22 & L.23,
Liquid	3 drops/min		3 drops/min	3 drops/min	minor ≥3 drops/min major = stream or mist
Valves	100 ppm		HL > 500; LL > 50k/10k*	10,000 ppm	minor ≥1,000 1,000 > major ≥ 10k
Connections	100 ppm		HL > 500; LL > 50k/10k*	10,000 ppm	
Pumps/ Compressors	500 ppm		HL > 500/100*; LL > 50k/10k*	10,000 ppm	
PRDs/PRVs	500 ppm		LL > 50k/200*	10,000 ppm	major > 200 ppm
			L = leak (in ppm or drops/min) HL = heavy liquid leak LL = light liquid/gas/vapor leak *Limits for leaks found above leak thresholds (see Turnaround Lists)		
INSPECTION FREQUENCIES	§§8-18-401.1→401.3		§§1173 (f)(1)(B) & (C)	§4451.5.2 & §4452.5.1	§74-7 D.1 & D.2
Valves	Quarterly		Quarterly	Quarterly	Monthly →Quarterly
Connections	Annually		Quarterly	Annually	Monthly →Annually
Pumps/ Compressors	Quarterly		Quarterly	Quarterly	Monthly →Quarterly
PRDs/PRVs	Annually		Quarterly	Quarterly	Quarterly (≤110 days)
Inaccessibles	Annually		Annually	Annual or shutdowns	
NON-REPAIRABLE LIST	§§8-18-306.2 & 306.3		Leak Thresholds: §1173(d)(1)Table 1	§4451.5.2 & §4452.5.1.4	
Duration	≤ 5 yrs.		No time limit (∞)	Next shutdown	none
Valves	0.5%	1%	0.5%	2%	none
Connections	0%	0%	0.5%	2%	none

	BAAQMD Rule 8-18		South Coast AQMD Rule 1173	SJVUAPCD Rules 4451 & 4452	Ventura Co. APCD Rule 74.7
Pumps/ Compressors	1%	5%	1%	2% Shutdown or one year	none
PRDs/PRVs	1%	5%	1%	2%	
REPAIR SCHEDULES	§§8-18-301→305		§1173 (g)(1) Table 2	§4451.5.3.2 & §4452.5.1.4	§74-7 E Table 1
Valves	24 hr (District)/ 7 days (operator)		500 < LL ≤ 10k: 7 days 100 < HL< 500: 7 days 3 drops/min & 100 < HL ≤ 500: 7 days 10k < L ≤ 25k: 2 days/ext 3 days L > 25k: 1 day HL > 500: 1 day/ext 3 days LL > 3 drops/min: I day	m: 1 yr M: 15 days reduce < 10 d/min / 10k or vent to flare or control or show control is infeasible	m: 14 days, M: 5 days, S: 1 days
Connections	24 hr (District)/ 7 days (operator)			m: 1 yr M: 15 days reduce < 10 d/min / 10k or vent to flare or control or show control is infeasible	m: 14 days, M: 5 days, S: 1 days
Pumps/ Compressors	24 hr (District)/ 7 days (operator)			15 day > 15 day: replace, vent to control or repair at shutdown	m: 14 days, M: 5 days, S: 1 days
PRDs/PRVs	7 days (District)/ 17 days (operator)		200 < L ≤ 25k: 2 days	m: 1 yr M: 15 days reduce < 10 d/min / 10k or vent to flare or control or show control is infeasible	m: 14 days, M: 5 days, S: 1 days
			L = leak (in ppm or drops) HL = heavy liquid leak LL = light liquid/gas/vapor leak ext = extended repair period	Leak: m≤ 10 drops/min or 10,000 ppm M > 9 drops/min or 10,000 ppm.	Leaks: m≤ 10,000, 10,000 <M ≤ 25,000 S >25,000

Appendix B

Emissions Estimates

EMISSION ESTIMATES FOR VALVES

Valves
200,000 valves at a Leak Rate 0.5 percent

Screening Value (ppm)	Numbers of Valves	Leak Rate (lb/day)
0	198,575	82
0<S<100	425	1
100<S<10,000	850	16
>10,000	150	507
Total		**606**

Valves
200,000 valves at a Leak Rate 0.3% with only 0.025% of the valves above the 10,000-ppm limit

Screening Value (ppm)	Numbers of Valves	Leak Rate (lb/day)
0	199,145	82
0<S<100	255	0
100<S<10,000	550	10
>10,000	50	168
Total		**260**

Emission Reduction:

Emission Reductions @ 0.3 percent Leaking	Emission Reductions @ 0.2 percent Leaking
346 lbs/day	458 lbs/day
0.21 TPD	0.23 TPD

Approach and Assumptions

Source of Emission Factors:

Emission estimates were calculated using the ARB's "California Implementation Guidelines for Estimating Mass Emissions of Fugitive Hydrocarbon Leaks at Petroleum Facilities."

TABLE IV-3a: CAPCOA-REVISED 1995 EPA CORRELATION EQUATIONS AND FACTORS FOR REFINERIES AND MARKETING TERMINALS [a]

Component Type/ Service Type	Default Zero Factor (kg/hr)[b]	Correlation Equation (kg/hr)[c]	Pegged Factor (kg/hr)[d]	
			10,000 ppmv	100,000 ppmv
Valves/All	7.8E-06	2.27E-06(SV)^0.747	0.064	0.138
Pump seals/All	1.9E-05	5.07E-05(SV)^0.622	0.089	0.610[e]
Others [f]/All	4.0E-06	8.69E-06(SV)^0.642	0.082	0.138
Connectors/All	7.5E-06	1.53E-06(SV)^0.736	0.030	0.034
Flanges/All	3.1E-07	4.53E-06(SV)^0.706	0.095	0.095
Open-ended lines/All	2.0E-06	1.90E-06(SV)^0.724	0.033	0.082

Number of Values at Refineries:

The number of valves in currently in operation at all the five Bay Area refineries is estimated to 200,000 and is based on WSPA Evaluation of Regulation 8, Rules 8 and 25 conducted by Radian (December 1996), which estimated 180,000 valves.

Number of Value Leaking in Excess of 10,000 ppm:

Based on data collected during inspection audits of refinery fugitive components (July 1999 BAAQMD Inspection Audit of Fugitive Components at Refineries and May 1997 BAAQMD Inspection Audit of Fugitive Components at Refineries), staff estimated that 15 percent of the leaking valves leak above 10,000.

Additional Assumptions for Emission Estimates:

For valves with leak concentrations between 0 and 100 ppm, the average leak concentration is 30 ppm; and the percent of leaking valves between 0 and 100 ppm is 0.5 times the number of valves leaking below 10,000 ppm.

Appendix C

CEQA Analysis

Appendix D

Socioeconomic Analysis