

**Bay Area Air Quality Management District**  
939 Ellis Street  
San Francisco, California 94109

**Draft Staff Report**

**Proposed Amendments to Regulation 8, Rule 28:  
Episodic Releases from Pressure Relief Devices at  
Petroleum Refineries and Chemical Plants**

**August 12, 2005**

**Prepared By**

**Victor Douglas  
Senior Air Quality Engineer**

# TABLE OF CONTENTS

<b>I.</b>	<b>INTRODUCTION .....</b>	<b>2</b>
<b>II.</b>	<b>BACKGROUND.....</b>	<b>2</b>
A.	Types of Pressure Relief Devices .....	2
B.	Emissions from PRDs.....	3
C.	Detecting Emissions from PRDs .....	3
D.	PRDs at Bay Area Refineries .....	5
<b>III.</b>	<b>REGULATORY HISTORY .....</b>	<b>6</b>
A.	Requirements of Regulation 8, Rule 28 .....	6
B.	Other District Regulations Applicable to PRDs .....	8
<b>IV.</b>	<b>RULE EVALUATION.....</b>	<b>8</b>
A.	2002 PRD Audit Summary and Findings .....	9
B.	2002 Technical Assessment Document .....	10
C.	2005 Rule Review .....	10
<b>V.</b>	<b>PROPOSED AMENDMENTS .....</b>	<b>14</b>
A.	Require “Telltale Indicators” On All PRDs .....	15
B.	Require Pressure Monitoring Systems for Detecting and Characterizing Releases	15
C.	Require Data Recording and Recordkeeping .....	16
D.	Define “Process Components” Subject to the Rule .....	16
E.	Minor Non-Substantive Amendments.....	17
<b>VI.</b>	<b>EMISSIONS .....</b>	<b>17</b>
A.	Sources and Release Events:.....	17
B.	Emissions Summary:.....	18
C.	Emissions Reductions .....	21
<b>VII.</b>	<b>ECONOMIC IMPACTS .....</b>	<b>21</b>

A.	Costs of Telltale Indicators and Pressure Monitoring .....	22
B.	Cost of Control .....	22
VIII.	ENVIRONMENTAL IMPACTS.....	23
IX.	REGULATORY IMPACTS.....	23
X.	RULE DEVELOPMENT PROCESS.....	23
XI.	CONCLUSIONS .....	24
	REFERENCES .....	25

## **I. INTRODUCTION**

Amendments to Regulation 8, Rule 28: Episodic Releases from Pressure Relief Devices at Petroleum Refineries and Chemical Plants (Rule 8-28) are being proposed to improve enforceability and compliance. This report examines and makes recommendations for improvement of the existing rule. Based on Further Study Measure FS-8 in the 2001 Ozone Attainment Plan, staff considered control requirements for existing atmospheric pressure relief devices (PRDs). Staff reviewed and summarized each release event report and the preventative measure reports and process hazards analysis submitted by the refineries. The results of that examination are reflected in the proposed amendments.

PRDs are installed on equipment that processes a wide variety of materials, including volatile organic compounds (VOCs); hydrogen sulfide and other acutely hazardous materials, such as ammonia, halogens (e.g., chlorine and fluorine) and halogenated compounds; steam, or other inorganic compounds.

Emissions from PRDs are intermittent and vary because PRDs are used as safety devices to manage excess pressures that occur under upset conditions. In general, emissions from PRDs can vary greatly, from tens of pounds to as much as tens of tons of material. Also, the duration of releases can vary greatly – from as little as seconds to a period approaching the length of a day. Further, emissions may not correlate with the duration of venting because the components equipped with PRDs process a range of materials and operate under a wide range pressures.

## **II. BACKGROUND**

Pressure relief devices are a means to safely relieve excessive pressures to protect process equipment, piping, and other components to prevent the rupture of equipment or other safety hazards. PRDs are designed to vent, or “lift”, at a prescribed “set pressure” to relieve excess pressure before it can exceed safe operating and/or equipment design levels. In most new refinery construction, PRDs in VOC service relieve to a control system that recovers the process gases or routes them to a disposal system such as a safety flare or thermal oxidizer. However, many older installations still have PRDs that vent directly to the atmosphere, resulting in the emission of VOCs and/or other material when the PRDs lift or if the valve leaks at pressures below the set point. These PRDs are called “atmospheric” PRDs and are the subject of Regulation 8, Rule 28.

### **A. Types of Pressure Relief Devices**

PRDs can be classified into the following general categories:

Pressure Relief Valves: The basic relief valve must open automatically and quickly during a rise in system pressure beyond a specified set pressure, must close with minimal leakage when normal operating pressure is restored, and

must be highly reliable. Pressure relief valves are designed to lift as necessary to relieve pressure levels before unsafe operating and/or equipment design levels are reached.

Thermal Relief Valves: Thermal relief valves protect liquid pipelines from over-pressurizing. Since the compressibility of liquid is minor, releases from thermal relief valves are normally small. These valves close as soon as the pressure in the closed system is relieved. These valves are generally vented to process drains, back into the pipeline or into the atmosphere.

Rupture Disks: A rupture disk is a thin metal diaphragm held between flanges. Rupture disks as a control device are used to protect relief valves from the process pressure. They are typically thin metal disks located on the pressure side of the relief valve. They are designed to burst at the relief valve setting. Owing to their “one-time” use, rupture disks are applicable for relief devices that are expected to be vented only in emergencies. Because they are to be used once, they are installed with block valves that will ensure that the piping can be closed once the emergency is contained. Rupture disks can also be used in place of relief valves in certain applications.

## **B. Emissions from PRDs**

PRDs emit air pollutants when they “lift” to relieve pressure in the equipment they are serving. Such releases are often referred to as “episodic” releases because they occur only during those occasions when the PRD opens to relieve process overpressures. In general, emissions from PRDs can vary greatly, from tens of pounds to as much as tens of tons of material. Also, the duration of releases can vary greatly – from as little as seconds to as much as a day. Further, emissions may not correlate with the duration of venting because the components equipped with PRDs process a range of materials and operate under a wide range pressures.

PRDs can also release material through leaks. Emissions from leaks are often referred to as “fugitive” emissions, and are addressed in District Regulation 8, Rule 18.

## **C. Detecting Emissions from PRDs**

Facility operators rely on a variety of indicators to determine whether or not a PRD has vented and what kind of release was involved.

### Telltale Indicators:

The most reliable mechanism for determining with certainty whether a PRD has experienced a release is a telltale indicator, which is a physical device placed on the PRD’s exhaust outlet in such a way that it will be moved or otherwise

impacted if any material is vented out of the PRD. Operators can readily determine whether there has been a release by checking the device to see whether it has been activated. Some common telltale indicators are:

- Socks – Socks are pieces of cloth or other material placed over the exhaust of a PRD such that when the PRD releases the sock is blown off by the releasing gas. If the sock is absent, that is a telltale sign that there has been a release.
- Flags – Flags are brightly colored metal tabs that are activated during a venting and become visible and can be easily seen by an operator.
- Rupture Disks – As mentioned above, rupture disks are thin metal diaphragms held between flanges. When the PRD releases, the disk will rupture. A ruptured disk is a telltale sign that there has been a release.

Telltale indicators are very useful in determining whether there has been a release. These indicators do not necessarily provide any information about the release, however, such as when it occurred, how long it lasted, how much material was involved, or the nature of the material released.

#### Other Indicators:

In addition to a telltale indicator, there are other ways to determine whether a PRD has lifted. These include:

- Audible indicators – when PRDs vent, they normally make a loud distinctive sound.
- Pressure indicators – PRDs are pressure relieving devices that are set at a specific pressure. As the pressure increases, pressure monitors will indicate the increasing pressure, and once the set point of the PRD is reached, the PRD will vent. When this happens, the pressure monitors indicate a constant pressure reading, unless the PRD is unable to fully relieve the excess pressure. Pressure monitoring is most useful when there is a monitor that reads the actual pressure at the PRD; in many situations, however, the only available monitoring is in some other area, and the actual pressure experienced by the PRD must be estimated based on assumptions about the equipment and process involved.
- Temperature – Temperature can be used as a way to indicate the release of PRD. As temperature increases, pressure will also increase potentially triggering a release. A decrease in temperature indicates pressure relief.
- Flowrates – Process flowrate can also indicate the venting of a PRD. An initial increase in a process flowrate from a vessel indicates a pressure increase. A leveling off or decrease in the flowrate would indicate flow being released at another point, such as at a PRD. Although the process flowrate is a surrogate indicator, this information taken along with pressure readings can be used to indicate and quantify a release event.

These alternative mechanisms are not ideal substitutes for telltale indicators because they do not normally provide a definitive and unambiguous indication as

to whether a release has occurred. For example, an audible indicator may be missed if there is nobody in the vicinity to hear it, or if the sound is masked by other noises at the facility. Similarly, indications from a pressure, temperature or flowrate monitor may be missed if the operator is not actively watching the monitor at the time of the release. For these reasons, telltale indicators are preferred where it is feasible to install and monitor them. Where such indicators are not feasible, alternative mechanisms can be fitted with alarms, data records, and other improvements that can make them better substitutes for telltale indicators in alerting operators that a release has occurred.

#### Quantifying Releases:

Telltale indicators provide a simple and effective means to determine whether a release has occurred, but they do not provide any information about when the release occurred, how long it lasted, how much material was involved, what type of material was involved, *etc.* Such information can normally be obtained only by reviewing historical operating data from the equipment involved in the release. For example, a review of operating pressure may show pressure increasing at a certain time, then leveling off at the PRD's set point, and then decreasing after a short time, which is the pressure signature of a PRD release. By reviewing the type of material that the equipment was processing at the time, the pressure at which the PRD opened, the size of the PRD opening, the time period over which the PRD was open, and other factors, one can characterize the release fairly accurately.

#### **D. PRDs at Bay Area Refineries**

There are 328 atmospheric PRDs located at the five Bay Areas refineries. Of the 328 PRDs, approximately 50 are either rupture disks or pressure relief valve / rupture disk combinations, with the remaining being pressure relief valves. Approximately ten of the PRDs are equipped with socks and the vast majority has some type of pressure monitoring indicators, although some are remotely located, so not all of the pressure indicators measure the pressure experienced at the PRD. Table 2.1 summarizes the total number of atmospheric PRDs and the total number of process vessels or components and process units served by atmospheric PRDs located at each refinery.

**Table 2.1  
Population of Atmospheric PRDs at Each Refinery**

<b>Refinery</b>	<b>Atmospheric PRDs</b>
Chevron-Texaco	41
ConocoPhillips	16
Shell	107
Tesoro	99
Valero	65
<b>Total</b>	<b>328</b>

Chemical Plants in the Bay Area also use PRDs on various process components. For these PRDs, which usually service components containing non-hydrocarbon compounds, release event reports (as required pursuant to Section 8-28-401 of the rule) were evaluated during the rule review process and determined not to emit large amounts of VOCs. Because of this, the current rule development effort is focused primarily on PRDs at refineries and so staff has not attempted to survey the population of PRDs at chemical plants with the same level of detail as with the refineries.

### **III. REGULATORY HISTORY**

Rule 8-28 was originally adopted July 16, 1980 and was aimed primarily at fugitive emissions. The rule established a leak standard of 10,000 parts per million for PRDs, but it did not place any restrictions on PRD venting as long as the venting was reported and the PRD reseated (closed) after releasing any excess pressure. The rule also required quarterly leak inspections for accessible PRDs and annual inspections for inaccessible PRDs. Since its adoption in 1980, minor amendments were made to the rule in 1981, 1982, 1983, and 1994.

The current form of the rule resulted from significant amendments that were adopted in 1997. The 1997 amendments required more comprehensive reporting of PRD releases, and also added requirements to address episodic PRD releases in addition to the fugitive emissions addressed by the original rule; these requirements are discussed in more detail below. The fugitive emissions provisions were moved to the leak-detection provisions of Rule 8-18. Further minor amendments were made 1998 and 2004.

#### **A. Requirements of Regulation 8, Rule 28**

Regulation 8, Rule 28 addresses episodic emissions of both organic and inorganic compounds from PRDs located at refineries and chemical plants. For chemical plants, the rule requires only that facilities report any releases of over 10 pounds from a PRD to the District. For petroleum refineries, the rule requires release reporting and also requires certain substantive measures to reduce the likelihood of releases. The requirements of the rule are summarized as follows.

### New and Modified Sources

Rule 8-28 requires that PRDs at new and modified sources at petroleum refineries meet District Best Available Control Technology (BACT) as defined in Regulation 2, Rule 2 and the District BACT Guideline, which is to vent PRDs to a fuel gas recovery system, furnace, or flare with a control efficiency of at least 98 percent.

### Existing Sources

Rule 8-28 requires that any atmospheric PRD in organic compound service at an existing source at a petroleum refinery must implement specified prevention measures procedures. These prevention measures procedures include (i) establishing training, equipment, inspection, maintenance and monitoring requirements in order to minimize releases; and (ii) implementing prevention measures such as process flow, temperature, level, and pressure indicators with interlocks; documented and verified routine inspection and maintenance programs; inherently safer designs; and deluge systems. Refineries triggered this requirement at their first scheduled turnaround after July 1, 1998. All five refineries in the Bay Area have had such turnarounds, and so the requirement is now in effect for all of these facilities.

### Releases from PRDs

Within 90 days of a reportable Release Event (defined as a release from a PRD to the atmosphere of over 10 pounds of air pollutants), a petroleum refinery must: 1) conduct a process hazard analysis including an evaluation of the cost effectiveness and technological feasibility of controls; 2) implement prevention measures procedures (to the extent they have not already been implemented); and 3) conduct a failure analysis to discover the cause of the release and prevent recurrences. Within 120 days of the release event, the PRD must be equipped with a telltale indicator and be evaluated for control.

Should any source experience two or more Release Events from any of the PRDs on the source within five years, all PRDs on that source must be vented to a control device.

### Reporting Requirements for Refineries and Chemical Plants

All Release Events at petroleum refineries or chemical plants must be reported to the District by the next working day. PRDs must be inspected within five days of a Release Event under Rule 8-18 to ensure that they are not leaking. Within 30 days, the facility must report:

- the date, time, and duration of the Release Event;
- the device that experienced the Release Event;
- the District-assigned release number;
- the type and size of device;
- the type and amount of material released;

- any information used to estimate duration and amount released;
- the cause of the release;
- the schedule prevention of re-occurrence action; and
- the results of the fugitive emission inspection.

The requirement to report this information implies that facilities must monitor PRDs to determine whether a Release Event has occurred and if so, the duration, cause, type and amount of material released must be monitored. There is no explicit monitoring requirement in the rule, however.

## **B. Other District Regulations Applicable to PRDs**

There are three other District regulations that are directly applicable to PRDs, Regulation 8, Rule 5 (Rule 8-5), Regulation 8, Rule 18 (Rule 8-18) and Regulation 8, Rule 22 (Rule 8-22).

### Rule 8-5: Storage of Organic Liquids

Rule 8-5 requires the pressure vacuum valves (synonymous with PRDs) on tanks used to store organic liquids be set at a pressure within 10 percent of the maximum working pressure of the tank and that the valves be properly installed and maintained in good working order.

### Rule 8-18: Equipment Leaks

Rule 8-18 addresses fugitive emissions of VOCs from various components, including PRDs, at petroleum refineries, chemical plants, gasoline bulk terminals and bulk plants. Fugitive emissions are those that escape from non-airtight fittings or connections. Rule 8-18 prohibits VOC leaks from PRDs over 500 ppm, subject to certain qualifications.

### Rule 8-22: Valves and Flanges at Chemical Plants

Rule 8-22 addresses fugitive emissions of VOCs from small chemical plants. When fugitive emissions rules were amended in 1990, large chemical plants were made subject to the more stringent rules for petroleum refineries. Rule 8-22 was maintained for small (fewer than 100 valves) chemical plants.

## **IV. RULE EVALUATION**

In the San Francisco Bay Area 2001 Ozone Attainment Plan for the One-hour National Ozone Standard, the District committed to study several activities at petroleum refineries to determine if additional emissions reductions could be achieved and whether implementation of control measures would be feasible. Specifically, in Further Study Measure 8 (FS-8), the District committed to evaluate whether there is the potential to reduce emissions by venting more PRDs to control systems.

In accordance with FS-8, District staff conducted an audit of refinery PRDs and drafted a technical assessment document, both in 2002. District staff also reviewed release event reports submitted to the District by the affected facilities since the implementation of the 1997 amendments, visited refineries and chemical plants, interviewed refinery staff, and discussed concerns with District inspection and permitting staff to get a complete understanding of how the rule is being implemented. These efforts revealed that the following aspects of the current rule should be evaluated:

1. Facilities may not be capable of detecting, characterizing, and reporting Release Events as thoroughly and comprehensively as was anticipated when the current Rule was adopted;
2. There is some ambiguity and potential for confusion in some of the provisions as currently written, as well as some obsolete language; and
3. The feasibility of requiring additional controls for episodic PRD releases, beyond what is already required by the rule should be evaluated.

The results of these Rule Evaluation efforts are summarized below.

#### **A. 2002 PRD Audit Summary and Findings**

Beginning at the end of 2001 and continuing through mid-2002, District staff conducted an audit of PRDs located at the five Bay Area refineries. Staff reviewed and documented all monitored and recorded data made available by the refineries that would indicate PRD venting, e.g., pressure, temperature, and flow data. The goals of the audit included 1) identifying all PRDs that vent directly to the atmosphere at units common to all refineries, (e.g., hydrotreaters and hydrocrackers), 2) verifying the PRD set points, and 3) determining to what degree of confidence the District can establish whether the PRDs at the refineries experienced releases during the audit period.

The 2002 Audit concluded that:

- PRD data may not be accurate – most monitors are located remotely from the PRD (thus requiring engineering calculations to estimate the pressure at the PRD) and pressure data is recorded in one-minute averages which may miss short ventings;
- There is no requirement to retain data or calibrate pressure recorders;
- Refinery staff rely mostly on sound to determine if a venting occurred;
- Undisclosed PRD releases were discovered;
- A follow-up study on the feasibility and methodology behind requiring approved monitors to capture all pressure releases at each PRD was recommended.

## **B. 2002 Technical Assessment Document**

The Technical Assessment Document, published in December, 2002, re-iterated the findings of the PRD audit report and recommended several actions to improve Rule 8-28. The recommendations are to:

- Remove the “turnaround” reference that triggers the certain requirements in Rule 8-28;
- Re-define or clarify the timelines for repeat releases;
- Require monitoring and/or indicators to determine an initial release event; and
- Establish a leak or emission standard for PRDs and an inspection program to ensure that no releases have gone undetected.

## **C. 2005 Rule Review**

Building on the 2002 Audit and Technical Assessment Document, District staff further evaluated the rule and developed the following recommendations.

### Detecting Releases

The District’s review confirmed the finding of the 2002 PRD Audit that the majority of PRDs are not equipped with telltale indicators. Of the 328 PRDs District-wide, fewer than 50 are equipped with telltale indicators. As mentioned above, facility operators rely on a variety of other indicators to determine whether or not a PRD has vented. Although these mechanisms may be able to provide useful information about a release, they are not as reliable as telltale indicators because they do not provide such a clear, easily-noticed, and lasting indication that the PRD has vented. Ideally, telltale indicators should act as a “red flag” warning that there has been a release from a PRD, which would then prompt the facility to examine all of the other available indicators (e.g., pressure records) to identify further details such as the duration of the release and the amount and type of material involved.

In some cases, it may not be feasible to install a telltale indicator on a PRD because the PRD is not readily accessible. In such cases, other types of indicators (such as pressure monitoring) may provide an acceptable substitute provided that they are equipped with alarms, dataloggers, and other features to ensure that they will provide the clear and ready indication of a release that one would expect from a telltale indicator. The use of substitute indicators should be restricted to situations where a telltale indicator would be unworkable, however.

Additionally, the rule as currently written does not define telltale indicator. Although facilities may have a general conception of what a telltale indicator is, it is not clear that there is specific definition that is commonly accepted among those affected by this Rule. This term should be defined to ensure that there is a clear understanding of what a telltale indicator is and how to comply with the associated provisions.

### Characterizing Releases

Section 8-28-401 of Rule 28 requires that facilities report all releases of over 10 pounds of any air pollutant from a PRD. They must provide detailed information about each release, such as the “[t]ype and amount of material released in pounds, accurate to two significant digits” and the “[n]ecessary information and assumptions used to report the duration and amount released during the event.” However, there is no explicit requirement that facilities have equipment installed to enable them to detect all such releases and collect the information that must be reported, and there is no standard by which to determine compliance. As a result, facilities are using a variety of different monitoring approaches for their various processes and equipment, which vary greatly in their ability to detect and quantify releases. For example, the vast majority of PRDs have some sort of pressure monitoring of the system being served by the PRD, but few of them actually measure the pressure at the PRD itself. Similarly, many monitoring systems are not sensitive enough to detect small releases, and may not be detecting releases in the vicinity of the 10-pound threshold that triggers the reporting requirement. For these reasons, staff believes that the refineries need to ensure that they have the capability to detect, characterize, and record all PRD releases, and that they need to demonstrate this capability to the District.

In addition, refineries need to use such systems in conjunction with telltale indicators. Telltale indicators alert operators that there has been a release, but they do not provide any further information on the size or duration of the release, the material involved, *etc.*

### Data Recording and Retention:

The 2002 PRD audit also indicated that even where PRD pressure monitoring is used, pressure monitoring data are often not recorded or retained. The lack of data retention for some PRDs makes it difficult for District Enforcement staff to independently verify the pressure and venting history of those devices. It is recommended that measurements and recordings of the pressures experienced by the PRD be maintained for an explicit period of time in the rule. The time period should be long enough to allow facility and/or District staff to go back and review the details of an incident some time after the fact, in situations where it was not immediately obvious that there were issues of interest to be investigated.

### Definition of Equipment Subject to the rule

Several provisions of Rule 8-28 use the term “source.” These include the provision that requires the installation of a telltale indicator on each PRD on a “source” within 120 days following a release event from that source (§ 8-28-304.1); and the provision that requires each PRD on a “source” to be piped to an emissions control device following a second release within five years from any PRD on the “source” (§ 8-28-304.2).

However, “source” is not defined, which can lead to confusion on how the rule is to be implemented. Typically, petroleum refineries have a vast array of interconnected pieces of process equipment and a large number of pumps, compressors, and piping to move petroleum products between the various stages of refining. Because these equipment typically do not operate in isolation, various equipment and groups of equipment have been defined as “sources” over time for different regulatory purposes. For example, in one context “source” may be used to refer to an individual piece of equipment, such as a pressure vessel. In other contexts, “source” may be used to refer to an entire process unit, which may be made up of a large number of pressure vessels, piping, and related equipment. The rule does not indicate which definition should be used in the context of Regulation 8-28, and the general definitions in other regulatory provisions (e.g., Regulation 2, Rule 1) are not specific enough to provide any further guidance.<sup>i</sup>

The lack of a clear definition of “source” can lead to confusion in how the rule is applied, given that all PRDs on a “source” need to be fitted with a telltale indicator after the first release event, and must be piped to an emissions control system after a second release event in five years. To give a concrete example, suppose a PRD on a pressure vessel experiences a Release Event and triggers these requirements. It is not clear whether the requirements are triggered just for PRDs on that pressure vessel, or on all PRDs on any equipment that is part of the larger process unit of which the pressure vessel is one component. The rule needs to define “source” to clarify what is required in this situation.

When the current rule was adopted, the intent was that whenever there was an overpressure that caused a PRD to vent, the substantive requirements of Section 8-28-304 would be triggered for all PRDs that could have been impacted by that overpressure. That is, if the pressure rose in a system of multiple pieces of equipment served by multiple PRDs, but it caused only one of the PRDs to release, all of the other PRDs potentially affected by the overpressure would trigger the requirements to have a telltale indicator installed (for a first release) or to be vented to a control system (for a second release in five years). The District has used this approach in enforcing the rule, and staff continues to believe that it is the most appropriate regulatory approach. Any definition of “source” should utilize this approach.

Defining “source” for purposes of Rule 8-28 differently than elsewhere in District regulations could cause further confusion, however. The term would have different meanings depending on the context in which it is used. Staff therefore

---

<sup>i</sup> This distinction has an important impact on the number of affected sources at Bay Area refineries. If “source” is interpreted to mean a single PRD, then there are 328 refinery “sources” in the District; if “source” is interpreted to mean an individual process vessel or component, then there are 185 refinery “sources” in the District equipped with PRDs, according to staff’s review; and if “source” is interpreted to mean an entire process unit, then there are only 58 refinery “sources” in the District equipped with PRDs.

recommends that a different term be substituted for “source” to avoid any potential for confusion. A term such as “process component” would be appropriate, as it describes the concept involved but is not as commonly used elsewhere in the District’s regulations.

### Feasibility of Additional Control of PRD Releases

During the development of the 1997 Rule amendments, staff considered whether it would be appropriate to require PRDs to be vented to an emissions control system, such as vapor recovery or a combustion process. Staff concluded that PRDs that experienced multiple releases should be controlled before PRDs that seldom, if ever, vented. This approach ensured that refineries focus their efforts on controlling PRDs that have a history of emissions. The 1997 amendments therefore required that any source that experiences two release events within five years must be vented to a control system. Further, the 1997 amendments required that refineries conduct an evaluation of the technical and economic feasibility of controlling emissions from any PRD that experienced a single Release Event. Subsequent to the adoption of the 1997 amendments, staff committed to revisit this issue. This commitment is embodied in Further Study Measure 8 in the 2001 Ozone Plan.

To determine whether additional control requirements would be advisable, staff examined how facilities would be likely to implement such a requirement. Although some PRDs could be vented to fuel gas recovery or to a closed loop system, it is most likely that they would vent to a disposal system such as a flare. Flaring is not a practice that the District encourages, and the District has just adopted a new rule (Regulation 12, Rule 12: Flares at Petroleum Refineries) that is intended to reduce flaring. But flaring is a feasible method of controlling episodic releases from PRDs, and it is the option that most facilities would be likely to use.

Staff reviewed refinery practices to see whether other alternatives besides flaring might be available. One refinery was able to reroute the vents from eight PRDs back into the refining process to result in a closed loop. This is considered control because the PRDs no longer vent to the atmosphere and would not be subject to this Rule. However, this strategy is highly unlikely to be achievable for most pressure relief systems. It is doubtful that refining processes could accommodate the additional load from a PRD release.

Another refinery, in an attempt to diminish the chance of multiple release events on a single source, has installed (during a scheduled turnaround when work such as this is optimal) de-pressurizing valves that vent smaller amounts of material to the flare header system. These de-pressurizing valves are set at a lower pressure and have a smaller material release capacity than their associated PRDs and will, therefore, provide some pressure and material relief that will help to forestall a release event from their associated PRD. Two important points must be noted. First, the PRDs in these cases could not be routed to a flare

header because of the potential to create excessive back pressure in the system that could cause the process component to rupture. Second, the refinery did an analysis to determine which PRDs (and their configurations and the process components) would best lend themselves to this type of modification. The analysis revealed that only a small number could be accommodated within existing header capacity in a cost-effective manner, and the same type of modification at less advantageous locations could easily cost ten times as much for a similar amount of relief load.<sup>1</sup> Although this may have helped to reduce the likelihood of a release event, it is not control because the emissions from the PRDs in question would still be vented to the atmosphere.

Staff therefore concluded that requiring additional PRDs to be vented to control systems would effectively require them to be sent to flares. Requiring all PRDs that are currently uncontrolled to be vented to flare systems would overwhelm the capacity of the refineries' current flare systems and would require the installation of multiple new flares. As discussed in detail in Section VII below (Economic Impacts), installing new flare systems would be very costly, requiring an investment of \$140 million to \$210 million District-wide. Given that the cost would be high, that the emission reductions that could be achieved are not commensurate, and that there are other ancillary downsides associated with flaring, staff does not recommend additional control requirements beyond what is in the current version of the rule.

#### Non-Substantive Amendments and Clarifications.

Finally, the District's review identified several areas where the current language of the rule was obsolete or confusing in some way. These are not areas where the substantive requirements of the rule need to be changed. All that is needed are minor, non-substantive changes to make the rule more clear and workable.

- "Turnaround" Reference: Many of the provisions of the 1997 amendments to Rule 8-28 take effect following the first turnaround after July, 1998. Staff has determined that the reference to turnaround is no longer needed because all the affected PRDs are in service on equipment that has undergone at least one turnaround since the adoption of the 1997 amendments.
- Some administrative requirements were not placed in the proper locations in the rule. To address this and add clarity, staff is proposing to relocate some of the provisions.

## **V. PROPOSED AMENDMENTS**

The rule review described above illuminated several areas in which the rule could be made more effective. Staff is therefore proposing that the Board of Directors

adopt certain amendments to the current rule. The proposed amendments would:

1. Require "telltale indicators" or the equivalent for all atmospheric PRDs, and add a definition of "telltale indicator";
2. Require facilities to ensure that they have the capability to detect and quantify all release events, including small releases of 10 pounds, which is the reporting threshold, or more, and require facilities to demonstrate this capability to the District;
3. Require data recording and recordkeeping for venting and emissions verification;
4. Define the equipment subject to the rule to ensure the rule applies to individual process components and related PRDs;
5. Make minor, non-substantive changes to the rule such as deleting obsolete references to "turnarounds", moving requirements where appropriate, and clarifying various sections of the rule.

#### **A. Require "Telltale Indicators" On All PRDs**

The rule currently requires the installation of a telltale indicator only following a release of more than 10 pounds. There is no requirement to install a telltale indicator on PRDs that have not experienced a release event. Staff proposes to require that all PRDs have such an indicator (or equivalent).

Where a PRD cannot feasibly install a telltale indicator, because of the PRD's location or configuration, for example, the proposal would require a District-approved pressure monitoring system in lieu of a telltale indicator. A pressure monitoring system used in lieu of a telltale indicator must be:

- Capable of indicating the pressure experienced by that PRD,
- Equipped with a tamperproof alarm, and
- Equipped with a pressure recording system that records not only pressure, but also the occurrence of alarms.

Further, to help ensure that the telltale indicators and/or pressure monitoring equipment operate effectively, staff proposes that any time a telltale indicator or equivalent indicates that a release event has occurred, that information be reported to the District. This requirement would provide an incentive to the facilities to ensure that the indicating system does not provide "false positives" that would have to be reported to the District and become part of the compliance record. If the release event is a "false positive," the facility may provide evidence to demonstrate that no release has actually occurred.

#### **B. Require Pressure Monitoring Systems for Detecting and Characterizing Releases**

Currently, there is no explicit requirement that facilities have monitoring equipment on PRDs capable of providing the information about releases that must be reported to the District, such as when a release event occurred, how

much material was involved, what kind of material was involved, *etc.* Staff proposes making this requirement explicit. An explicit requirement will give affected facilities better guidance on what is expected of them and will provide a clear standard for determining compliance with the rule.

In addition, given that facilities have varied greatly in the past in their abilities to detect and characterize releases, the proposal would require each facility to demonstrate to the District the capability to detect and record a release event, (that is, a ten-pound venting from any atmospheric PRD). This one-time demonstration would take the form of a report to the District that details exactly how each PRD is monitored to determine whether or not it has experienced a release event. This report would include:

- Diagrams clearly indicating the location of each PRD associated with an identified “process component” and the location(s) of any device used to monitor the pressure of each PRD;
- The sensitivity of the pressure monitoring device and period between calibrations (if any);
- The estimated pressure difference between the PRD and the pressure monitoring device (including methodology for the estimation, engineering calculations and associated errors);
- The normal operating pressure of the “process component”;
- The set point of the PRD and the maximum potential variation; and
- The feasibility of the installation of a pressure monitoring device to directly measure and record the pressure actually experienced by the PRD.

Furthermore, the release reporting requirements in Section 8-28-401 apply to chemical plants in addition to refineries. Staff proposes making these amendments applicable to both chemical plants and refineries, because they are intended to improve the Section 8-28-401 release reporting program, which applies to both chemical plants and refineries.

### **C. Require Data Recording and Recordkeeping**

There are currently no requirements for pressure monitoring data recording or retention. To address this issue, staff proposes to require that facilities record pressure monitoring and make these data available to District staff for a minimum of two years following creation.

### **D. Define “Process Components” Subject to the Rule**

Staff proposes using the term “Process Component” instead of the term “Source” to define the equipment that is subject to the rule. “Process component” would be defined as any pressure-related system of process equipment, including but not limited to, process vessels, tanks, heat exchangers, distillation columns, pumps, compressors or other equipment and peripheral piping that cannot be isolated from any other portion of the system via valves or any other obstructions.

This definition would make clear that when one PRD experienced a release event, all PRDs associated with that process component would be required to have telltale indicators installed and, upon the second release event from any PRD on that process component, all PRDs associated with that process component would have to vent to a control device. This was the intent behind the current rule, and it is the interpretation that the District has used in enforcing the rule.

#### **E. Minor Non-Substantive Amendments**

Sections 8-28-303 and 304 of the 1998 amendments to the rule become effective after the first scheduled turnaround following July 1998. Discussions with refinery personnel indicate that all affected process units have undergone at least one scheduled turnaround since July 1998. As a result, these conditional provisions would be modified to eliminate the reference to “schedule turnaround.”

Portions of the rule are proposed to be moved or clarified. These are not intended to add new requirements, but to clarify and put requirements into their most appropriate location. For example, administrative and reporting requirements are appropriately located in Section 400 and 500 of District rules, respectively.

#### **VI. EMISSIONS**

Emissions from excess pressure in facilities’ process units occur at the exhaust of the PRD. These pressure releases result from problems in the process that could result in catastrophic failure of the process equipment if the pressure is not released in a controlled manner.

##### **A. Sources and Release Events:**

Since the 1998 amendments to Rule 8-28 took effect, there have been 43 release events reported by the five Bay Area refineries (through May 2005), according to release event reports submitted to the District. These 43 release events vented a total of 113 tons of VOC emissions, according to the refineries’ calculations. Of the 43 release events, two triggered the provision requiring the installation of telltale indicators, and eight PRDs were required to be controlled. Table 6.1 compares the number of release events reported for individual atmospheric PRDs, process vessel / components and process units. The first column lists the total number of atmospheric PRDs in use in the District, the number that have experienced one release event, and the number that have experienced two or more such events. The second column lists the number of individual vessels or other components of a refinery process unit that are fitted with PRDs, the number of such vessels or other components that have experienced one release event, and the number that have experienced two or more release events. Finally, the third column lists the number of different

processes that have components fitted with PRDs, the number that have experienced one release event, and the number that have experienced two or more release events.

**Table 6.1**  
**Summary of Reported PRD Release Events Relative to PRD, Vessel / Component, and Process Unit**

Release Events reported since 1998 pursuant to Rule 8-28 (§8-28-401)

	Atmospheric PRD	Vessel / Component	Process Unit
Total <sup>a</sup>	328	185	58
One Release Event <sup>b</sup>	20	20	14
Two or more Release Events <sup>c</sup>	3	3	0

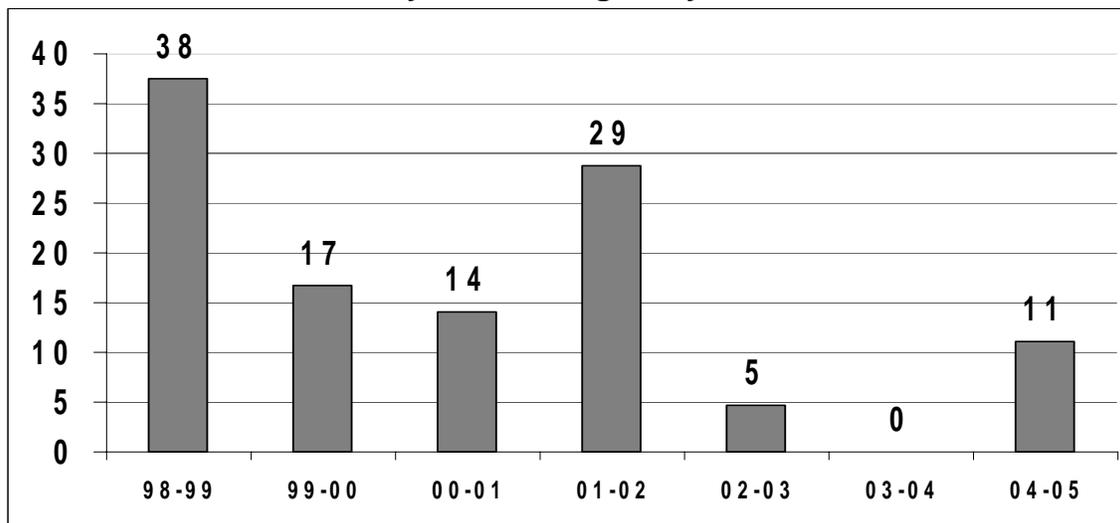
- a. These values represent the population of individual atmospheric PRDs, the population of vessels/components equipped with PRDs, and the population of process units made up of at least one component PRD, respectively, at all of the refineries.
- b. One release event requires that installation of a “telltale” indicator on each PRD of that source (§8-28-304.1, rule requirement took effect following the first scheduled turnaround after the 1998 amendments).
- c. Two or more release events require control of all PRDs that experienced the second release (§8-28-304.2, rule requirement took effect following the first scheduled turnaround after the 1998 amendments).

---

**B. Emissions Summary:**

Emissions are reported to the District (pursuant to Section 8-28-401 of the rule) by each facility concerning release events at that facility. Since July 1998, each affected facility has been required to estimate VOC emission for each release event and report that information to the District. These reported emissions are summarized in Table 6.2.

**Table 6.2**  
**VOC Emissions from Reported PRD Release Events**  
**July 1998 through May 2005**



This graph illustrates the total annual emissions (tons) from reported release events with each year starting at July beginning in July 1998.

The 113 tons of reported VOC emissions translates to average emissions of approximately 16 tons/year (88 lbs/day), with maximum annual emissions of 38 tons (137 lbs/day on average) in July 1998 through June 1999. Emissions have exhibited a general downward trend. Over the last five years, the average annual emissions are approximately 11.8 tons per year, (65 pounds/day) which is a reduction of about 26 percent over the total annual average since the 1998 amendments took affect and almost 50 percent reduction over the first couple of years following 1998. This downward trend may be attributable to the implementation of the required prevention measures.<sup>ii</sup> All process units affected by this Rule are required to have implemented such measures, as they have all gone through at least one turnaround since adoption of the current version of the rule, which was the triggering event for the prevention measures requirement in Section 8-28-405 of the rule.

There is a limit to the conclusions that can be drawn from average emissions figures, however. PRD releases are episodic in nature, and generally involve short periods of significant emissions interspersed among long periods of inactivity. Furthermore, there can be great variability in the duration and extent of releases when they do occur. Tables 6.3 and 6.4 illustrate the wide range of variation in number of and emissions from reported release events since July 1998. As these tables show, a particular release event may be far larger or

<sup>ii</sup> Prevention measures include 1) flow, temperature, level and pressure indicators with interlocks, deadman switches, monitors, or automated actuators, documented and verified routine inspection and maintenance programs, 3) inherent safer designs, and 4) deluge systems.

smaller than the “average,” and there can be significant individual releases even during periods where the “average” release is fairly small.

**Table 6.3  
Summary of Release Events Reported Since July 1998**

<b>Year</b>	<b>Number of Release Events</b>	<b>Annual Average Emissions per Release Event (tons)</b>	<b>Range of Emissions per Release Event</b>
July 98 – June 99	9	4.2	45 lbs – 16 tons
July 99 – June 00	5	3.3	0.54 tons– 11.5 tons
July 00 – June 01	4	3.5	530 lbs – 6 tons
July 01 – June 02	11	2.6	19 lbs – 15.5 tons
July 02 – June 03	8	0.6	32 lbs – 1.6 tons
July 03 – June 04	2	83 lbs	37lbs – 46 lbs
July 04 – June 05	4	2.8	70 lbs – 9.3 tons
<b>Total</b>	<b>43</b>	<b>–</b>	<b>–</b>
<b>Overall Average Emissions per Event</b>		<b>2.7</b>	<b>–</b>
<b>Overall Range of Emissions per Event</b>		<b>–</b>	<b>19 lbs – 15.5 tons</b>

This table illustrates the total number of reported release events, the annual average emissions per release event and the range of the emissions per release event with each yearly time period starting with July beginning in 1998.

**Table 6.4  
Release Event Distributed by Amount of VOCs Released**

<b>Amount of VOCs Release per Event (lbs)</b>	<b>Number of Events since July 1998</b>
10 – 100	8
100 – 1000	9
1000 – 10,000	18
10,000 – 100,000	8

Furthermore, emissions data may be somewhat underestimated because some releases may not have been discovered and reported to the District. For example, where PRDs do not have telltale indicators or comprehensive pressure monitoring systems that can detect releases, facilities may have experienced releases that they never detected. The refineries are confident that they have detected most (if not all) of the releases that have occurred, however. Moreover, if any releases did go undetected, it is most likely that they were smaller events, as it would be hard not to detect a large release even without a comprehensive monitoring system. In addition, the emissions summaries do not account for emissions of less than 10 pounds because these small releases are not required to be reported to the District. But again, these are small events and the annual

total of these emissions is not expected to be significant. Staff, therefore, believes that the data on current levels of PRD emissions are sufficiently reliable for present purposes, although it clearly can be improved.

Finally, emissions can result from equipment leaks. PRDs typically leak from foreign material deposited on the seating surface, corrosion or erosion. The likelihood of leaks increases after each lifting of the device. These fugitive leaks can be controlled by an aggressive inspection and maintenance program, improved device design, installation of rupture disks with telltale indicators in conjunction with a pressure relief valve, or venting the system to a control system. The fugitive emissions are subject to the control requirements in Regulation 8, Rule 18: Equipment Leaks. Fugitive emissions are not addressed by Rule 8-28 (except to the extent that venting of a PRD may increase the likelihood of leaks from improper valve re-seating, which Rule 8-28 addressed by requiring a leak inspection within five days of a Release Event).

### **C. Emissions Reductions**

Due to the proposed amendments, facilities would become better aware of the conditions associated with the PRDs and, consequently, be able address issues that may potentially lead to releases from PRDs and discover smaller venting that may have gone unnoticed. These emissions include both direct emissions from release events, fugitive emissions associated with improper reseating of PRDs following a release event, and what is known as “chattering” (where the process pressure levels are close to the set point of the PRD and as a results the PRD periodically release small amount of material).

Although, from time to time, US EPA has estimated a 10 to 20 percent emissions reduction due to enhanced monitoring and prevention measures in various rulemakings, staff estimates that an additional five percent emissions reduction may be achieved from the implementation of these amendments. This conservative estimate is because the rule already requires significant prevention measures. Better monitoring (telltale indicators and pressure monitoring) may result in the detection of smaller release events which, in turn, would lead to earlier implementation of required control of those low-emitting PRDs. Fewer atmospheric PRDs available to emit VOCs would likely result in emission reductions. An estimated emission reduction of five percent would equal about 0.6 tons per year.

## **VII. ECONOMIC IMPACTS**

The section contains the cost impacts of the proposal, and also discusses the economic feasibility of requiring additional control of PRD emissions beyond what is required under the current rule.

## A. Costs of Telltale Indicators and Pressure Monitoring

The proposed amendments require that each PRD be equipped with a telltale indicator or an equivalent pressure monitoring system. From conversations with refinery personnel and cost quotes from vendors, staff estimates the cost of installing of a telltale indicator, such as a sock, range from \$500 to \$1000 per PRD and the cost of installing a pressure monitoring system would range between \$1,000 and \$1,500.<sup>(2 3 4 5)</sup> There are 328 PRDs at the five Bay Area refineries, approximately 10 to 15 percent of these PRDs are equipped with rupture disks or valves and rupture disks combinations<sup>(6)</sup> and about a dozen are already equipped with socks. Of the remaining 267, staff estimates that at least 80 percent (or 214) would lend themselves to the installation of telltale indicators at a total cost of ranging between \$110,000 and \$214,000. This leaves 53 PRDs District-wide that would potentially have to rely solely upon a pressure monitoring system installed at the PRD in lieu of a physical telltale indicator. It is estimated that it would cost approximately \$1000 to \$1500 per PRD to install a wireless pressure monitoring system that would be capable of complying with the proposed requirements.<sup>iii (5)</sup> (This translates to total costs ranging between \$53,000 and \$79,500 District-wide.) Therefore, the total cost of the proposed amendments would fall between **\$165,000 and \$300,000** District-wide.

## B. Cost of Control

Staff also examined the cost of venting additional PRDs to control systems. Retroactively controlling emissions from PRDs is considered technically feasible and it is currently a requirement of Rule 8-28 under specified circumstances. There are two methods of control that are generally available to the refineries:

1. Venting PRD emissions to a flare system or thermal oxidizer, or
2. Routing PRD emissions into the fuel recovery system or refining process.<sup>(7)</sup>

### Cost of Flare System

Conversations with refinery personnel and reference to past staff reports indicate that the cost to install a flare system that would control (or incinerate) the emissions from 50 PRDs would range from \$20 to \$30 million<sup>(2, 3, 7)</sup>. Therefore, at least seven flares would be needed to control 328 PRDs; this would result in a total capital cost of \$140 to \$210 million District-wide. To estimate cost effectiveness, the capital cost must be annualized. If cost was annualized at an interest rate of seven percent over ten years, the annual costs would be **\$19.5 to \$29.3 million per year**; annualized over 20 years, **\$13.0 to \$19.5 million**. The

---

<sup>iii</sup> These cost estimates are based on the installation of wireless instrumentation which cost approximately five percent of the cost of hard wired instrumentation.

average annual amount of VOC emissions from PRDs over the last five years has been approximately **11.8 tons**. Flares are considered to have a control efficiency of 98 percent; consequently, an emission reduction of **11.6 tons per year of VOC** – an average of 63.4 pounds of VOC per day – could be realized. Therefore, the overall annual cost to control for the entire population of PRDs would be **\$1.1 to \$1.7 million per ton of VOC emissions per year**. Based on the recent socioeconomic analysis for proposed Regulation 12, Rule 12: Flares at Petroleum Refineries, the cost of control as a percentage of profits would be from 2.7 percent to 4 percent of annual profits annualized over 20 years. Due to the very high cost, requiring control of all PRDs is not recommended.

#### Other Control and Emission Reduction Methods

As noted previously, one refinery was able to reroute the vents from eight PRDs back into the refining process to result in a closed loop. The approximate cost of this effort was \$2 million to control these eight PRDs. Based on this cost, if this strategy were implemented District-wide, the minimum total capital cost would be \$82 million.<sup>(8)</sup> If, as iterated previously, this strategy cannot be achieved for most pressure relief systems, the cost to control PRD emissions in a similar matter, may be orders of magnitude greater than the scaled \$82 million estimate based on this circumstance.

### **VIII. ENVIRONMENTAL IMPACTS**

Pursuant to the California Environmental Quality Act, the District will prepare an initial study for the proposed amendments to determine whether or not they would result in any significant environmental impacts. It is expected that the adoption of the proposed amendments will create environmental benefits from reducing emissions of both total and toxic organic compounds from PRDs.

### **IX. 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 28: Episodic Releases from Pressure Relief Devices at Petroleum Refineries and Chemical Plants applies to emissions from atmospheric pressure relief devices located at refineries and chemical plants. The proposal does not expand the applicability or the current rule. No federal air pollution control requirement was identified for the equipment or source type affected by the proposal.

### **X. RULE DEVELOPMENT PROCESS**

Staff hosted a workgroup meeting on Pressure Relief Devices on May 9, 2005. The workgroup, consisting of representatives from the five Bay Area refineries,

Western States Petroleum Association, Communities for a Better Environment, and staff from the District and ARB, discussed the status of the current rule, findings of the 2002 PRD Audit report, the Technical Assessment Document, and the reported release history since July 1998. Regulatory concepts were discussed including:

- Clarification of “source” in the rule,
- A requirement for telltale indicators on all PRDs,
- A requirement for pressure monitors and for retention of data recordings,
- A requirement for certification and calibration of pressure monitoring equipment, and
- Removal of the reference to “turnarounds”.

## **XI. CONCLUSIONS**

The 1997 amendments to Rule 8-28 have been successful in preventing releases and requiring control of those pressure relief devices that need it most. The rule has required refiners to consider these releases and integrate control technologies into their future plant modifications.

The proposed amendments to Regulation 8, Rule 28: Episodic Releases from Pressure Relief Devices at Petroleum Refineries and Chemical Plants are based on Further Study Measure FS-8 in the 2001 Ozone Attainment Plan. The proposal will enhance to District’s ability to enforce the rule and enhance the operator’s ability to detect releases. The proposal also clarifies the rule so that it can be more easily understood and enforced.

The costs of the proposed amendments are reasonable; they will enhance staff’s ability to monitor and enforce the existing requirements in the rule. Staff has investigated the option of requiring all PRDs to be vented to control and found it not to be cost-effective.

## REFERENCES

---

- <sup>1</sup> Anonymous refinery staff member – Proprietary telephone conversation with District staff, May 31, 2005.
- <sup>2</sup> Kathy Wheeler, Shell – Telephone conversation with District staff, June 1, 2005.
- <sup>3</sup> Lisa Polos, ConocoPhillips – Telephone conversation with District staff, June 2, 2005.
- <sup>4</sup> Omega Engineering, Inc. – Telephone conversation with District staff, June 1, 2005.
- <sup>5</sup> John Parker, Accutech Industrial Solutions – Presentation to staff, June 21, 2005.
- <sup>6</sup> Mike DeLeon, Tesoro – Telephone conversation with District staff, July 7, 2005.
- <sup>7</sup> Final Staff Report, Control of Episodic Releases of VOCs from Pressure Relief Devices at Petroleum Refineries, Bay Area Air Quality Management District, December 9, 1997.
- <sup>8</sup> Anonymous refinery staff member – Proprietary telephone conversation with District staff, May 26, 2005.