Bay Area Air Quality Management District

939 Ellis Street
San Francisco, CA 94109

Bay Area 2010 Clean Air Plan
Control Measure SSM-5
BAAQMD Regulation 8, Rule 53:
Vacuum Truck Operations

Workshop Report
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Prepared by:
William Thomas Saltz
Air Quality Specialist
Planning, Rules and Research Division

WORKSHOP REPORT

Proposed Regulation 8, Rule 53

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I. INTRODUCTION

This workshop report provides preliminary information regarding the proposed adoption by the Bay Area Air Quality Management District (BAAQMD or District) of a new regulation that would control emissions from vacuum trucks and similar equipment at certain Bay Area industrial facilities. Vacuum trucks are essentially large vacuums on wheels and are used to collect, contain and move materials, primarily waste liquids and semi-solids. If the materials contain petroleum, petroleum products, or other hydrocarbon liquids, vacuum truck operations have significant potential to release ozone-forming compounds into the atmosphere. The proposed new rule, Regulation 8, Rule 53: Vacuum Truck Operations, would apply only to certain types of facilities handling materials likely to produce ozone-forming emissions. The rule would reduce total organic compound (TOC) emissions by establishing a TOC emission limit that would apply at the outlet of a vacuum truck or associated equipment. In addition, the rule would establish TOC emission limits for vapor leaks and liquid leaks from vacuum truck equipment.

Currently, the District does not regulate vacuum truck emissions. Regulation 2, Rule 1, Section 103.1 exempts vacuum truck operations from permitting requirements. However, permits may be required for control equipment used to limit organic vapor emissions from a vacuum truck. The District committed to investigating this type of equipment in Control Measure SSM-5 of the District's Bay Area 2010 Clean Air Plan, which sets forth a plan to achieve the California ozone standards as well as other air quality objectives. TOCs contribute to the formation of ground-level ozone, which is the principal ingredient in smog. The Bay Area is not in compliance with State and federal ozone standards, and has committed to implement all feasible measures to reduce emissions of ozone precursors, including TOC.

The proposed limits would be consistent with the only current California air quality regulation – South Coast Air Quality Management District (SCAQMD) Rule 1149 – that limits organic vapor emissions from vacuum truck operations. Whereas Rule 1149 limits VOC emissions from vacuum trucks that are involved with the cleaning or degassing of storage tanks and pipelines, Regulation 8, Rule 53 would limit organic vapor emissions, including methane, from specific types of industrial facilities that utilize the services of vacuum truck operations. The emission limits in Regulation 8, Rule 53 have also been derived from vacuum truck emission limits that have been established for refinery maintenance, startup and shutdown operations by the Texas Commission on Environmental Quality (TCEQ).

TOC emission reductions from the proposed rule will depend upon the level of vacuum truck activity involving TOC-containing material. Co-benefits will include the reduction of Toxic Air Contaminants such as benzene, toluene, xylene, hexane, and GHG emissions, specifically methane. In Control Measure SSM-5, the District estimated potential emission reductions to be up to 6 tons per day, based on an assumption that there are about 200 hours per day of vacuum truck activity in the Bay Area that involve TOC-containing materials. The District will attempt to refine this estimate during the rule development process.

Industry impacts will depend upon the extent to which the Bay Area vacuum truck fleet is currently equipped with control technologies. Cost-effective technologies that can achieve the proposed TOC emission limits required by Regulation 8, Rule 53 are readily available. Such technologies are used in the South Coast Air Basin, Texas refineries, and New Jersey refineries. The necessity to use control technology may require facilities to adjust some of their operational procedures. The District will develop control cost estimates during the rule development process.

The District is publishing this report to outline and explain the proposed rule to the public, affected facilities, affected operators, and any other interested persons. This report includes a description of the vacuum truck industry in the Bay Area, an overview of vacuum truck operations, and an explanation of how TOC emissions can be minimized. The report then describes the draft rule that staff is proposing.

District staff will hold one or more public workshop(s) to discuss the proposed rule and invite participation in the workshop and written comments on any aspect of the proposal. When staff finalizes the proposed rule and staff report, they will be submitted for consideration by the District's Board of Directors.

II. BACKGROUND

A. Vacuum Trucks in the Bay Area

Vacuum trucks are used by a variety of Bay Area industries to remove materials from storage tanks, vessels, boxes, and pipelines; to transfer materials from one container to another; and, to transport materials from one location to another such as a landfill or processing facility. Vacuum trucks are also used to clean equipment such as barges and to clean up spills. The types of industries that utilize vacuum truck services include petroleum refineries, marine terminals, industrial wharfs, gasoline dispensing facilities, gasoline bulk terminals, gasoline bulk plants, gasoline cargo tanks, gas well and oil well fields, pipelines, railcar loading facilities, gas dispensing facilities, soil remediation projects, truck loading racks, auto dismantlers, and pipelines that deliver gasoline, natural gas, crude oil, petroleum products, and ethanol.

In addition to servicing industrial facilities, vacuum trucks are also used by many other entities in the Bay Area. Vacuum trucks are used to transport waste from restaurants, dairies, septic systems, and portable toilets. Government agencies, including cities and towns, the State Public Utilities Commission, and CalTrans, use vacuum trucks to service spills on streets and highways, sewers, catch basins, lift station wet-wells, wastewater treatment plants, septic tanks, waterlines, drainage systems, and other projects.

The total number of vacuum trucks that operate in the Bay Area varies from day to day. Some facilities own and operate their own vacuum trucks while other facilities contract the services of vacuum truck companies. Industry sources, including vacuum truck operators and control equipment suppliers, have informed staff that, routinely, the total number of vacuum trucks operating daily in the Bay Area fluctuates between 125-150 trucks, sometimes more.[1] The total number of trucks that operate on a given day depends on the specific needs of Bay Area companies. Some vacuum truck operations are routine and are scheduled to load specific materials virtually daily, while other vacuum truck operations load other types of materials on an intermittent or as-needed basis. When several vacuum trucks are required to respond to a major event, such as a crude oil spill in the San Francisco Bay for example, some vacuum truck companies may mobilize additional vacuum trucks from other parts of the state or, if necessary, from nearby states.

B. Vacuum Truck Operation Overview

A vacuum truck is a transportable, truck-mounted, industrial vacuum system designed to load materials into the truck's containment vessel. Vacuum trucks are commonly referred to by a variety of other names including "super-suckers", "vac-jets", and 'air-movers". Vacuum trucks are manufactured to load materials at different flow rates and capacities. They must be capable of loading different types of materials into their barrels under a variety of conditions.

Blower

A vacuum truck's pump or "blower" is used to create a vacuum to extract materials and load them into the vacuum truck's containment vessel which is called a barrel or tank. Pumps and blowers are usually powered by the vehicle's engine through an auxiliary drive and universal shaft. Vacuum pumps can also be driven by an auxiliary on-board engine. In some instances, an on-board engine can be the vacuum source (pump) as well as the vapor abatement device. Positive displacement pumps, engines and blowers typically come in one of three design types: a sliding vane pump, a liquid ring pump, or rotary lobe blower. Each type is designed to operate under specific applications and operational parameters. The maximum vacuum and flow that is attainable for any given pump is dependent on barometric pressure and elevation above sea level as well as the pump's design limitations.

Extraction & Emissions

Materials are typically drawn into a vacuum truck through suction lines, and sometimes with a device called a "stinger" attached to the suction line. Suction lines may range in size from 2 inches to 4 inches in diameter and are of various lengths. TOC emissions are derived from the loading of materials containing hydrocarbons such as wastewater, sludge, slop oil, crude oil, and various other mixtures and slurries.

During some loading events, vacuum truck operators may completely submerge the suction nozzle into the material during the loading process, while other events require that the hose be directly connected to tanks, vessels, or containers, thus eliminating or minimizing the introduction of air (and vapors) into the truck's barrel. In some instances, the suction nozzle is partially submerged into the material that is being loaded, consequently bringing a combination of air and material (liquids/solids) into the barrel. This is done to increase the velocity of incoming air which can help lift the liquid/solid material more so than the vacuum alone. The same technique is used when a spill is cleaned up. When purposely introducing air to generate "lift", the air to liquid ratio is kept to a minimum in order to maximize the amount of material that can fill a vacuum truck barrel.

The significance of the introduction of air into the loading event is that the extra turbulence generates additional vapors within the barrel and ultimately more TOC emissions. This turbulence increases a liquid's surface area, thus allowing more liquid to change into a vapor state until the saturation point is reached and "evaporation" can no longer take place. If vapors in the barrel headspace are allowed to escape, potentially significant amounts of TOC can be released into the ambient air.

The fill capacity for a typical vacuum truck can range anywhere from 2520 gallons (60 barrels) to 5040 gallons (120 barrels) or more. At a typical fill rate of 411 gallons per minute (GPM) (55 scfm), the fill times would range from 6 minutes to 12 minutes based on the two above referenced tank sizes respectively. Staff has observed fill times that range from five (5) to forty-five (45) minutes to complete. Figure 1 is a basic diagram of a vacuum truck that highlights critical components. Figure 2 shows a vacuum truck servicing a sewer. Figure 3 is an image of a large vacuum truck trailer which has a fill capacity capable of 9,000 gallons.

Figure 1
Illustration of a Typical Vacuum Truck

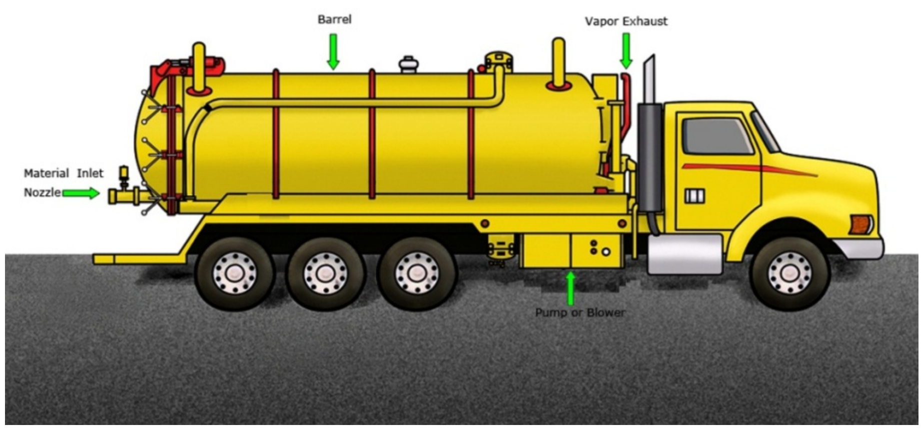

Image Source: thevactrukboy.com

Figure 2
Vacuum Truck Servicing a Municipal Sewer

Image Source: Google.com/teamelmers.com

Figure 3
Vacuum Truck Trailer with a
Fill Capacity of 9,000 Gallons

Image Source: Clean Harbors Facility in Martinez

TOC emissions occur when the vapors in the barrel's headspace – the air trapped above the material in the bottom portion of the barrel – are displaced into the ambient air. As material is loaded into the barrel, the volume of the incoming material displaces an equal volume of vapor in the headspace, which is typically vented out of the vacuum device's exhaust uncontrolled. Different operational factors affect the rates of TOC emissions. They can include: the volumetric flow rate of the material being loaded into the vacuum truck, the vapor pressure of the material, the temperature within the vacuum truck's barrel, and the extent to which the material is being agitated while being loaded into the vacuum truck.

In addition to TOC vapors that are emitted a vacuum truck's blower exhaust or the emissions that are emitted from control devices connected to vacuum truck blowers, additional emissions can occur from the following vacuum truck processes:

- Passive vapor emissions that occur from the barrel when vacuum trucks transport materials. Changes in temperatures, pressures, and material agitation affect passive emissions during transport.
- Sometimes materials are unloaded from vacuum trucks by tilting the barrel and opening the rear hatch, thus allowing the materials to slide out into a container;
- Typically, at the end of the day, or in between loading events involving incompatible materials, the truck's barrel is cleaned out at a wash pad. Liquids or other substances are used to loosen materials that stick to the inner walls of the barrel so they will come out more readily when the barrel is washed.

III. TECHNICAL REVIEW

The emission limit requirements in Regulation 8, Rule 53 would apply to commercial facilities that use vacuum trucks to load materials containing organic compounds and are capable of emitting TOCs equal to or greater than 500 ppmv measured as methane. The ppmv limit would apply to the following types of facilities:

- Petroleum Refineries;
- Bulk Terminals;
- Bulk Plants;
- Marine Terminals; and,
- Organic Liquid Pipeline Facilities.

After performing several source tests, District staff concluded that the loading of some materials generate few emissions, and thus should not be subject to the requirements of this rule. Accordingly, in an effort to make the applicability of materials of this rule consistent with other Regulation 8 Rules, the materials that are loaded into vacuum trucks will be subject to the provisions of Regulation 8, Rule 53 only if such materials are currently subject to the provisions of Regulation 8, Rule 5: Storage of Organic Liquids, and Regulation 8, Rule 8: Wastewater (Oil-Water) Separators or Regulation 8, Rule 44: Marine Tank Vessel Operations.

The emission limit in Regulation 8, Rule 53 would minimize TOC emissions whenever organic-compound containing material is loaded into a vacuum truck barrel. This requirement is applicable regardless of whether material loading occurs through suction, external pumps, or gravity feed methods.

When materials are loaded into a vacuum truck, the vapor in the headspace in the truck's barrel is displaced into the atmosphere resulting in TOC emissions. Two methods of lowering TOC emission rates from vacuum trucks, without the use of a control device, include the use of an external pump or the use of gravity feed to load material at low flow rates. Lowering the flow rates will lessen the degree of turbulence that generally occurs when material fills a vacuum truck barrel, which in turn lessens vapor growth. It has been demonstrated that a lower volumetric flow rate will reduce TOC emissions.[i]

A. Emissions Inventory

In Control Measure SSM-5, the District estimated potential emission reductions for the control measure to be up to 6 tons per day. The District based the estimate on an assumption that there are about 200 hours per day of vacuum truck activity in the Bay Area that involve TOC-containing materials. Information to support the assumption originated from discussions with Bay Area vacuum truck operators. The District assumed an emission rate of 150 lbs/hr for the vacuum truck activity, giving total potential emissions of 15 tons per day. The District further assumed that 50% of the emissions were already controlled, given a not insignificant presence of controlled vacuum trucks in the Bay Area. An assumption that the remaining 7.5 tons of emissions

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[i] District staff has observed these various methods of loading materials. On one particular occasion when a local facility was observed pushing naphtha into a clean vacuum truck barrel via a small, external pump, instead of using the vacuum truck's more powerful pneumatic equipment, TOC emissions were detected nonetheless. The drawback to using a small external pump to load materials is that it is a very slow process. It is not the norm for this industry because it increases the overall time required to load the materials into the truck, which in turn increases cost. Slowing down the fill rate may initially reduce TOC concentration because of less agitation; however, TOC will still be displaced because of the vapors accumulating in the head space of the tank from the evaporation of the liquid.

could be controlled with roughly 90% efficiency, gave the District its 6 ton-per-day emission reduction estimate.

Subsequent to the initial emission estimate, it has been determined that less than 10% of vacuum truck operations at facilities use equipment to control emissions from vacuum truck barrels. This determination is based on staff's observations while conducting several source tests at various facilities as well as conversations with vacuum truck operators at the facilities. Based on approximately 24 source tests that have been conducted thus far, the TOC emission rates have ranged from very few to 21 pounds per hour per loading event. Emission rates depend on material vapor pressure, material flow rate into the vacuum truck barrel, ambient temperature, and other factors as well, including the diameter and length of hose the material travels through. It should be noted that all of the source tests that have been conducted to date have been performed during the winter and spring seasons when temperatures have been cool. Cool ambient temperatures result in less vapor growth because lower pressures and less head space are generated during vacuum truck loading events. The District has outstanding information requests and will continue to further refine its emission estimates through the rule development process.

B. Controlling Organic Vapor Emissions

The organic vapor emissions generated from vacuum truck operations may be minimized by utilizing external positive displacement, submersible or diaphragm pumps. While these pumps may not load liquid and sludge materials into the barrel of a vacuum truck as quickly as the truck itself, they minimize the agitation of the liquid and sludge which decreases vapor emissions. The drawback to these methods of loading materials is the extra time it takes to complete the loading event.

Once vapors are generated, a variety of technologies are available to limit TOC emissions. Most of them can achieve capture and control efficiencies that are greater than 95 percent. Technologies include carbon adsorption systems, internal combustion engines, thermal oxidizers, refrigerated condensers and liquid scrubbers. Sometimes these technologies are combined as in the case of an engine/chiller or carbon/scrubber.

However, most vacuum trucks in the Bay Area are not equipped with control equipment. Of the group that use control equipment, most are currently using carbon adsorption systems while others use thermal oxidation or internal combustion engine technologies, according to industry sources. Organic vapor emissions can be limited with control technologies that are integrated into the truck or connected to the truck via a mobile unit that is sometimes referred to as a "skid-mount" or "portable trailer unit". Some of the small percentage of vacuum trucks operating in the Bay Area that currently use control equipment are doing so on a voluntary basis for odor control, while others use control equipment to comply with Federal requirements, (e.g., Subpart FF—National Emission Standard for Benzene Waste Operations).

The following is a brief discussion of each technology available for controlling vacuum truck emissions.

Carbon Adsorption Systems

A carbon adsorption system is a system that is comprised of a tank or vessel containing a specific amount of activated carbon onto which organic gases or vapors molecularly adhere as they flow through the particles. Activated carbon is a form of carbon that has been processed to make it extremely porous. Its porosity results in a very large internal surface which enables it to adsorb gases within its structure. The degree to which activated carbon adsorbs organic vapors is affected by the temperature, humidity, flow-rate, concentration, and molecular structure of the gas. High vacuum truck blower discharge temperatures may actually desorb previously adsorbed TOC, thus allowing TOC to vent into the ambient air. According to various industry sources, it may take anywhere from 2 to 10 pounds of carbon to control 1 pound of TOC.[35] Figure 4 is an image of a pile of activated carbon. The carbon has the consistency of small pieces of gravel. It is also available in a more granulated form. The image in Figure 5 is a microscopic cross-section of a single particle of activated carbon that illustrates the molecule's large surface area. This image depicts the flow of organic molecules into the finger-like cavity of a carbon particle where they adhere to the cavity's walls.

Figure 4
Activated Carbon Material

Image Source: www.water.siemens.com

Figure 5
Cross-Section of Activated Carbon

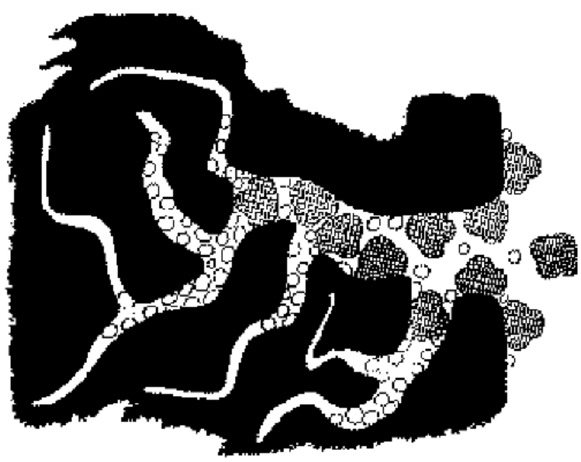

Image Source: www.carbtrol.com/voc

When observing Bay Area vacuum truck operations that used activated carbon to control organic emissions, staff observed two types of carbon adsorption systems. One type was a small-to-intermediate sized container integrated into the vacuum truck that contained 200 - 300 pounds of carbon. It was typically used to control the two types of loading events: 1) those that lasted a short duration because small amount of material-containing hydrocarbon were loaded into the vacuum truck barrels; and 2) those that included hydrocarbon-containing materials that were loaded into the vacuum truck barrel at low flow rates. In each case, the carbon adsorption system was used to reduce odors.

A second type of carbon adsorption is a larger, portable system that includes two or three vessels, each containing 1,000 lbs of activated carbon. This type of system controls larger volumes, flow rates and concentrations of organic emissions. When staff observed the system in operation, it was being used to comply with federal requirements for hazardous air pollutants (NESHAP).

Portable carbon adsorption is best used for the control of emissions from small cleanup operations like spills; emissions from large operations like the degassing and cleaning of a large crude oil tank would quickly overwhelm the capacity of most portable carbon adsorption units. Once a carbon adsorption unit has reached its holding limit, "breakthrough" occurs, and TOC emissions pass through unabated. Changing out carbon vessels on a frequent basis can become cost prohibitive.

A potential drawback to using carbon adsorption as the primary method to control TOC emissions is its inability to control methane, a hydrocarbon compound that is sometimes a component of TOC emissions. Methane is not adsorbed effectively by activated carbon.[39] Depending on the concentration and flow rate of a given hydrocarbon-containing material in a given vacuum truck operation, if a carbon adsorption unit is used as the primary method of control, an additional control may be necessary to control methane vapor emissions.

Carbon adsorption units should be monitored for breakthrough. Staff observed a vacuum truck loading event at a local refinery that used carbon adsorption to control organic vapor emissions from naphtha that was extracted from a pipeline. In spite of an unusually low flow-rate (3-4 scfm) used to load the material, the TOC emission concentrations, including methane, were determined to be approximately 80,000 ppmv, when the carbon adsorption unit reached breakthrough. Thus the emissions that should have been abated went straight through the carbon vessel and into the ambient air uncontrolled. This could have been avoided had the operator monitored the emissions from the carbon adsorption unit more frequently and been able to replace the carbon before breakthrough. A larger carbon adsorption system might be more suitable for larger jobs. Figure 6 is an image of a portable carbon adsorption system. Note that the two carbon vessels, each containing 1,000 lbs. of activated carbon, can be transported to locations where vacuum truck operations occur.

Figure 6
Portable Carbon Adsorption Unit

Image Source: http://www.vocpollutioncontrol.com

Under certain circumstances, carbon adsorption can be a less expensive technology compared to other control methods, specifically when it is used to control vapor emissions from materials containing relatively low organic compound concentrations. However, carbon adsorption is limited by virtue of the dimensions of portable carbon vessels because they must be sized to allow for sufficient residence time to maximize adsorption efficiency. Temperature and humidity also affect carbon's ability to adsorb. When carbon adsorption systems are used to control emissions from loading events with materials that have high organic concentrations, there is some risk of spontaneous combustion due to temperature increase.

All adsorption is exothermic, meaning that the adsorption process releases heat, causing the temperature in the carbon bed to rise. US EPA as well as industry sources indicate that under certain conditions, especially when high concentrations of organic vapors are adsorbed on activated carbon at a high flow rate, the temperature of the carbon bed can increase to a level at which the carbon or the organic vapors spontaneously ignite, starting a fire in the carbon vessel.[36] Common practice is to add a pre-scrubbing type of device to lower TOC levels, and thus the temperature, before the organic vapor stream reaches the carbon.

Internal Combustion Engines

Internal combustion engine technology is currently available to control organic vapor emissions. The equipment contains the vacuum source and vapor control device in one unit. Internal combustion engines that are utilized to control organic vapors from vacuum trucks are able to do so because they have a large cubic inch displacement and are able to run on compressed gas such as propane. When an internal combustion engine is used to control organic vapor emissions, it initially runs on propane and then switches to the incoming organic vapors as the primary fuel source. In some applications, the engines can power a refrigerated condenser to condense a portion of the organic vapor stream back to liquid.

In a Southern California demonstration observed by District staff, the refrigerated condenser was powered by the truck's engine using the extracted TOC as the primary fuel source. Emissions were monitored from the control device's exhaust with a portable engine analyzer manufactured by Horiba (Mexa series 534J), that was previously source-tested, as required by the SCAQMD, to confirm the accuracy of the instrument readings. While loading transmix (a material blend containing primarily gasoline and diesel fuels) into a vacuum truck, the peak VOC concentration measured at the truck's inlet exceeded 250,000 ppmv; however, the VOC concentration did not exceed 20 ppmv at the exhaust of the control device. The ICE/chiller vapor control equipment abated approximately 33 lbs. of potential organic vapor emissions for this 10 minute loading event.[37] Figure 7 is a picture of an engine/chiller combination unit mounted on a vacuum truck.

Figure 7
Vacuum Truck with a Combination
I.C. Engine-Refrigerated Condenser Control Device

Image Source: fsi-us.com

Thermal Oxidizers

Portable or "skid-mounted" thermal oxidizers are used to control TOC emissions in vapor streams containing hydrocarbons diluted down to less than 50% of the lower explosive limit (LEL) at controlled flow rates to meet National Fire Protection Association (NFPA 86) Safety Guidelines. Thermal oxidizers are sometimes referred to as "afterburners." Thermal oxidizers are a type of incinerator that destroys TOC emissions by raising the temperature of the organic materials in the vapor stream above their auto–ignition point in the presence of oxygen, and maintains the high temperature for a sufficient amount of time to complete the combustion of the materials to carbon dioxide and water. Time, temperature, turbulence (for mixing), and the availability of oxygen are all factors that affect the rate and efficiency of the combustion process. TOC destruction efficiency depends upon design criteria which include chamber temperature, residence time, inlet TOC concentration, compound type, and degree of mixing. Typical design efficiencies range from 98% and above depending on system requirements and characteristics of the vapor stream. Figure 8 is an image of a portable thermal oxidizer.

Figure 8
Portable Thermal Oxidizer

Image Source: Vapor-Tech.net

Refrigerated Condenser Systems

A refrigerated condenser system can be effective in reducing organic vapor discharge. It is a device that cools a vapor emission stream containing hydrocarbons by changing it from a vapor state to a liquid state. The condensed organic vapors can be recovered for transportation or refining, preventing their release to the ambient air. A refrigerated condenser works best on emission streams containing high concentrations of volatile organic emissions. They are less effective on dilute streams (i.e., where the air flow is much greater than organic vapor flow).

A refrigerated condenser functions by exposing influent organic vapor streams to a chilled heat exchanger surface, causing the organic vapors to condense on the cold heat exchanger (or heat transfer) surface. As the organic vapor stream condenses, it loses volume, which produces a lower vapor concentration near the heat exchanger surface. The condensation process is assisted by turbulence in the emission stream that also brings the emission stream close enough for heat transfer and subsequent condensation of the organic vapors. Figure 9 is an image of a refrigerated condenser system, which includes a blower, compressor and after-cooler.

Figure 9
Portable Refrigerated Condenser

Image Source: geoinc.org

Liquid Scrubbers

TOC emissions can be controlled effectively by liquid scrubbing technology via a chemical process known as absorption. A variety of wet scrubber designs are used to extract gaseous pollutants from vacuum truck vapor streams: packed towers, bubble tray towers, sparging scrubbers, and a new wet scrubber process called hydraulic amalgamation. Usually, the exhaust stream from a vacuum truck is introduced at the bottom of the scrubber tower. The gas stream flows upward through the tower where the TOCs come into contact with the absorptive chemicals. Packed towers and bubble tray towers are designed to introduce the waste gas into the tower chamber where a liquid absorption chemical is introduced through a series of spray nozzles that emit liquid droplets downward in a counter direction to the stream. The interaction between the upward flowing waste gas and the downward flowing liquid absorption chemical creates an environment for the absorption process. Sparging scrubbers and hydraulic amalgamation scrubbers introduce the waste gas through a submerged reaction chamber. The interaction between the waste gas and the absorption liquid within the reaction chamber creates an environment in which the TOCs are absorbed.

A high hydrocarbon-to-liquid contact ratio is essential to maximize the efficiency of the absorption process. Physical absorption depends on properties of the exhaust stream and the liquid such as density and viscosity, as well as specific characteristics of the hydrocarbons in the exhaust stream. These properties are temperature dependent: lower temperatures generally favor absorption of hydrocarbons by solvent. Absorption is also enhanced by higher liquid-gas ratios and higher concentrations in the hydrocarbon stream. Chemical absorption may be limited by the rate of reaction, although the rate-limiting factor is typically the physical absorption rate, not the chemical reaction rate.

Figure 10 is an image of a vacuum truck that has a combination of liquid scrubbing and carbon adsorption control technologies designed into the truck.

Figure 10
Vacuum Truck Containing a Combination of a
Liquid Scrubber and Carbon Adsorption Control Device

Image Source: PSC Industrial Outsourcing, LLP

To achieve desired hydrocarbon control objectives, some companies provide custom designed systems that utilize combinations of control technologies discussed above. The control technologies referenced in Figure 10 are an example of such an approach. In order to comply with the proposed 500 ppmv TOC emission limit in Regulation 8, Rule 53, client-specific configurations will sometimes be necessary. For example, under certain conditions, controls that utilize carbon adsorption as the primary method to minimize TOC emissions might have to be further customized to control methane emissions.

C. Green House Gas and Toxic Reductions

Limiting vapor stream emissions from vacuum truck loading events may result in methane emission reductions as well. Methane, a significant GHG that has over 20 times the global warming potential of CO2, is present in several materials that are typically loaded into vacuum trucks. Because methane is within the definition of TOCs, and is therefore subject to the 500 ppmv emission limit proposed to be included in Regulation 8, Rule 53, compliance with the limit will reduce methane emissions.

However, the compliance technology used will determine the overall effects of the rule on GHGs. Internal combustion engines utilize energy from the TOC waste stream to run the engine and destroy methane in the process. In addition to TOC and methane emission reductions, toxic air contaminant emissions will be limited as well. Toxic air contaminants include benzene, toluene, xylene, and hexane.

Even though refrigerated condensation technology emits a small amount of GHGs from the energy source used to generate the cold temperatures needed to condense TOC vapor streams, generally speaking, this technology has the potential to emit the least amount of

GHG emissions of all the vacuum truck TOC control technologies that are available. This is because the vapors that are condensed can be re-refined or blended with fresh product and resold. The recycling of organic vapors offsets CO_2 emissions that are generated during the condensation process, which can result in a net global warming benefit.

IV. PROPOSED RULE BEING CONSIDERED

Vacuum truck operations associated with maintenance, shutdown, and start-up activities in petroleum refineries in Texas and New Jersey are currently required to use control technology to limit organic vapor emissions from vacuum trucks. The SCAQMD currently requires vacuum truck operations that are associated with the cleaning and degassing of tanks and pipelines to control organic vapor emissions below 500 ppmv.

Staff has reviewed information from vacuum truck operations in the Bay Area, Southern California, New Jersey, and Utah. Staff has observed a variety of vacuum truck loading events at different facility types and has conducted twenty-five source tests to date. Staff has reviewed vacuum truck controls and requirements in other regions and believes the proposed limits for Bay Area vacuum truck operations that will be subject to Regulation 8, Rule 53 are feasible.

Applicability

Staff proposes to regulate certain materials in specific facilities currently subject to District regulations. These facilities are petroleum refineries, gasoline bulk plants, gasoline bulk terminals, marine terminals and organic liquid pipeline facilities. In an effort to provide certainty to the regulated community and to control vacuum truck loading events with significant emissions, the proposal is further limited to the types of materials already regulated in these facilities, gasoline and other high vapor pressure organic liquids, crude oil and other materials handled at marine terminals and liquids requiring control in petroleum refineries' wastewater collection systems and oil-water separators. To provide certainty, regulated materials have been made consistent with, and taken from other District rules. This approach will give facilities a way to estimate the amount and cost of control equipment needed for day-to-day operations. Staff does not propose to require control on vacuum truck operations associated with emergencies such as spills.

Emission and Leak Standards

Based on staff's technical evaluation as well as the source tests that have been conducted, the District proposes the following TOC emission and leak standards for vacuum trucks that operate at petroleum refineries, bulk terminals, bulk plants, marine terminals and organic liquid pipeline facilities in the Bay Area:

- Exhaust Emission Limit: Vacuum truck pump, blower exhaust or control device shall not emit TOC concentrations that are greater than or equal to 500 ppmv;

- Equipment Liquid Leaks: Components of vacuum trucks such as hoses, connectors, flanges, lines and stingers shall not emit liquid leaks at a rate in excess of three (3) drops per minute; and,
- Equipment Vapor Leaks: Components of vacuum trucks such as hoses, connectors, flanges, lines and stingers shall not emit TOC concentrations that are greater than or equal to 500 ppmv.

Staff believes the 500 ppmv limit is feasible based on the limits in South Coast and Texas. The equipment and vapor leak standards are consistent with requirements for gasoline handling in District Regulation 8 Rules.

Emission Monitoring Requirements

The District proposes the following emissions monitoring requirements from the blower exhaust of vacuum trucks during loading events:

- Vacuum trucks shall be checked for vapor and liquid leaks prior to and during each loading event;
- Prior to reaching 20% of fill capacity, vacuum trucks would be required to monitor TOC emissions. A second emissions reading would be required prior to reaching 60% of fill capacity;
- When carbon adsorption is used as the primary TOC control, emissions monitoring would be required every 10 minutes after the initial emissions reading is taken; and,
- Emission measurements shall include the date and time of the loading event, the TOC concentration, the material flow rate (in acfm or scfm), and the model of the TOC emission control device.

If a control device is connected to a vacuum truck during a loading event, emissions monitoring would be required to be performed at the exhaust of the control device.

Recordkeeping and Reporting Requirements

The District proposes the following recordkeeping requirements for each vacuum truck loading event:

- Vacuum truck owners/operators would be required to maintain records of TOC emission monitoring readings; and,
- Vacuum truck owners/operators and facilities would be required, within five (5) working days of a request, to submit a list of future scheduled loading events. This will enable staff to schedule an inspection of operations from time to time to determine compliance.

Bay Area facilities that operate vacuum trucks or contract for the services of vacuum trucks would be responsible for compliance with the proposed requirements in Regulation 8, Rule 53. They are already familiar with the process of complying with other BAAQMD Rules and Regulations. They also have knowledgeable staff to operate monitoring equipment that will necessary to comply with Regulation 8, Rule 53.

Vacuum trucks in petroleum refineries and other facilities are operated by independent companies under contract to the facility. The facility operator is responsible for ensuring compliance with District regulations, consistent with contractors who service and degas tanks, monitor fugitive emissions and construct new equipment.

Emissions Reductions

In Control Measure SSM-5, the District estimated potential emission reductions for the control measure to be up to 6 tons per day. As discussed, the District is refining its initial estimate of emission reductions during the rule development process.

Costs

According to industry sources, control equipment used to control TOC emissions from vacuum truck operations is not typically purchased. Instead, the equipment is rented on an as-needed basis. It is also more cost effective to rent control equipment because control equipment isn't required for every loading event. The economics of renting may change with the imposition of requirements to control vacuum trucks. If a contractor is required to utilize particular control equipment on a frequent basis, it might be worthwhile to purchase and own such equipment rather than rent it. Moreover, no particular TOC control technology is the best control for every type of loading event given the variety of materials, throughput rates, and operational factors that affect each loading event. Combinations of control technologies are sometimes required to effectively control TOC emissions.

Table 1 reflects the range of costs to rent a variety of control equipment currently available for the vacuum truck industry.

Table 1

Type of TOC Control Device	Cost To Rent (per day)
Carbon Adsorption*	$600 - $2,000
Liquid Absorption**	$750 - $1,400
Internal Combustion Engine	$2,100 - $2,900
Thermal Oxidizer	$675 - $975
Refrigerated Condenser	$1,100 - $1,400
Emission Monitoring Equipment	**Average Cost**
Hand-Held TOC Monitoring Device	$65 (daily cost to rent device)
Hand-Held TOC Monitoring Device	$2,000 - $3,000 (cost to purchase device)

*****Includes cost of carbon material that has to be changed out periodically but does not include cost to regenerate carbon or to deliver carbon to landfill. It is assumed those costs are built in.

******Includes cost of liquid absorbant material that has to be changed out periodically.

It should be noted that the costs to rent the same control technology for the same type of vacuum truck loading event can vary. Prices differ because the same control application utilized at two similar but separate facilities can differ due to each facility's internal management practices and infrastructure.

Another reason for the range of control equipment costs is that, for a given volume of material loaded, different sizes and configurations of equipment may be required. To maximize the control efficiency for a loading event, the TOC control capability of each technology configuration must be matched with the concentration and vapor flow rates it will be required to handle.

V. RULE DEVELOPMENT / PUBLIC CONSULTATION PROCESS

In developing a draft of Regulation 8, Rule 53: Vacuum Truck Operations, District staff met with companies that provide vacuum truck service, companies that specialize in controlling vacuum truck emissions, and observed vacuum truck loading events at several facilities. Staff also consulted with representatives from other air districts, US EPA Region 9 office, vacuum truck manufacturing industry representatives, vacuum truck equipment operators, and vacuum truck emission control equipment manufacturers and operators to discuss technological issues, TOC limits, costs, health effects, and future trends in the vacuum truck industry.

The District will conduct a public workshop to solicit comments from the public on draft Regulation 8, Rule 53. During the workshop, District staff will seek comments and answer questions on material presented in this report. Staff will review and consider all comments received during the public workshop and revise the proposal as appropriate.

Staff is specifically seeking comment on the feasibility of the proposed emission limit for loading different types of materials. Staff seeks information on volumes and types of materials loaded in and outside of these facilities. Finally, staff seeks further information on costs of control equipment used on vacuum trucks.

Staff will prepare an analysis of environmental impact under the California Environmental Quality Act (CEQA), a socioeconomic analysis, a final proposed rule and staff report that will be available for public comment prior to a public hearing before the District's Board of Directors.

VI. REFERENCES

1. Bay Area Air Quality Management District; *"SSM 5 – Vacuum Trucks, Bay Area 2010 Bay Area Clean Air Plan"*, Volume 2; September 2010.
2. BAAQMD Regulation 2 Rule 1; Regulation 8, Rules 2, 5 and 9.
3. Consultation with Mr. Mike Morris, Rule Developer, South Coast AQMD.
4. South Coast AQMD, Staff Report Rule 1149, 2008.
5. South Coast AQMD, Rule 1149.
6. Utah Department of Environmental Quality: Free Product Removal Project # 06E-7155, IHI Environmental, October 2010.
7. Multiple Consultations with Mr. John Menatti, Utah Department of Environmental Quality, 2010.

8. Consultation with Mr. Joe Sunday, Tehama County APCD.
9. Safe Operation of Vacuum Trucks, American Petroleum Institute Recommended Practice 2219, 3rd Edition, November 2005.
10. http://www.epa.gov/ttncatc1/dir1/refrigeratedcondensers.pdf
11. Shepherd, Austin (2001), Activated Carbon Absorption for Treatment of VOC Emissions; http://www.carbtrol.com/voc.pdf
12. Consultation with Mr. Stanley Tong, U.S. EPA Region 9 Office, June 2010.
13. Consultation with Mr. Frank Mele, CalTrans, June 2010.
14. Consultation with Mr. Chris Orsolini, Windsor Pick N Pull Auto Dismantlers, Richmond, CA. July, 2010.
15. Consultation with Mr. Chris Longo, GEM Mobile Treatment Services, July 2010.
16. Consultation with Mr. Jeff St. Amant, Vapor Point, July 2010.
17. Multiple consultations with Mr. Malcolm Maxwell, National Response Corporation Environmental Services, 2010.
18. Consultation with Mr. Steven Hancock, Mr. Ron L. Jones, and Sandra Stanford of Clean Harbors, June 2010.
19. Consultation with Mr. Elliot Moorhead, Nanovapor Fuels Corporation, May 2010.
20. Consultation with Mr. Steve Sellinger, Envent Corporation, March 2010.
21. Consultation with Mr. Hilliard Townsend, PURGIT Tank Degassing, September 2010.
22. Multiple Consultations with Mr. Kevin Fritz, Remediation Service International, 2010.
23. Multiple Consultations with Mr. Jeff St. Amant, Vapor Point, July 2010.
24. Consultation with Mr. Steve Villata, Jack Doheny Companies, June 2010.
25. Consultation with Mr. Ken Mitchell, Veolia Environmental Industrial Services, Inc., September 2010.
26. Multiple Consultations with Guy Bjerke, Western States Petroleum Industry, 2010.
27. Consultation with Mr. Mike De Leon, Tesoro Petroleum Refinery, September 2010.
28. Consultation with Ms. Jeanette Smith of Siemens Water Technology, San Francisco, California, July 2010.
29. Consultation with Mr. Mark Patterson of ECO VAC Services, Woodstock, GA November 2010.
30. Consultation with Ms. Satara C. Henry of PSC Industrial Outsourcing, Houston TX, November 2010.
31. Consultation with Mr. Lowell Kessell of EnviroLogek Technologies, Culver City, CA November 2010.
32. Maintenance/Startup/Shutdown (MSS) Permitting Issues, prepared by Sage Environmental Consulting, LP for The Texas Oil and Gas Association Refinery Environmental Committee, 11 June 2007.
33. PURGIT, Discussion of Mobile Equipment Used For Tank Degassing http://www.purgit.com/?p=223

34. Carbon Adsorption Capacity Index http://www.islandcleanair.com/pdf/Activated%20Carbon%20Explained.pdf

35. EPA Air Pollution Control Technology Fact Sheet: Spray-Chamber/Spray-Tower Wet Scrubber http://www.epa.gov/ttncatc1/dir1/fsprytwr.pdf
36. CATC Technical Bulletin, Choosing an Adsorption System For VOC, May, 1999 http://www.epa.gov/ttnchie1/mkb/documents/fadsorb.pdf
37. September 10, 2010 Transmix Degassing Event, BP Hathaway Terminal, Signal Hill, CA, 2010.
38. New Jersey State Department of Environmental Protection, Administrative Code, Title 7, Subchapter 16.2(r); http://www.nj.gov/dep/aqm/Sub16.pdf.
39. Consultation with Mr. David Owen of the New Jersey State Department of Environmental Protection, January 2011.
40. Staff meeting with Guy Bjerke, ConocoPhillips Refinery, Shell Refinery, Chevron Refinery, and the Tesoro Refinery to discuss vacuum truck source test results, future vacuum truck testing, and proposed major elements of draft vacuum truck rule, June 14, 2011.