

SAN JOAQUIN VALLEY UNIFIED AIR POLLUTION CONTROL DISTRICT

FINAL STAFF REPORT

Rule 4695 (Brandy Aging and Wine Aging Operations)

September 17, 2009

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I. SUMMARY

A. Reasons for Rule Development and Implementation

The California Air Resources Board (ARB) and United States Environmental Protection Agency (EPA) classified the San Joaquin Valley Air Basin (SJVAB) as a severe and serious non-attainment area for the state and federal ozone standards, respectively. In accordance with Federal Clean Air Act (CAA) requirements for non-attainment areas, the San Joaquin Valley Unified Air Pollution Control District (District) adopted the 2007 Ozone Plan to establish the strategy for attaining the federal eight-hour ozone standard. That plan is comprised of regulatory and incentive-based measures to reduce emissions of nitrogen oxides (NO_x) and volatile organic compounds (VOC), which are the precursors to ground-level ozone.

The 2007 Ozone Plan contains a commitment to develop a control measure for VOC emissions from brandy aging and wine aging operations. Emission controls have already been installed on most of the large brandy aging operations as an emission reduction measure to comply with the requirements of Rule 4694 (Wine Fermentation and Storage Tanks), to which these emission reductions are credited. In addition to controlling VOC emissions from brandy aging operations, this control measure would require Reasonably Available Control Technology (RACT) controls on wine aging operations at Major Sources.

As stated in the 2007 Ozone Plan possible cost effective emission reductions could be achieved for brandy aging through adding emission control technologies. Such

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additional technologies are considered to be beyond RACT but are not yet achieved in practice for these operations. After a more extended operational period and a determination that there would be no adverse impact on either the aging operation or the quality or consistency of the product, the District may revisit this for Best Available Control Technology (BACT) for new or modified sources. The identified control technologies are considered to be applicable to the aging of wine as well as to brandy since the basic process of aging in wooden tanks or barrels in a warehouse is very similar. Major differences exist in the level of emissions, between the two operations and the impact of this difference on technology transfer as examined by this project.

The adopted rule fulfills the District's 2007 Ozone Plan commitment for control measure S-IND-14 (Aging of Brandy and Wine) in an effective, practicable, technologically feasible, and economically reasonable method, as determined by the District's Governing Board. This rule also satisfies SIP commitments with the requirement of emission controls which help produce Reasonable Further Progress (RFP) for the Attainment Demonstration; reduces emissions that are quantifiable, surplus, real, and enforceable; and satisfies the federal requirement to design a plan to achieve ozone attainment.

B. Climate Change

The California Global Warming Solutions Act of 2006 (AB 32) created a comprehensive, multi-year program to reduce greenhouse gas (GHG) emissions in California, with the overall goal of restoring emissions to 1990 levels by the year 2020. In the coming years, ARB and the Legislature will be developing policies and programs to implement AB32.

The District believes that the evidence and the rationale that climate change is occurring is compelling and convincing. In addition to the long-term consequences of climate change, the District is concerned with the potential ramifications of more moderate but imminent changes in weather patterns. The Valley depends heavily on agriculture for its economy. Unanticipated and large fluctuations in these patterns could have a devastating effect on the Valley's economy.

While there are many win-win strategies that can reduce both GHG and criteria/toxic pollutant emissions, when faced with situations that involve tradeoffs between the two, District staff believes that the more immediate public health concerns that may arise from criteria or toxic pollutant emissions should take precedence.

C. Description of the Project

This rule codifies the requirement for Best Available Retrofit Control Technology (BARCT) and Reasonably Available Control Technology (RACT) VOC emission controls and management practices which have been employed by wine fermentation operators under Rule 4694's alternative emission reduction option. This rule specifies RACT for

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major sources as the means to achieve the maximum amount of VOC emission reductions by using control technologies that are reasonably available. Any VOC emissions reduction from the control of brandy aging have already been accounted for by Rule 4694 and are not considered to be additive for SIP purposes.

This rule applies to all brandy aging and wine aging facilities but exempts those facilities which have a Stationary Source Potential to Emit of less than 10 tons per year since they are not Major Sources. The federal Clean Air Act (CAA) requires all operations at Major Sources to have RACT, so controls for aging operations at those facilities are included in the rule, regardless of the size of the aging operation, as long as it is conducted at a Major Source. Separate thresholds for brandy aging and wine aging operations were determined based on operating characteristics, emissions, and a cost effectiveness analysis.

Existing brandy aging control systems have been installed and operating on four warehouses for almost two years, but, due to the brandy aging process length, this is not sufficient time to judge the impact of the controls on operations and product quality. Therefore, the compliance date has been set to allow for time to reexamine rule requirements if operational or product quality issues are deemed to be seriously detrimental. District staff reviewed rules from other air districts in California, gathered information from the Federal Alcohol and Tobacco Tax and Trade Bureau, the Wine Institute, and from individual stakeholders to serve as guidance and as information sources for rule development. District staff found that, at this time, there are no air districts in the nation that have regulations to control VOC emissions from brandy aging and wine aging operations.

The District staff understands that the nature of whiskey aging operations differs from wine and brandy aging. Specifically, the ambient conditions, such as storage temperature and humidity, as well as seasonal variations, are important factors in the whiskey aging process. All aging processes, depends upon the interaction of product in oak barrels, whiskey aging operations strive for a particular blend of temperature, humidity, and ventilation, leading to different types of warehouse. (Source: EPA, *Final Report: Emission Factor Documentation for AP-42, Section 9.12.3, Distilled Spirits*, p. 2-7 (March 1997).) Therefore, whiskey aging is not considered or included in this rule development process.

D. Rule Development Process

As part of the rule development process, District staff conducted a series of public work shops on February 4, April 9, and June 17, 2009. At these meetings, District staff presented the objectives of the proposed rulemaking project and solicited comments and suggestions, which were then used to develop the rule and amend/augment the staff report.

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Pursuant to state law, District staff was required to perform a socioeconomic impact analysis prior to the adoption, amendment, or repeal of a rule that has significant air quality benefits or that will strengthen emission limitations. As part of the District's socioeconomic analysis process, District staff sought representatives from interested groups to participate as members of a Socioeconomic Focus Group. The Focus Group assisted District staff in determining the appropriate method for gathering information on regulatory compliance costs and business impacts resulting from compliance with the rule. The results of the socioeconomic analysis were compiled into a report that was presented along with the refined version of the proposed rule to the public and interested parties during the final workshop on June 17, 2009. The date for the public hearing to consider adoption of the proposed rule amendments was September 17, 2009.

II. DISCUSSION

A. CURRENT REGULATIONS

There are no existing rules in the nation that require controlling VOC emissions from brandy aging and wine aging operations. Rule 4623 (Storage of Organic Liquids) limits VOC emissions from the storage of organic liquids. Although not identified as a rule deficiency, EPA expressed concern that the rule provides an exemption for tanks used in wine fermentation and storage of resulting products, by-products, and spirits. EPA considers VOC emissions from this source category to be significant and recommended further study and analysis.

District Rule 4694 (Wine Fermentation and Storage Tanks) requires installation and operation of VOC emission control system to reduce emissions from wine fermentation and storage operations. As an alternative to controlling the emissions from wine fermentation and storage tanks, Rule 4694 allows operators to mitigate fermentation emissions by controlling alternative emission sources, such as reductions in surplus emissions from mobile sources, area sources, or other stationary sources. In lieu of installing VOC control devices on wine fermentation tanks to fulfill the Rule 4694 requirements, operators voluntarily offered to control surplus emissions from brandy aging operations to obtain equivalent reductions which could then be creditable as Certified Emissions Reduction Credits (CER) under Rule 4694.

To obtain the CER, operators of brandy aging facilities modified existing brandy aging warehouses to meet the requirements for a Permanent Total Enclosure as specified in EPA Test Method 204. This enabled ethanol emissions to be captured and destroyed using regenerative thermal oxidizer technology. Until the successful demonstration that the operation of the capture and control system will not result in unacceptable impacts on brandy quality, consistency, or volume loss, the conditions of the operating permits are provisional and subject to revisions. Operation of these controls has demonstrated that they are technologically feasible as VOC controls and are tentatively considered

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applicable to both wine aging and brandy aging, pending final determination of the controls impacts on the brandy aging operations.

B. SUMMARY OF PROPOSED RULE

Proposed new Rule 4695 would implement a VOC control measure (S-IND-14) in the Ozone Plan. The draft rule would serve as a “backstop” measure to codify the control of VOC emissions from the aging of brandy which are currently being implemented by operators as an alternative compliance option in lieu of controlling the emissions from wine fermentation and storage in order to comply with Rule 4694 (Wine Fermentation and Storage). This proposed new Rule will require appropriate VOC control measures for wine aging operations which are currently uncontrolled. The rule applies to wine aging and brandy aging operations at Major Sources, which have a Potential To Emit of at least 10 tons VOC per year. If the facility is a Major Source, the rule requirements apply to that facility’s brandy and wine aging operations, regardless of aging operation’s size, container size, or container material type. The rule requires the brandy aging and wine aging operations to be assessed separately with independent thresholds and application of control technologies.

The major rule requirements include RACT, Additional RACT, and BARCT based on the throughput or emissions from the brandy aging or wine aging operations:

- For a facility with a brandy or wine aging operation which has either an inventory or emissions less than Table 1 thresholds, operators must implement Reasonable Available Control Technologies (RACT) to include record keeping and work emission minimization practices. Such work practices include: prevent, minimize, and restrict the unnecessary occurrence of brandy or wine exposure to the atmosphere; prevent, minimize, and restrict the occurrence of leaks and spills; implement immediate clean up of leaks and spills by rinsing leaks or spills with water and washing the rinse into a proper drain; and implement immediate corrective actions to prevent a reoccurrence of a similar leak or spill. These are all reasonable practices currently being used by existing operations.
- For a facility with a brandy aging operation that equal or exceed both the applicable inventory and the emissions thresholds listed in Table 1, the operator shall implement brandy RACT by implementing record keeping and work emission minimization practices in addition to BARCT emission capture and control by use of a Permanent Total Enclosure (PTE) that is vented to a control device.
 - This emission control implementation is more stringent and has a total control efficiency of 90 percent through the use of the Permanent Total Enclosure (EPA Method 204) to encapsulate the emissions in the building (92% control efficiency) which are then vented to a Thermal Oxidizer (TO) that burns off the VOC emissions (98% control efficiency).

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- BARCT does not require refrigeration, but large warehouses usually practice refrigeration to minimize ethanol evaporative loss.
 - The rule requires warehouses to continuously meet the criteria for Normal Operation except for periods when the non-Personnel access doors are opened for personnel and equipment access as required for operational or maintenance functions and/or when the VOC control device is shutdown for scheduled routine maintenance. Cumulative duration for all such periods are not exceed eight (8) percent of the total operating hours or 701 hours per year, whichever is less. This duration includes periods of downtime as required to perform scheduled routine maintenance, which are not to exceed three (3) percent of the total hours of operations or 240 hours per year, whichever is less.
 - The rule also provides for an alternative control measure which may be approved by the APCO, provided it is demonstrated that brandy emissions will not exceed 0.3 proof gallons per 50 gallons. This would be equivalent to a warehouse with a system capable of a 90% combined capture and control efficiency.
- For a facility with a wine aging operation which equals or exceed both the applicable inventory and the emissions thresholds listed in Table 1, the operator shall implement RACT record keeping and work emission minimization practices in addition to Additional RACT. Additional RACT is RACT for larger sources based on the observed emission reduction techniques commonly used by such operations. Additional RACT is not applied to smaller operations and is not as stringent as BARCT for this class and category of source. Additional RACT specifies maintaining a nominal warehouse daily temperature, averaged over a calendar year, not to exceed 70 degrees Fahrenheit.
 - As explained later in this report, research into the affects of humidity and temperature has shown that controlling these factors can reduce evaporation and therefore control VOC emissions. The 70 degree temperature threshold was set high enough to allow for variations in aging practices and equipment limitations while still being low enough to produce meaningful reductions.
 - The applicability threshold of 590,000 gallons is based on a 10,000 barrel inventory of 59 gallons per barrel. Such an operation would have an Uncontrolled Aging Emission (UAE) of 16,000 pounds per year and was selected as a natural breakpoint between the large wine aging operations that implement refrigeration or temperature control and the small wine aging operations that do not implement refrigeration.
 - Two additional RACT control alternatives to the temperature option are provided in the rule. The first alternative would allow a control that reduces the VOC Uncontrolled Annual Emissions by 50%. This factor will be calculated by using the UAE calculation equation and an Aging Emission Factor (AEF) of 0.02783, which is based on the District default

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- 3% evaporative loss rate, as explained below. This option is considered to produce equivalent reductions to the temperature option.
- The second control alternative is to age wine in non-porous tanks. These tanks must be equipped with operable pressure-vacuum relief valves and the temperature of the aging wine must be maintained at or below 75 degrees Fahrenheit. This alternative is already achieved in practice on tanks which are used for wine storage and must comply with Rule 4694 (Wine Fermentation and Storage) requirements.

Table 1 below summarizes the thresholds and applicable requirements for the various sizes of operations, as discussed above.

Table 1.				
Product Type	Total Annual Aging Inventory (gallons per year)	Uncontrolled Aging Emissions (lbs/yr)	Requirement	Control Technology Level
Brandy	< 40,000	< 8,000	Records & Work Practices	RACT
	≥ 40,000	≥ 8,000	Records & Work Practices & PTE vented to a control device	RACT and BARCT
Wine	< 590,000	<16,000	Records & Work Practices	RACT
	≥ 590,000	≥ 16,000	Records & Work Practices & Temperature control	RACT and Additional RACT

The difference between brandy aging and wine aging thresholds are due to the District calculating emission factors based on an average annual brandy evaporative loss rate of 3 proof gallons per barrel per year, and an average annual wine evaporative loss rate of 3% by volume per barrel per year, and a cost effectiveness of approximately \$25,000 per ton for both. Using these emission factors, wine has an ethanol level of nearly one-sixth that of brandy and a proportionally lower emission rate. Because of the differences in emission rates, wine aging controls have much higher cost effectiveness values compared to a similarly-sized brandy aging warehouse. Cost effectiveness details are provided in Appendix C.

The rule allows facilities the opportunity to calculate and use their own Uncontrolled Aging Emissions (UAE) in relation to this rule's thresholds. To determine a specific operation's Uncontrolled Aging Emissions (UAE) use the following formula:

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$$UAE = TAAI * AEF$$

Where:

UAE = Uncontrolled Aging Emissions, in pounds of ethanol per year.

TAAI = Total Annual Aging Inventory, in gallons per year.

AEF = Aging Emission Factor, in pounds of ethanol per gallon.

Total Annual Aging Inventory is an average of a calendar year inventory derived from the Tobacco Tax and Trade Bureau (TTB) Form 5110.11 for brandy and Form 5120.17 (replaced Form 702) for wine. The calculation is as follows:

$$TAAI = \sum GMI \div 12 \text{ months/year.}$$

TAAI = Total Annual Aging Inventory, in gallons per year.

GMI = Gallons in Monthly Inventory, in gallons per year.

The District's default Aging Emission Factors (AEF) are: brandy 0.1986 lb ethanol per 50 gallon barrel and wine 0.02783 lb ethanol loss per gallon wine. These values are based on the District default values of evaporative loss of 3 proof gallons per barrel per year. This loss rate is based on the average loss rate for all permitted facilities in the District, except one facility that is not industry representative. The wine default value is based on an evaporative loss rate of 3% by volume per barrel per year. This is explained in great detail below. Using the above loss rates allows for the aging emission factors to be calculated as follows:

$$\begin{aligned} \text{Brandy Default AEF} &= 3 \text{ proof gallons loss/50 gallon barrel} \times 0.5 \text{ gallon ethanol/ proof} \\ &\quad \text{gallon} \times 6.616 \text{ lb ethanol/gallon.} \\ &= 0.1986 \text{ pounds of ethanol/gallon of brandy aged} \end{aligned}$$

$$\begin{aligned} \text{Wine Default AEF} &= 0.03 \text{ gallons loss/gallon wine} \times 8.14 \text{ lb wine/gallon wine} \times \\ &\quad 0.114 \text{ lb ethanol/lb wine (simplified from Santa Barbara Air} \\ &\quad \text{Pollution Control District's 'Wine Production Emission Factors).} \\ &= 0.02783 \text{ pounds of ethanol/gallon of wine aged} \end{aligned}$$

Wine aging operators have indicated that their site-specific loss rate may be significantly lower than the assumed 3% rate. The rule allows operators to calculate the brandy and wine AEF using such a site-specific loss rate in place of the District's default values. This allowance is to reflect the effects of individual practices that may be employed to reduce evaporative losses.

Additionally, the rule provides for two alternative emission controls for tanks that are not housed in a PTE and vented to a VOC control device. First, the rule allows use of such tanks if the operator can demonstrate that the aging emissions do not exceed 0.3% by volume. This fugitive emission value is equivalent the fugitive emissions released by a

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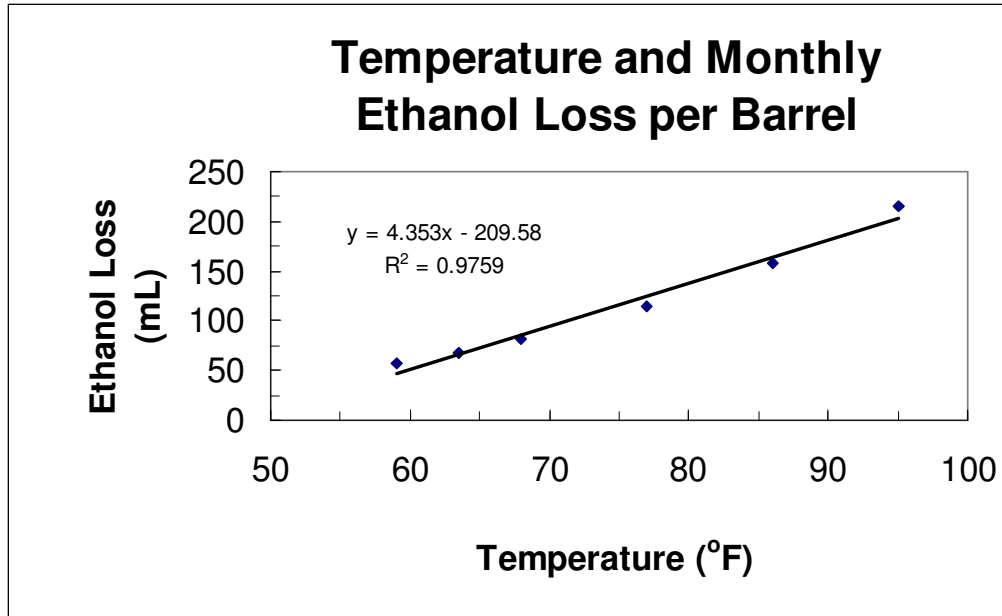
PTE and RTO that have a combined destruction efficiency of 90%. The basis for this allowance is as follows:

- Wine barrels have a District default evaporative loss rate of 3%.
- The PTE captures 92% of this 3% evaporative loss.
- The PTE is vented to a VOC control device that destroys 98% of the emissions captured by the PTE.
- Total capture and control of the system is
 $0.92 \times 0.98 = 0.90$ capture and control destruction efficiency
- If 90% of the evaporative loss is captured and destroyed, then 10% of the ethanol (or 0.3% of the total wine) would be emitted to the atmosphere.
 $0.03 \times (1 - 0.90) = 0.003$ or 0.3% of the total wine
- Therefore, a system with VOC emissions of less than 0.3% of the total wine is equivalent to a PTE and VOC control having a 90% capture and control efficiency.

Secondly, the rule allows operators to use non-wooden tanks if they are equipped with pressure vacuum relief (PVR) valves and temperature controls. The combination of the PVR valves and temperature control reduces or eliminates evaporation and emissions from the aging operations by maintaining the tank contents in a static state. The PVR valves stay closed during aging since refrigerating the tank contents prevents them from evaporating and expanding and contracting due to temperature variability. Tank contents are maintained at or below 75°F. Volumetric loss rates for these tank controls are expected to be 0.3% or less, which would be equivalent to the other two control options.

District research has found that temperature can be used as a primary, singular, and direct wine ethanol emission reduction/control technique. Based on an initial study's data (Blazer, R. M., Wine Evaporation from Barrels, Practical Winery and Vineyard Jan/Feb 20-22 (1991)), District staff ran a linear regression that showed a proportional relationship between temperature and ethanol loss from wine aging in barrels. Further research concluded that ethanol loss is independent of humidity. The Blazer data may have limited use but it is an appropriate example that aptly demonstrates for the purposes of this rule the scientific relationship of decrease temperature and proportional decrease of monthly ethanol evaporation from barrel aging wine as shown below in Diagram 1.

Diagram1. Linear regression of temperature and ethanol loss per barrel.



Because there are no other wine aging emission controls regularly put into practice other than temperature control, as currently achieved in practice for larger brandy aging and wine aging operations, and because temperature control is not only used to substantially reduce evaporative loss but to increase product quality; temperature control is to be considered a Reasonably Available Control Technology (RACT) practice. Because this practice will not generate additional reductions from current practices, no further emission reductions for RACT will be credited to this rule.

The use of a controlled nominal daily temperature, averaged over a calendar year, is considered RACT for two reasons. First, the San Joaquin Valley has great diurnal and seasonal temperature variations. Diurnal variations from night to day average 30 degrees, with extreme diurnal variations of up to 64 degrees Fahrenheit. The seasonal winter to summer monthly variations average 60 degrees, with extreme variations of up to 98 degrees Fahrenheit, based on a summer high of 115 degrees to winter low of 18 degrees. Second, the existing larger brandy aging and wine aging operations already employ refrigeration to maintain summer temperatures below a certain point, generally around 60 degrees Fahrenheit. The exact aging temperature can vary by 10 degrees Fahrenheit at certain times of the year, depending on the outside temperature, related operations occurring in the warehouse, and the refrigeration equipment limitations.

Another seasonal operational factor involved in an aging warehouse’s daily temperature fluctuations is fermentation. Fermentations produce large amounts of carbon dioxide gas. During the fall months of wine fermentation, doors nearest a fermentation section of the aging warehouse may be opened to exit the excess carbon dioxide gas thus contributing to daily variations in a controlled warehouse’s daily temperature. Consequently, because of the above detailed diurnal and seasonal temperature

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fluctuations the warehouse nominal daily temperature must be averaged over the course of a calendar year.

All wine aging and brandy aging operations at Major Sources must implement RACT as detailed earlier. Larger brandy operations must also implement capture and control of VOC emissions by using a PTE vented to a control device. This system is much more costly than the RACT requirements and is therefore considered a BARCT. As detailed in Appendix C, the high cost effectiveness of this BARCT requirement limits its application to the largest brandy aging operations which would otherwise have the highest emissions of VOC.

Currently, four of five largest brandy aging operations in the District are using a warehouse that is a PTE venting to a Regenerative Thermal Oxidizer (RTO). Out of several control devices at stakeholder disposal, the brandy aging industry has universally selected the use of a Regenerative Thermal Oxidizer (RTO) due to its low annual maintenance costs for this control application. Because of the current installation and operation of the RTOs, it has been demonstrated that RTOs are practical and effective controls for high levels of VOC emissions. The RTOs that are currently in operation were installed as an alternative compliance option in lieu of controlling the emissions from wine fermentation and storage for Rule 4694 (Wine Fermentation and Storage).

As explained in Appendix B, the expected reductions are summarized in Table 2 below. These emission reductions only include the reductions which will be realized from the one, uncontrolled brandy aging warehouse and do not include those reductions that are creditable to the Rule 4694. The compliance date for achieving this reduction is January 1, 2012.

Operation	Tons per Year	Tons per Day
Brandy Aging	42.6	0.12
Wine Aging	0 ¹	0
Total	42.6	0.12

¹ Current wine aging facilities meet RACT control requirements.

In determining a reasonable level at which to require BARCT, staff used a \$25,000 per ton cost effectiveness cut point. This level is similar to that which has been historically used in other VOC control rule determinations. This value will not generally cause a significant socioeconomic impact and yet will still affect a reasonable level of emission control.

The brandy evaporative loss rate of 3 proof gallons per barrel per year is based on the average loss rate for all permitted facilities in the District (except one facility that is not

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industry representative). The subsequently calculated brandy aging emission factor is 0.1986 pounds ethanol per gallon annually.

District research developed an evaporative loss rate scale showing that the annual wine aging evaporative loss rate for various operations in the District may range from 0.16% to 10% by volume. It was found that within that range, the 3% value is the appropriate value to use for the District's evaporative loss rate, which takes into account weighted inventories and evaporative loss rates. The wine evaporative loss rate of 3% by volume per barrel per year and the wine aging emission factor of 0.02783 pounds ethanol per gallon are based on the results of District research outlined in the following:

- According to Tobacco and Tax Trade Bureau (TTB) data for the years 2004, 2005, and 2006; and Wine Institute wine production values for those same years, wine loss during production is only 0.16%. This includes losses due to spillage, leakage, soakage, evaporation, include aging, and other losses normally occurring from racking and filtering. However, the overwhelming majority of this wine production is not aged. Therefore, for those wines that go through this production process and are then aged, the loss rates can be no less than 0.16% by volume per year. This sets the low end of the evaporative loss scale to 0.16%.
- District research has also shown that non-climate controlled wine aging warehouses in hot climates may lose up to 10% by volume, thereby setting the high end of the evaporative loss rate scale at 10%. From District surveys there are 22 wine aging facilities in District operation. Of those facilities, 21 facilities are less than one-tenth the size of the largest facility. These smaller facilities average approximately 800 – 1,000 barrels in aging inventory. District staff understands that these smaller facilities do not utilize climate controls for their aging barrels and that these barrels are aged in existing operational buildings (fermentation, storage tank, filtering, and/or bottling rooms/buildings). From the District survey these smaller facilities make up 37% of the annual wine aging inventory gallons.
- District research has also shown wine aging warehouses that are in mild climates (or warehouses that are operated with climate controls of approximately 60 degrees Fahrenheit and 75 percent humidity, according to stakeholder information) are expected to have loss rates of no greater than 3% by volume, based on the factor developed by the publicly-vetted Santa Barbara Air Pollution Control District permit development process. Santa Barbara has a mild climate with average temperature of 61 degrees Fahrenheit and 50% humidity.
- The likelihood that losses of no greater than 3% is also supported by data from the TTB whereby losses due to spillage, leakage, soakage, evaporation, including wine aging, and other losses normally occurring from racking and filtering, of up to 3% loss by volume, are not taxed. It is assumed that this allowance is recognition that the 3% loss is what would normally occur from a reasonably well-managed wine production operation. Since the other 97% is

taxed, operators would have an incentive to minimize emissions or they would end up being taxed on lost product.

- Published research has also shown that measured wine evaporative loss rates which were measured under environmentally controlled conditions in wine aging warehouses and caves - demonstrate a wine aging evaporative loss range from 0.3% to 1.4% by volume. This measured wine evaporative loss rate range was based on the spread of relative humidity from 60 to 75% and temperature 59 to 95 degrees Fahrenheit. This relative humidity and temperature spread was selected from the data set to reproduce the wine evaporative loss rates submitted by stakeholders of 0.29% to 1.4%.

The rule includes an allowance for operators to use site-specific loss rates in determining the applicability of the rule requirements to their aging operations. Stakeholders have requested that the site-specific loss factors also be used in calculating the emissions inventory for this source category. While the District is always open to improving the accuracy of the emissions inventory, such a determination is beyond scope of his project and will be pursued as a separate issue.

District Staff welcomed input from stakeholders who submitted similar but a facility specific wine evaporative loss rate (1.4%), cost of control total capital and annual investment data, and a resulting cost effectiveness analysis. Staff Report Appendices B, C, and D incorporated stakeholder results. These analyses resulted in a second wine cost effectiveness value of \$76,695 per ton. The District subsequently adjusted up the above wine aging threshold limit to 30 tons (60,000 pounds) per year with a subsequent cost effectiveness of value of \$26,700 per ton. Because there are no wine aging warehouses of that size in the Valley, and because the District's permitting process would prevent the establishment of one that large, the scenario of a wine aging operation large enough that would require the installation of a BARCT PTE and VOC control was dropped from the rule.

III. BACKGROUND

A. Brandy and Brandy Aging

The name brandy comes from the Dutch word *brandewijn*, meaning "burnt wine." The name is apt as most brandies are made by applying heat, originally from open flames, to wine. This wine is boiled at a temperature between the boiling point of alcohol (ethyl alcohol) and the boiling point of water. This heating a liquid to separate components with different boiling points is called heat distillation. The low-boiling point liquids distilled from wine include almost all of the alcohol, a small amount of water, and many of the wine's organic compounds. It is these chemicals that give brandy its taste and aroma. The resulting vapors are collected and cooled. To drive out more of the water, always saving the alcohol, the distillation process can be repeated several times more depending on the alcohol content desired.

In California, these brandies are generally made of wine produced from many varieties of grapes but principally use Thompson Seedless and Chardonnay. Brandy is produced with an ethyl alcohol of less than 190° proof and bottled at a minimum of 80° proof. In the United States, "proof" denotes the ethyl alcohol content of a liquid at 15.6°C (60°F), stated in units of twice the percent ethyl alcohol by volume. For governmental reporting purposes, ethanol is reported in volume units of proof gallons, which is one liquid gallon of proof spirits which are 50% ethanol, by volume, at 60 degrees Fahrenheit.

B. Wine and Wine Aging

Wine is an alcoholic beverage produced by the fermentation of sugars in fruit juices, primarily grape juice. This fermentation process is an anaerobic breakdown of organic compounds by microscopic yeast organisms which provide complicated enzymes that, in the presence of sugar, form alcohol, carbon dioxide, glycerin, and other products.

The amount of time required to complete a fermentation is a function of temperature, where at 55 to 60°F, wines are fermented in 7 to 10 days, and at 75 to 80°F, wines will take 3 to 6 days to ferment. In commercial wineries fermentation of the grape juice or must (grape juice plus berry skins) commonly occurs in fixed-roof steel fermentation tanks inoculated with yeast. After fermentation, wine is transferred a number of times between storage tanks to perform various finishing operations such as racking or decantation for separation of sediment, and filtration.

In California, table wines can be made from either a single grape variety or made from a combination of many grape varieties. These table wines have an alcohol content that ranges from 7 to 14 percent by volume (14° to 28° proof). Some of these table wines are subsequently aged in oak barrels or casks, to improve the quality. The changes that occur during the aging process are the result of interactions between the aging wine and the oak barrel, driven by the conditions of the surrounding atmosphere which may have both diurnal and seasonal variation. Both the ethanol and water evaporate from the surface of the barrel during the aging process with the rate of evaporation depending upon both the porosity of the barrel and the atmospheric conditions of the storage room among other factors.

C. Fugitive Emission Source: The Barrel

Modern barrels (Diagram 2) are made of oak staves (Diagram 3) shaped into bulging cylinders that are bound by steel hoops and capped with flat circular heads at both ends. The belly, or bilge, allows them to be rolled and turned, and when stored horizontally, facilitates racking or the transfer of the liquid to another barrel.

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Diagram 2. Wood barrel components.

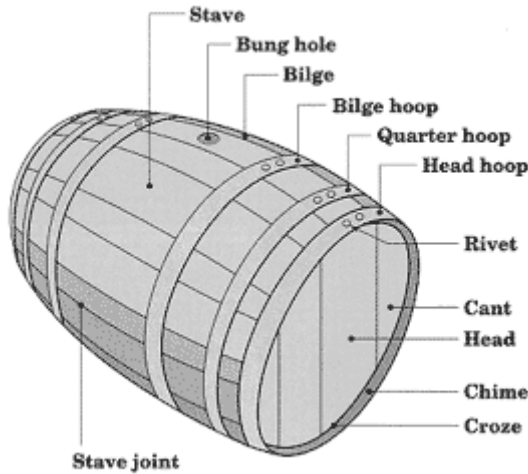
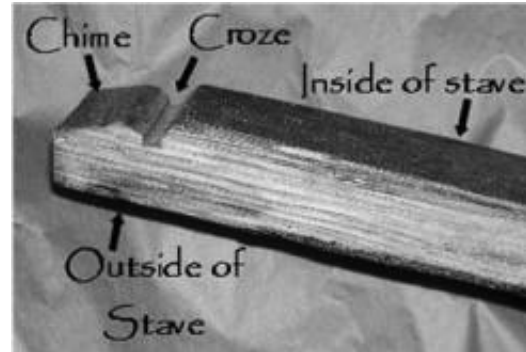


Diagram 3. Stave components.



The inside of the barrel is then subjected to fire, known as 'toasting' that caramelizes some of the woody substances (generally sugars) which develop into a multitude of sweet woody aromas, which will add flavor to whatever liquid is stored inside the barrel. For wines, this 'toast' level can be adjusted according to the customers' requests: light, medium or heavy toast. For Bourbon, the 'toasting' is heavy (or charred) that leaves a heavy charcoal layer on the inside that greatly mellows the liquid contents.

Once finished, a test of impermeability is made by pouring a small amount of hot water under pressure into the barrel. This procedure makes it possible to immediately detect any leaks, or mere traces of moisture caused by unusually porous areas or a manufacturing defect.

California brandy makers buy used American Bourbon barrels to age their brandy. These barrels generally hold 53 gallons are made of American oak. Barrels used for wine are fashioned in two principal configurations: the 59-gallon French Bordeaux and the 60-gallon French Burgundy. The latter is nearly three inches shorter and over one inch broader at the bilge. Wine barrels are purchased new or used and are made of oak from America, France, or Eastern Europe. Larger barrels of 79 to 185 gallons are called puncheons and offer a lower wood surface-to-wine ratio imparting less oak and vanilla characteristics to the wine. Large upright tanks generally fixed in place and constructed of wood are called casks and can be used to ferment or age the wine.

D. Fugitive Emission Driving Force: Diffusion

Wood is a solid, porous, and permeable material. Porosity is the volume fraction of void space in a solid. The porosity is reported to be 1.2 to 4.6% of dry volume of wood cell

wall. Permeability is a measure of the ease by which fluids are transported through a porous solid under the influence of some driving force, such as chemical potential. There are several types of chemical potential driving forces, but in this instance, it is diffusion. The diffusive movement of moisture and vapor through the wood is by several types of passageways and variations in wood structure. These pathways consist of cavities in vessel cells, fibers, ray cells, pit chambers, intercellular spaces, and transitory cell wall passageways.

Diffusion will redistribute moisture and vapor between the interior and exterior barrel surfaces, until the moisture or vapor level is uniform throughout the wood and the surrounding air, and a zero chemical potential gradient is reached at equilibrium.

Diffusion's constant driving force to reach equilibrium, forces a wine's 7 to 14%, or a brandy's 40% alcohol from the porous barrel into the housing room where, at least for brandy, there is a constant state of disequilibrium. This diffusion of alcohol and water over time causes a decrease in volume of the barrel's liquid contents. This loss is historically known as "the angels share" but is known today as fugitive emissions.

IV. Fugitive Emission Control Techniques

A. Emissions Capture System

The brandy storage warehouse functions as an enclosure from which the ethanol emissions can be captured. The capture efficiency is primarily a function of the configuration of this structure. Since such a structure can be sealed and ventilated to a control device such that it qualifies as a Total Enclosure pursuant to U.S. EPA Method 204, the theoretical capture efficiency could be considered to be 100%. However, since brandy aging and wine aging operations are a continuous 24 hour/day operation throughout the year, it would be difficult and expensive to continuously maintain the warehouse in a Total Enclosure status due to the on-going requirements to transport the product into and out of the warehouse and the requirements for maintenance during which the warehouse must be opened or the control device must be shut down. During such periods, uncontrolled emissions are delivered to the atmosphere in the absence of expensive air lock systems and/or redundant control devices.

Although neither of the terms "Fan Inlet Pressure Control Point" and "Maximum Allowable Negative Gauge Pressure" appear in EPA Method 204, the industry has previously indicated that there are technical difficulties with continuous monitoring and directly controlling a differential pressure of 0.013 mm Hg and has requested use of a surrogate for monitoring and for controlling of the induced draft fan. The selected surrogate is the pressure control instrument for the induced draft fan, typically located on the inlet ductwork near the fan inlet plenum. Due to pressure losses in the ductwork, the vacuum at this point is considerably higher than that in the warehouse (on the order of 2 "WC) which is more easily measured and controlled. The facility is required to

establish, control, and periodically demonstrate a control set pressure at this point which ensures that the PTE requirement of 0.013 mm Hg is met.

B. Control Technologies and Devices (Exhaust-type)

1. Thermal Oxidation (Incineration)

Thermal oxidizers (TO) use the process of combustion to destroy VOCs. A basic TO system consists of a combustion chamber, burner, stack, and combustion controls. All hydrocarbons are oxidized to carbon dioxide and water vapor by the proper mix of temperature, residence time and turbulence within the reactor chamber. Combustion of the contaminated gas stream occurs at high temperatures, normally 650°C to 870°C (1,200°F to 1,600°F) when treating low concentration streams. Recent source tests at existing facilities utilizing TO control have demonstrated a 98% destruction efficiency at a combustor temperature of 1400° Fahrenheit.

TO systems can be divided into recuperative or regenerative systems, based on methods used to increase operating efficiencies by capturing heat from the combustion process. Recuperative TO systems increase fuel efficiency by use of a gas pre-heating section and a heat recovery section. Heat recovery can be as high as 70%. A regenerative system provides extremely high thermal-energy recovery; up to 95% of heat energy can be recovered. Regenerative TO systems use a ceramic heat-exchange bed to preheat process air to within 5% of the oxidation temperature.

VOC conversion efficiencies range from 95% to 99.9% for TO systems. However, the combustion of supplemental fuel for the oxidation produces NO_x, an ozone precursor like VOC, thus offsetting some of the VOC emission reduction. The District considers thermal oxidation as technologically feasible for the application to brandy aging and wine aging.

Stakeholders have implemented thermal oxidation controls for their brandy storage warehouses and are currently adjusting the functional operations of this system to minimize any detrimental quality and evaporative effects. This control technology is currently operating on six permit units in the San Joaquin Valley.

2. Catalytic Thermal Oxidation

A catalytic thermal oxidizer (CTO) is essentially a thermal oxidation unit with a catalyst module. These units are similar in design to recuperative units, except that VOCs are oxidized at lower temperatures using precious metal or metal-oxide-based catalysts. Operating at about half the temperature of thermal oxidizers, catalytic units have smaller physical footprints and may offer lower operating costs in certain circumstances. Since catalysts are employed, these systems are subject to catalyst poisoning or deactivation due to operating upset and may require periodic catalyst replacement, which represents a substantial operating cost.

Other industries have demonstrated typical VOC removal efficiencies of up to 98%. The District considers catalytic thermal oxidation as technologically feasible for application to brandy aging and wine aging and that a control efficiency of 98% is reasonably achievable.

3. Adsorption Vapor Recovery

Adsorption vapor recovery is accomplished by passing the VOC-laden gas through beds containing adsorbents that have a high surface area to weight ratio. Typical adsorbents are activated carbon, zeolite, or organic polymers. As the gas stream passes through the bed, organic compounds adsorb weakly onto the adsorbent's surface. Adsorption of the hydrocarbon molecules proceeds until the available surface area is filled or saturated with VOC molecules. The VOC molecules are retained until the regeneration step, or disposal of the spent adsorbent.

Desorbing or removing captured VOCs regenerates the adsorbent. Decreasing the pressure, reducing the hydrocarbon concentration around the adsorbent or increasing the temperature of the bed can perform regeneration. A combination of these steps can also be used for regeneration. There are three basic types of adsorption systems available to recover or remove hydrocarbon vapors from an air stream. Two of these systems regenerate the adsorbent in-situ for reuse. The third system requires removal of the adsorbent to another site for regeneration.

The two systems that provide in-situ regeneration are: Pressure Swing Regenerated Systems and Thermally Regenerated Systems (or a combination of the two methods). Since the net result of the combined adsorption and regeneration process only results in transfer of the ethanol from the vent stream to another liquid or gaseous stream, further treatment of the effluent of the regeneration process is required to either destroy or recover the ethanol (typically thermal oxidation of the stripping gas stream or water treatment in the case of steam stripping).

The District considers adsorption vapor recovery (with appropriate handling of regeneration waste streams) as technologically feasible for application to brandy aging and wine aging. Based on a draft technical assessment document (TAD) prepared by the ARB, a control efficiency of 95% is considered reasonable for adsorption systems when controlling ethanol emissions (from wine fermentation), a more demanding application due to the presence of large amounts of CO₂.

4. Wet Scrubbing (Absorption)

The basic process involved in wet scrubbing is the contact of a polluted gas stream with a liquid solution. During operation, gas flows upward through a column containing packing or other mass transfer media. The scrubbing liquid is delivered to the top of the column and flows down (by gravity) through the porous mass transfer media, generating a substantial interfacial surface area between the gas and liquid phases in a counter

flow arrangement which provides optimal mass transfer. Gaseous contaminants are absorbed into the liquid and the decontaminated gas stream flows out of the scrubber.

Many scrubbing applications achieve emission reduction efficiencies of 99.9%. In a pilot study conducted by the ARB in 1987, wet scrubbing demonstrated greater than 90% reduction in ethanol emissions when operated for control of ethanol emissions (from wine fermentation tanks). The District considers wet scrubbing as technologically feasible for application to brandy aging and wine aging and that a control efficiency of 90% is reasonably achievable.

5. Condensation, Refrigeration, and Cryogenic Systems

Condensation, refrigeration, and cryogenic systems remove organic vapor by condensing the target gases on cold surfaces. These cold conditions can be created by passing cold water through an indirect heat exchanger, by spraying cold liquid into an open chamber with the gas stream, by using a refrigerant to create very cold coils, or by injecting cryogenic gases such as liquid nitrogen into the gas stream. The concentration of VOCs is reduced to the level equivalent to the vapor pressures of the compounds at the operating temperature. Removal efficiencies attainable with this approach depend strongly on the outlet gas temperature. For cold-water-based condensation systems, the outlet gas temperature is usually in the 40 to 50 °F range, and the VOC removal efficiencies can be in the 90% to 99% range depending on the vapor pressures of the specific compounds. For refrigerant and cryogenic systems, the removal efficiencies can be considerably above 99% due to the extremely low vapor pressures of essentially all VOC compounds at the very low operating temperatures of -70 °F to less than -200 °F. Water vapor content in the gas stream may place a lower limit on the outlet gas temperature due to potential ice formation.

The application of refrigerated condenser to the control of ethanol emissions (from a fermentation tank) was examined by ARB. The results of that study indicated that a 90% ethanol recovery could be achieved at an outlet gas temperature of -12 °F when controlling ethanol emissions. However, it was noted that ice formation could be a problem at this temperature and that special equipment designs would be required for reasonable operation. In addition, the ethanol is recovered in aqueous solution and must be further process for recovery of the ethanol. The District considers refrigerated condensation as technologically feasible for application to brandy aging and wine aging and that a control efficiency of 90% is reasonably achievable.

6. Biological Oxidation

VOCs can be removed by forcing them to absorb into an aqueous liquid or moist media inoculated with microorganisms that consume the dissolved and/or adsorbed organic compounds. The control systems usually consist of an irrigated packed bed that hosts the microorganisms (biofilters). A presaturator is often placed ahead of the biological system to increase the gas stream relative humidity to more than 95%. The gas stream

temperatures are maintained at less than approximately 105°F to avoid harming the organisms and to prevent excessive moisture loss from the media.

Biological oxidation systems are most often used for very low concentration VOC-laden gas streams for odor control. The VOC inlet concentrations are often less than 500 ppmv and sometimes less than 100 ppmv and achieve control efficiencies exceeding 95%. However, biofilters have been demonstrated in industrial applications achieving 90% control efficiency when controlling higher ethanol inlet concentrations (up to 3 g/1000 m³). The District considers biological oxidation to be technologically feasible for application to brandy aging and wine aging and that a control efficiency of 90% is reasonably achievable.

C. Emission Reductions

The 2007 Ozone Plan estimates a 2012 brandy aging and wine aging VOC emission baseline of 2.30 tons per day. This value has been adjusted to account for 4.5 tons per day of reductions from facilities that are part of alternative compliance options in Rule 4694 (Wine Fermentation and Storage Tanks). These emissions are SIP creditable to previous 1-Hour Ozone Plan commitments for the Brandy and Wine Aging (S-IND-14) control measure. Approximately 98 percent of the brandy aging emissions in the San Joaquin Valley (four facilities) are already controlled in accordance with the requirements of this rule. Implementation of this rule is expected to require emission controls on one additional brandy aging facility, resulting in an annual emission reduction of 0.12 tons per day attributable to this rule for brandy aging. The wine aging emission reductions are currently achieved in practice and are considered RACT and are not creditable to this rule.

As previously stated in this Draft Staff Report, the District sought as much reduction of VOC emissions from brandy aging and wine aging as expeditiously as practicable, technologically feasible, and economically reasonable, as determined by the District's Governing Board. The VOC emissions reduction analysis is presented in Appendix B of the Final Draft Staff Report and also includes stakeholder submitted data.

V. COST EFFECTIVENESS ANALYSIS

Pursuant to CH&SC section 40920.6(a), a cost effectiveness analysis is required for rules that implement RACT. The purpose of the cost effectiveness analysis is to evaluate the economic reasonableness of the rule or rule amendments. The analysis also serves as a guideline for developing the control requirements of the rule. District staff has conducted a cost effectiveness analysis for Rule 4695. The cost effectiveness analysis is presented in Appendix C of the Final Draft Staff Report.

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VI. SOCIOECONOMIC ANALYSIS

Pursuant to CH&SC 40728.5, “whenever a district intends to propose the adoption, amendment, or repeal of a rule or regulation that will significantly affect air quality or emissions limitations, that agency shall, to the extent data are available; perform an assessment of the socioeconomic impacts of the adoption, amendment, or repeal of the rule or regulation.” The socioeconomic impact of Rule 4695 is presented in Appendix D of the Final Draft Staff Report.

VII. RULE CONSISTENCY ANALYSIS

Pursuant to the state Health and Safety Code, Section 40272.2, District staff has prepared a rule consistency analysis of Rule 4695. The Rule Consistency Analysis is presented in Appendix E of the Final Draft Staff Report.

VIII. ENVIRONMENTAL IMPACTS

Pursuant to the California Environmental Quality Act (CEQA), District staff investigated the possible environmental impacts of the proposed Rule 4695. Based on the Initial Study District staff concluded that the proposed rule will not have any significant adverse effects on the environment. Staff recommends filing a Negative Declaration under the provisions of the Public Resource Code 15061 (b) (3) to be presented to the Governing Board Chair for signature.

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