

## **APPENDIX 27**

### **COMMENTS AND RESPONSES ON THE AIR POLLUTION CONTROL OFFICER'S DETERMINATION OF VOC EMISSION FACTORS FOR DAIRIES**

**(ON DRAFT REPORT - JUNE 27, 2005)**

## Responses to General Issues

In addition to addressing each of the specific comments submitted regarding the APCO Dairy VOC emission factor determination, the District is also providing the following responses to address some of the general issues raised regarding the proposed emission factor determination. These responses may also eliminate some misconceptions that have arisen during the process of developing the proposed emission factors.

**Dairy VOC emission factors are needed to implement the requirements of State Law.** Under State law (SB 700, Florez 2003) agricultural operations, including dairies, which emit over 25,000 lb of VOCs per year are required to obtain permits. In order to determine which operations exceed this level of emissions, VOC emission factors are needed. A process-based emission factor is also needed as a first step in establishing Best Available Retrofit Control Technology for the dairies as required under state law. However, the type and level of control that will ultimately be in a regulation covering dairies will not be solely driven by the magnitude of the emission factor. The District, through a public process, will fully examine the technological feasibility, availability, and the cost of possible control measures.

**Based on any viewpoint expressed in the comments we received, dairies are a significant source of VOC emissions that require controls under State law.** Even if the very low partial estimates of VOC emissions proposed by dairy industry representatives were correct (one advocated a VOC emission factor as low as 3.1 lb/head-yr), dairies would still be among the largest sources of VOC emissions in the Valley. Even if these partial emission factors were used, emission levels from individual dairies would still be far higher than most other individual sources of air pollution that have been successfully implementing VOC emissions controls for many years.

**San Joaquin Valley Air District staff is well qualified to develop VOC emissions factors.** Although the laboratory and field data used to develop emission factors are often collected by researchers; the selection, evaluation, and application of this data to real-world operations is almost solely the function of air agency engineers. Collectively, Valley Air District staff members directly involved in preparing and reviewing this report have over 60 years of experience in developing, evaluating, selecting and applying emission factors to real-world sources of air pollution, including agricultural operations. Furthermore, among California air districts and other agencies, Valley Air District staff members are considered the experts in this area. Technical methodologies for determining agricultural emissions that were compiled and developed by Valley Air District engineers and specialists are being used by agencies throughout California for establishing permitting requirements, determining the applicability of requirements under Title V of the Federal Clean Air Act, and developing air quality attainment plans.

***The VOC emissions factors for dairies proposed in this report are based on a detailed review of available science.*** In order to establish the proposed emission factors in this report, the APCO and his staff reviewed the Dairy Permitting Advisory Group (DPAG) report, each presentation to DPAG, and over 15 research studies, including all recent dairy emissions studies performed at California dairies and Universities.

In an academic setting, it is entirely appropriate to withhold data and action, often for years, until all questions are answered and until we have nearly perfect science. Some have argued that the District should withhold action until we have perfect science. Unfortunately, given the Valley's air quality, public health considerations, and the strict statutory deadlines, we do not have that luxury. This, however, does not mean that we should act carelessly and without regard to the economic health of the dairy farmers in the Valley. In arriving at an emission factor for the dairies, the District has employed a number of conservative guiding principles aimed at ensuring that the proposed factor would likely represent a low-range estimate of dairy emissions that is supported by best available science.

***In evaluating the research studies, California research was always given preference.*** In fact, most of the proposed emission factor values were obtained directly from California researchers. Of the five categories in which emission factor values were determined, recent California research was used for four of the five values, as well as for over 50% of the value in the fifth category.

Specifically:

- 1) *Enteric emissions and emissions from fresh feed* were determined directly from data reported by Dr Frank Mitloehner of U.C Davis;
- 2) *Ethylamines from Dairy Processes* were measured by Dr. C.E. Schmidt at a Merced County dairy;
- 3) *VOC emissions from miscellaneous dairy processes* were measured by Dr. C.E. Schmidt at a Merced County dairy;
- 4) *VOC emissions from lagoons and storage ponds* were measured by Dr. C.E. Schmidt and Dr. Charles Krauter of California State University at Fresno at a Merced County dairy, and by Dr. Charles Krauter at a Kings County dairy; and
- 5) *Enteric Volatile Fatty Acids* were determined from data reported by Dr Frank Mitloehner of U.C Davis.

Other studies (Hobbs et al and Koziel et al) were only used after considerable review to fill a data gap in one category (VFAs from dairy processes) where valid California data were not available.

***Before applying any data from outside California, the District performed a detailed analysis comparing the research study conditions with process conditions at California dairies.*** For reasons described in detail in this report, no valid

California research data were available for a portion of one of the VOC emissions categories, VFA emissions from dairy processes. In the absence of valid California data, other studies were reviewed to determine if any tests performed would be applicable to California dairies. After careful review, the test conditions in one study, the Hobbs et al study, were found to represent wet process conditions (flush lanes, solids separation, lagoons, etc.) at California dairies very well. The material (urine and feces from Holstein cows of similar size and milk production), the moisture content (over 90% water), the pH (7.1, approximately neutral), and the temperature were almost identical to the conditions found in wet dairy processes in the San Joaquin Valley.

In order to estimate VFA emissions from the other 40% of the manure that is captured in dry dairy processes (e.g., manure that is excreted and falls into dry exercise pens), data from another non-California study, the Koziel et al summertime studies of Texas feedlots, were used (See Appendix 13). After carefully comparing the test conditions to those at California dairies, the VFA emissions rate from the Koziel et al study was adjusted downward by a factor of eight (as described in the APCO report) to account for potential differences in diet between California dairy cattle and Texas feedlot cattle. Because VFA emissions are directly related to moisture and the Koziel et al study was based on dry summertime conditions, the proposed VFA emission factor is expected to be an underestimate of the annual emissions from dry processes.

***All comments, including those from California Scientists, were considered in the development of the proposed emission factor.*** Although the District received input from several research scientists on the proposed report, these scientists did not always agree upon the best approach for determining emissions. For example, while comments by several scientists strongly supported the District's approach in the use of the British Hobbs study to determine VFA emissions from wet dairy processes (Dr. David Grantz of the University of California; Dr. F.M. Byers, consultant and former professor of animal nutrition at Texas A&M; Diane Bailey of the NRDC, and Dr. James Morris of BION Corp.), others (Dr. Deanne Meyer of U.C. Davis, Matt Summers formerly of the California Dept. of Food and Agriculture, and Dr. Charles Krauter of California State University at Fresno) expressed concerns with this approach. These specific comments were considered and are addressed later in this Appendix.

One researcher (Dr. Frank Mitloehner of U.C. Davis) expressed concern with the use of the enteric VFA data that he himself had provided to the Dairy Permitting Advisory Group. Dr. Mitloehner stated that the study was "not designed to accurately determine total VFA emissions", and that he was "not able to conclude that application of the ratio of inlet and outlet data from other VOC compounds measured in our study can be used to predict inlet concentration due to their completely different chemical nature". Although the District shared Dr. Mitloehner's concerns regarding the variation in the data and the potential differences in chemical nature between VFAs and other VOCs, in reviewing the results, the District found that enteric VFAs were clearly found at high levels in these tests. In fact, nine specific VFAs were detected in these tests, and the total VFA results were orders of magnitude greater than detection limits. The APCO also found that, as noted in the APCO report, most of the potential inaccuracies

associated with the measurement and calculation of VFA emissions (e.g. sampling losses) would be far more likely to underestimate the emissions than overestimate them. The data far more accurately represented enteric VFA emissions than the alternative emission factor (zero) proposed by dairy industry advocates. Therefore, in the absence of any other data for enteric VFA emissions, after considering Dr. Mitloehner's concerns, the APCO chose to use the average of the enteric VFA data reported to DPAG.

***As noted in the report, the District strongly supports further research on California dairies to further refine and supplement these emission factors.***

## COMMENTS AND RESPONSES

### WORKSHOP HELD ON JULY 11, 2005

**Some comments indicate that further explanation of the reasons for the District's actions is necessary in determining an emission factor for dairies. Examples:**

#### **1. Comments:**

- *At this point in time there is no scientifically defensible methodology to estimate VOC emissions from dairies.*
- *The District appears to be proposing an EF much higher than what California air emissions researchers have reported.*
- *Dairies will be permitted and controlled even if the enteric and slurry-based process VFA emission factors are not included.*
- *Why are we debating the quantity of VOCs, VFAs or ROG<sub>s</sub> that our Valley's dairy cows are alleged to be producing? It is only because our air agencies (EPA, CARB, and SJVAPCD) and air quality activists contend that the Valley's ozone levels are producing extraordinarily high asthma rates among the young. Simply put, there is no substantial evidence that ozone at the levels at which we experience in the valley is causing an increase in the incidence of people developing asthma or other respiratory illnesses. Indeed the best evidence is to the contrary.*
- *Do not adopt an emission factor at this time; rather, continue to regulate and permit dairies under the existing Settlement Agreement (Western United Dairymen et al v. SJVAPCD et al). Under this option, the District would investigate the serious scientific and legal issues that have arisen related to its proposed emission factor and take one of the following three courses of action:*
  - *Propose a new emission factor after the legal and scientific issues raised here have been fully addressed, or*
  - *Address the legal issues raised here but wait until additional scientific data is available to address the outstanding scientific questions discussed in this letter related to Volatile Fatty Acids, or*
  - *Address the legal issues raised here and wait for the California Air Resources Board to complete additional research and establish a new emission factor for dairies, expected sometime late in 2005.*

**Response:** The comments below explain the intent of this report, and the obligations faced by the District and by dairies:

- a) Dairy operators MUST, under state and federal law, obtain permits for dairies that trigger permitting thresholds based on emissions from the dairies, and Air Districts must enforce these requirements. There is no option in law to postpone these permitting requirements. For comparison, other stationary sources (from gas stations and drycleaners, to refineries and power plants) have been subject to similar, but actually much more stringent, permitting regulations for decades.
- b) In order to determine which dairies require permits, the District is required to determine emissions from dairies, just as the District has been determining emissions from all other stationary sources of air pollution emissions for over thirty years.
- c) Rather than requiring every dairy to test its own emissions through very expensive testing, the District is developing a surrogate estimate, called an emissions factor, which will then be used to determine approximate emissions from each dairy.
- d) In developing an emission factor for dairies, the APCO must look at all available information, and use the best available science to build the emission estimate. This is a process that has been going on for decades for other sources of emissions, and is best represented by EPA's publication AP-42, "Compilation of Emission Factors", which contains emission factors for hundreds of types of emission sources.
- e) Each dairy is then able to use this emissions factor to quantify its own emissions, and may propose modifications to it if able to demonstrate that assumptions that went into the emissions factor are not valid for a particular dairy. This too is a process with which the District is very familiar, and in fact District staff are experts in performing such adjustments to accepted emission factors.

In summary, the District is legally obligated to require permits of dairies emitting above certain emissions thresholds, and dairies are legally obligated to obtain those permits. An emissions factor developed and used by the District is a legally accepted way to estimate emissions for the purposes of determining these permitting requirements. However, the legal acceptability of the emissions factor would be tainted if the District cannot justify that the emissions factor was developed using the best available science.

Therefore, in choosing the components to use for the dairy emissions factor (or any emission factor), the District can not use "zero" when in fact we know there to be significant emissions and data exists that allows us to quantify it. To use "zero" would be inappropriate, because it would knowingly underestimate emissions. The potential and likely ramification would be that many dairies would violate the law by not applying for required permits.

The comments listed in this section are all variations of asking the District to use "zero" for all or a portion of the emissions from dairies, when we know very well that emissions are not zero, and in fact are quantifiable. For the reasons discussed here, we cannot call them "zero".

2. **Comment:** *Some of these remedies require a minor amendment to the Settlement Agreement to remove the August 1 deadline to establish an emission factor. Western United Dairymen and the Alliance of Western Milk Producers, which are CARES members, have indicated they are willing to discuss this option.*

**Response:** The District does not agree that it would be a good idea to again postpone the release of the District's proposed dairy emissions factor. As discussed above, using an emission factor that is known to be lower than actual emissions is not acceptable, and would almost certainly result in dairies operating in violation of permitting requirements from state law. Additional delays will also prolong the confusion of dairymen proposing to install new and expanded dairies in the San Joaquin Valley. Our impression is that these dairymen are frustrated by the delays caused by the uncertainty in emissions factor, and the legal challenges to the District's permitting authority. Finalizing the factor will allow these dairymen to establish some finality as to the permitting requirements, and so they should be able to proceed with obtaining permits and beginning construction.

3. **Comment:** *Why did the 1930s number suddenly get overwritten and why are new ones being allowed?*

**Response:** Part of the lawsuit that was brought against the District by the dairy industry groups was the claim that the 1930's test was inaccurate and insufficient to be used in the District's permitting efforts. The District agreed with the dairy industry that it was possible to develop better emissions factors with new data. The settlement that was reached between the parties required the Air Pollution Control Officer to establish an up-to-date emissions factor, based on the best available science, including the recent tests by several California researchers. That is the purpose of this report.

4. **Comment:** *What is the justification for allowing 63 new dairies ranging in herd size from 2,000 to 14,000 to be granted permits so they can increase the valley's cows by 400,000 cows?*

**Response:** The District is responsible for permitting sources of air pollution. A permit is granted to any source that emits or may emit pollution once the District evaluates that all Federal, State, and/or local requirements have been met. All new dairies will be subject to District Rule 2201 (New Source Review Rule), and will be required to meet Best Available Control Technology (BACT) prior to operation.



5. **Comment:** *Is it reasonable for anyone to expect your employees who report to collect questions through July 25, read them thoughtfully, evaluate their usefulness, draw conclusions and publish a new VOC number by August 1<sup>st</sup>, less than a week after the July 25<sup>th</sup> deadline?*

**Response:** Fortunately, the majority of the comments were received prior to the July 25, 2005 date. The APCO was able to address every comment. The District apologizes if any commenter feels that we failed to understand or respond to their comments. We tried to address all comments thoroughly and fairly.

6. **Comment:** *How did we come up with the 800-1000 cow threshold?*

**Response:** This number is an estimation of the number of milk cows that would be subject to District permitting (emissions greater than ½ major source threshold) based on a typical California dairy design with milk cows and support stock. However, the number of cows that trigger the permitting threshold may vary for individual dairies.

**A number of the comments received, expressed that the District's decisions in developing a VOC emissions factor for dairies must be based on the best available science:**

**7. Comments:**

- *We want to express our concern over the recent tentative decision by the District to adopt a VOC emission factor for dairy cows. It is imperative that VOC emission factors adopted by the District, which will eventually be the foundation of regulations, be based on best available and applicable science.*
- *The California dairy industry should be regulated on an EF based on sound science which by definition must reflect California dairy conditions.*
- *The District ignores source testing using approved methods on a California dairy, without establishing an adequate basis for rejection of that data.*
- *The proposed emission factor is inconsistent with the District's own rules, regulations and policies. Any application of the emission factor for purposes of triggering permitting requirements is not authorized by the District's rules, regulation or policies.*

*The District's policy on use of emission factors requires the use of "best available data" (see, Use of Revised Generally Accepted Emission Factors, 4/29/04). Neither the District nor Mr. Crow has used the best available data. The District's policy sets forth a data hierarchy, which includes source test from an emission point or similar emission point. The best available data include the source test data developed by Dr. Schmidt from an emission point, a dairy, and the District.*

*This emission point is similar to other dairies in the District. This data has been disregarded by Mr. Crow. Instead Mr. Crow has relied on an article on purported emissions from a manure slurry (which does not exist in practice in the valley). Mr. Crow has also relied on data from a chamber study, which the principle researcher has advised is manifestly unreliable. Indeed, the data relied upon by Mr. Crow for VFA does not even fall within the data hierarchy set forth in the District's policy.*

**Response:** The District agrees that emissions factors must always be based on the best available science, and we do so for all of the hundreds of different types of industries we regulate. The intent of the report is just that – a compilation of the facts that led the APCO to determine that the best available emissions factor is 20.6 lb/hd-yr, and the explanation of how those facts were used.

Although the District did give preference to California studies in this report, we do not agree that the best available science necessarily comes from California. For instance two California studies were designed to capture VFA emissions. One California study, to measure VFA emissions from dairy processes, was inadequate in that it captured no VFA emissions, even though no one who has studied emissions from dairies suggests that zero VFA emissions come from dairies. Therefore, for dairy process VFA emissions, we had to look elsewhere for potential data.

On the other hand, four California studies were found to be acceptable for the purposes of generating a component of the dairy emission factor, and are used by the District to characterize enteric emissions in this report.

In all cases, the District used the very best data available as explained in the report.

8. **Comment:** *It has been argued that only data obtained from California dairies should be considered in determination of the dairy emission factor. If complete data were available from such studies this would be defensible, but such data are not available. It is appropriate and, I believe obligatory, to use the most relevant data available from any source. The rules of chemistry and physics are universal. While data from other environments may not reflect local conditions, in some cases the local measurements may be converted to local conditions, semi-quantitatively, using differences in temperature, pH, moisture content, etc.*

**Response:** The District agrees. California data was always given preference when applicable. In our report, test conditions were carefully compared to actual conditions.

9. **Comment:** *California researchers agree that emissions from dairy operation are quite complex and no single study has yet been able to characterize each category of VOC from each significant dairy operation.*

**Response:** District also agrees that no one test measured all components, and in fact, some VOCs known to exist at dairies have never been measured in such a way as to be able to determine an emission factor. Also, no VOC tests were performed for some important dairy processes. This is the very reason that APCO had to look at other data and add together the various pieces of the VOC puzzle to arrive at a composite VOC emission factor, and why we believe our composite VOC emission factor to be an underestimate of true dairy emissions.

**10. Comment:** *As you know, only work in sources which have established VOC profiles (principally combustion sources) can justifiably use the current methods for quantifying partial VOC to estimate of true VOCs. This justification does not apply to the dairy source. Since only non-justified partial VOC measurement methods have been used in dairy studies to date, it follows that a scientifically defensible estimate of true VOC or ROG cannot be made until an accurate VOC profile has been established for the dairy source.*

**Response:** The District agrees that our use of the “partial VOC” measurements has resulted in a certain underestimation of the total VOCs from a dairy. The District also agrees that we have made no attempt to correct that underestimation by assuming a “VOC profile” for dairy sources, and that such a correction is not possible at this time because no such VOC profile has been developed. Unfortunately, the legal requirements that are guiding the District’s actions in developing an emission factor do not allow us to wait for a fuller understanding of all of the VOCs in dairy emissions (see response to comment 1). The APCO must determine, by August 1, 2005, the most justifiable best-science number that can be developed with the data available today. As better and more complete data becomes available, we will incorporate that data into future revisions to the emissions factor.

**11. Comment:** *The need to produce the interim emission factor (IEF) for dairies provided an opportunity for the District to advance the science of emission factor development by, for example, attempting to establish a validated a partial VOC measurement. Instead, there appears to have been no attempt to mine data provided in the viewpoints in the DPAG final report or published literature for a VOC profile. Instead, data from an arbitrary collection of partial VOC measurements are combined without understanding what portion of the unique VOC profile of the dairy source is represented.*

**Response:** The APCO agrees that a profile for dairy emissions must be developed, but it certainly is not a necessary part of piecing together the currently available data into a best-science estimate of emissions. The APCO is very hopeful that such an emissions profile can be developed in the near future as work plans are developed for future dairy emissions testing. Also, the District did not use an “arbitrary collection of partial VOC measurements” – we reviewed and analyzed every dairy VOC measurement we could find, and only used those that met our criteria for use

as an emission factor. Finally, we agree that we do not know to what degree our number underestimates dairy emissions.

**12. Comment:** *The IEF is based on different partial VOC measurements applied to different subsets of the dairy source. In the case of VFAs, there is not even consistency in the measurement methodology when emission factors for a compound identified in one study combined with that seen in other work.*

**Response:** The above statements are correct – again, the District used every valid VOC measurement we could find, and analyzed it for applicability as described in detail in the report. Consistency between source test methods is simply not available in the data available today.

**13. Comment:** *Neither source study for the APCO's emission factors, the largest fraction of the IEF, included quantification of VFA recovery efficiency. This is an aspect of the research that is critical – not optional – to determine that all of the VFA (both the full spectrum of compounds in the total mass) emitted are actually measured. As a class, VFA are notoriously sticky and diffusive and can easily be lost in the transfer of air samples to analysis or gained in carry over from one sample to another. Without control experiments in which a known quantity of VFA are added to the source and sampled, it is not valid to estimate source emissions, and resulting data can only be, at best, qualitative.*

**Response:** The District agrees that it will be very important for future research to be designed to analyze recovery efficiency, for all VOCs, and especially VFAs, to address our serious concern of undercounting these difficult-to-measure chemicals. However, the District is not aware that the peer-reviewed Hobbs study has been called into question in that regard, so we assume his peer-reviewers found the data to be adequate. In addition, we are very familiar with the Mitloehner VFA sampling methodology, and do not believe that it has the slightest potential for carryover of VFAs from one sampling run to the next. Therefore, we found in our report that the VFA emissions factor may very well be an underestimate, due to sampling losses, but is very unlikely to be an overestimate.

**14. Comment:** *In dismissing the Schmidt data, the District concludes solely on the out-of-context statements of two researchers – neither of which participated in or had any direct knowledge of the parameters of the CARB study – that significant losses occurred in the Schmidt study because VFAs were too “sticky” to travel through an eight-foot sampling tube, and that such losses would render the data invalid. In fact, what the cited researchers actually said was:*

- *“VFAs have a high affinity for adsorption to any surface ... Adsorption to tubing can result in underestimation of measured concentrations.”*
- *“Volatile Fatty Acids, phenols, peroxides ... may [emphasis added] have a tendency to condense or be absorbed by many of the materials typically used in sampling lines.”*

*In neither case were the researchers asked to comment on, nor did they comment on, whether the CARB study was valid or if significant sampling losses could be expected in the method specifically used by Schmidt. In other words, the District's report translates the possibility of losses to undisputed fact, without providing any specific evidence to suggest why they dismissed a study funded by a California regulatory agency, conducted by one of the state's most experienced livestock emissions researchers and using an EPA-approved method for collection and analysis of samples.*

**Response:** The statements of experts that the District relied upon in evaluating the Schmidt study were not used out of context. The statement from Dr Koziel that the use of sampling tubing in sample collection can result in sampling losses clearly applies to the Schmidt study, in which such sampling tubing was used and no VFAs were detected. The statement by Dr. Goldstein, (*"Volatile fatty acids, phenols, peroxides... may have a tendency to condense or be absorbed by many of the materials typically used in sampling lines... Therefore, these compounds often can only be detected if at sufficiently high concentrations, and then only qualitatively, as these loss processes often do not occur at correctable rates."*) is also applicable to the Schmidt study in which such sampling tubing was used and no VFAs were detected. Based on these expert opinions, the APCO concluded that the non-detect values in the Schmidt Study may have simply been the result of sampling bias, and that it was clearly not appropriate to use the analytical limits of detection from these tests to estimate VFA emission factors. Although flux chamber test methods have been approved for a variety of purposes, the expert opinions above indicate that the specific arrangement used by Dr. Schmidt was not appropriate for quantitative VFA measurement.

**15. Comment:** *VFAs are major components of odors on dairy enterprises, as well as being VOCs, and are found in sources throughout dairies- fermented feeds, cows, and moist wastes. The approaches used in the current report make common sense, and capture the essence of feed bunk, ruminal (cud chewing), anal gases, and moist waste handling VFA-VOC emissions. Certainly, the exact magnitude of emissions from these sources will be much better defined with necessary research, targeted on major categories and sources of emissions, and which will be forthcoming in the near future.*

**Response:** The District agrees.

**16. Comment:** *The big concern isn't so much the number (emission factor) you settle on, but (that) a scientifically unjustifiably large number would likely lead to unnecessary regulations which would be economically harmful to the dairy industry.*

**Response:** While the District continues to maintain that the proposed emission factor is justifiable, and has been justified in our report, it is very important for the District to address the root comment here: the fact is that, whether we use the DPAG emission factor supported by the dairy industry (5.6 lb/head-yr) or something

closer to the APCO's draft report emission factor (20.6 lb/head-yr), dairies are one of the most significant sources of VOC emissions in the valley, if not the most significant.

That fact means that dairies will be asked to do as much as is reasonably possible to control their emissions, through the upcoming rule-development process, regardless of where the "final" emission factor ends up. All interested parties are invited to take part in the rule-development process, which should begin with public workshops in September of 2005. However, this attempt to establish an emission factor does not establish emission control requirements – the two efforts are separate and distinct.

### **Specific Comments:**

**The following comments were made regarding the use of Hobbs' VFA data:**

**17. Comment:** *The District's proposed EF relies heavily on studies performed outside of California, which do not appear to be reflective of actual conditions at California dairies in terms of climate, feed and manure management. The District further ignores testing on a Texas beef feedlot, which tends to corroborate the California research results.*

**Response:** In the absence of valid California tests, data from two studies performed outside California were used to determine VFA emission factors. The Hobbs et al study (Appendix 12) was used to determine VFA emissions from wet dairy processes, and the Koziel study (Appendix 13) was used to provide data for dry dairy processes. For each study, the District carefully compared the test conditions to process conditions at actual California dairies in our evaluation.

The test conditions in the Hobbs et al study were found to represent the wet processes on California dairies remarkably well, and no adjustments to the data were required. In evaluating the transferability of the Hobbs et al data, the APCO compared the test material and conditions:

*Material:* The material used in the Hobbs study was manure (urine and feces) from dairy cattle, the same material that is flushed into wet processes on California dairies.

*Manure Source:* Based on a 7/5/2005 discussion with Dr. Hobbs, the animal type (Holstein), size and milk production were essentially the same as for California dairies. Although the District was not able to determine the exact feed composition for the Hobbs et al dairy cattle, nutrient requirements would be the same as for the California (also mostly Holsteins) with similar milk production, so differences in diet are not expected to be a significant factor.

*Moisture Content:* The moisture content in the test studies (> 90% Moisture) was also similar to that found in the wet processes in a California dairy. (The APCO report contains a more detailed discussion of the impact of moisture content)

*Acidity/Alkalinity:* The pH of the test slurries was 7.1, which is very similar to the pH of wet dairy processes, as reported to the DPAG by California Scientists.

*Temperature:* The temperature of the slurry in the Hobbs et al study was 59 degrees F. This is very similar to the average temperature of San Joaquin Valley wet dairy processes, which is approximately 61 degrees F.

In summary, the Hobbs et al test conditions were very reflective of the “climate, feed, and manure management” on California dairies.

For dry dairy processes (e.g., manure that is excreted and falls into dry exercise pens), in the absence of valid California data, the VFA emission factor was based on data from Koziel et al summertime studies of Texas feedlots (See Appendix 13). Climate, feed, and manure management conditions between the Texas feedlots and California dairies were also carefully compared.

*Climatic Conditions:* As detailed in the APCO report, manure moisture content is a key factor in VFA emissions. Koziel's studies were based on very dry summertime conditions, when minimal VFA emissions would be expected. The San Joaquin Valley climate also includes wet foggy seasons when manure moisture contents would be higher and the manure would remain moist longer, and higher VFA emissions would be expected. Therefore, because of the differences in climatic conditions, the Koziel data would be expected to underestimate VFA emissions from California dairies.

*Feed:* As noted in the APCO report, comments from Dr. Deanne Meyer, a dairy researcher from U.C. Davis, indicated differences in starch contents in the feed for feedlot cattle may have resulted in higher VFA emissions in the Koziel et al study than would be expected at California dairies. Because the APCO did not want to overestimate California dairy emissions, the VFA emission rate was adjusted downward by a factor of eight to reflect the differences in diet as described by Dr. Meyer.

*Manure management:* Manure management practices were not found to be significantly different to those in California dairies. Although the stocking density was found to be higher in the Texas feedlots than in California dairies, because dairy cattle are larger and eat more, the deposition rate of manure per unit area was not significantly different. Other manure management processes were also found to be similar. The manure is deposited directly onto the lot surface in both the California dairy dry areas and the Texas

feedlots, and the manure is removed by a dry scraping process in both cases. So, the manure management practices were found to be essentially the same

In summary, the adjusted Koziel et al data, as used in the APCO report, was also found to be reflective of the "climate, feed, and manure management" on California dairies.

**18. Comment:** *The chemical composition of the substrate fermented determines the type of bacteria and as a consequence the VFA production (quantity) and its chemical composition (e.g. acetic, propionic, butyric, etc.) The manure chemical is related to chemical composition of feed, for example, considering only one feed, a typical diet for lactating animals in the United Kingdom is based on grass silage. This is forage with high Nitrogen content and relatively low energy concentration. Meanwhile the main forage to produce milk in the central valley in California is corn silage, which is forage characterized as low nitrogen, high energy content. In terms of chemical composition different feeds will produce different manure, and its fermentation will produce different end products.*

**Response:** Although the overall diets of Holstein cows of similar size and milk production would be expected to be similar, the District agrees that there are differences in diet (even within California), and that these differences in diet may have some impact on emissions. Because the non-fiber carbohydrate content for corn silage is higher than for grass silage, higher VFA emissions might be expected from the California cows that are fed corn silage than the Hobbs study predicts. For California cows that are fed alfalfa silage, on the other hand, less difference would be expected. Future research may help us further refine our emission factors, which are based on the best data currently available, to account for these differences in diet.

**19. Comment:** *These (Mitloehner and Hobbs VFA studies) laboratory studies were not designed to produce an emissions factor for VFAs for California dairies. For example, the British study (Hobbs et al) measured VFA's only from stirred manure slurry in a small container and as such it does not form a sufficient basis for calculating an emissions factor from California dairies.*

**Response:** On the contrary, the work plan provided by Dr. Mitloehner to the District specifically indicates that those VFA tests could be used to create an emission factor (See Appendix 24). Although the Hobbs et al tests were not specifically designed to create an emission factor for California dairies, a careful comparison of test conditions to the conditions in wet processes in California dairies (see Response to comment 17 above) shows the data are very applicable to California dairies. The test temperature, material type, pH, manure source, and moisture contents are practically the same as for the wet processes in California dairies.



**20. Comment:** *Aside from the fact that manure slurry is vastly different from flushed manure, British dairy facilities differ substantially from California operations in areas such as basic facility design, manure collection and handling, feeding management and climate.*

**Response:** The District went to great lengths to identify the parts of a California dairy that the Hobbs and Koziel studies do well represent, and then we limited their applicability to those areas. See the report for a complete discussion of the limited applicability of Hobbs' and Koziel's work. As demonstrated in the response to comment 17 above, a careful comparison of test conditions to the conditions processes in California dairies shows the data are very applicable to California dairies.

**21. Comments:**

- *The District has not responded to the issue that the slurry in the British slurry was stirred, which is not representative of most California lagoon conditions and could dramatically affect both VFA production and emissions.*
- *The British study "stirred" the slurry to increase emissions, thus creating a worst case*
  - *This is not representative of any portion of a California dairy. No California dairy uses British-style slurry pits. The British study is not even representative of British dairies, because the laboratory experiment required the slurry to be agitated, which is not representative of how British slurry pits are operated.*
  - *The District assumes the British study is representative of the great majority of a California dairy, when it is in fact representative of no portion of California dairies.*

**Response:** Hobbs reports to the District that the slurry was "gently stirred". The wet processes on California dairies include areas where there is significantly more agitation than in the Hobbs study (on the flush lanes and at solids separation), as well as areas where there is significantly less agitation than in the Hobbs study (in the lagoon). There are two concerns with these differences in agitation levels.

*Aerobic Activity:* The first concern with agitation is that it may increase dissolved oxygen levels to a point where aerobic activity reduces VFA emissions. Neither the gentle stirring in the tests or the circulation in California wet dairy processes is expected to result in significant aerobic activity. Dr. Mitloehner indicated to the District's Agtech committee that U.C. Davis tests indicated that mild circulation in lagoons did not significantly increase oxygen levels or induce aerobic activity. In wastewater treatment plants large blowers with high energy consumption levels (more than gentle stirring) are generally required to generate the dissolved oxygen levels that promote aerobic activity. Aerobic activity is not expected to be a factor in the applicability of these tests.

*Increased Mass transfer.* The second concern is that agitation may increase mass transfer rates from the surfaces of manure particles, through the interstices of the manure particles to the liquid surface, across the gas-liquid interface, and into through the air stream, resulting in higher emission rates. While it is true that agitation rates may, in fact, to a small extent affect VFA and ammonia emission rates in this way, one must remember that Hobbs used the ratio of VFA emissions-to-ammonia emissions from his tests, and not absolute VFA emissions rates, to determine emission factors. Any minor increase in agitation rates would affect both the VFA and ammonia emissions rates similarly, and the impact on the ratio of VFA to ammonia emissions would be minimal, so the difference in mass transfer due to stirring is not expected to significantly impact the applicability of the emission factor.

**22. Comment:** *Slurry studies are not a scientifically supportable way to determine process emission factors. In addition, apportioning 60% of the VFA emission to feed lanes and lagoon is not justified.*

**Response:** Prior to using slurry studies to represent wet processes in California dairies, test conditions were carefully compared to the process conditions on California dairies. A complete discussion of the comparison of the slurry conditions to wet processes in California dairies is provided in the APCO report and the response to comment 17 above.

In response to the second part of this comment, it should be noted that the District did not apportion 60% of the VFA emissions to the feed lanes and lagoon as stated in the comment. The District apportioned 60% of the manure produced on a typical California dairy to the wet processes (flush lanes, processing pits, settling/separation systems, treatment lagoons, storage ponds, etc.). However, the District agrees that the justification for this 60% apportionment is a bit weak – a more accurate number would be 80%, according to the Regional Water Quality Control Board (see explanation of the use of Hobbs data in the Report). However, because of the known uncertainties in the data, we chose to err on the side of lower emissions, effectively reducing the expected emission rate from wet processes by 25%, and leading us to believe that the proposed VFA emissions from wet processes is likely an underestimate.

**23. Comment:** *The District suggests that while Schmidt still must be dismissed as “invalid,” Koziel’s data, with some correction, is acceptable for establishing so-called “dry” emissions from dairy corrals, or about 40 percent of dairy surface areas. But the District makes the surprising contention that a different emission factor is needed for the remaining 60 percent of the dairy, which it describes as “wet.” This “wet” portion of the dairy in fact includes freestall flush lanes, which are intermittently wet and dry, solids separation, and the retention pond.*

**Response:** As noted in the APCO report, in evaluating the applicability of the Koziel et al and Hobbs et al data to California dairies, the District carefully compared test conditions to California dairy process conditions. The adjusted Koziel data, which

was based on dry (the moisture content was reported as 8% to 15%) summertime feedlot studies, was found to represent the dry areas of the dairy such as the exercise pens. The Hobbs et al test conditions were found to represent areas where the moisture of the manure content was high including the flush lanes, solids separation, and the lagoons. Because both urine and feces are deposited and water is added during the flushing process, the freestall flush lanes emissions are best represented as a wet process.

**24. Comment:** *To support its contention that the Koziel “dry” factor is not sufficient for the remainder of the dairy, the District cites numerous studies and characterizes them as suggesting that VFA production rises in direct relationship to manure moisture content, that is, the wetter the manure the more VFAs are produced. In fact, the District’s is not an accurate characterization at all. What the studies in fact suggest is that moisture is necessary for VFA-producing bacteria to survive and remain productive, and that as manure dries out, bacterial activity decreases but VFAs are released with moisture as it evaporates. However, high amounts of maintained moisture also suppress the ability of VFAs to evaporate. In the case of lagoons, dilution is so high and conditions so anaerobic that methanogens – which produce methane, not VFAs – preferentially convert dissolved solids to methane. In simple terms, the conditions that exist on a typical California dairy actually discourage VFA production, by separating solids and drying them out, thus discouraging further VFA production, or by submerging the dissolved solids in highly diluted form, suppressing VFA formation and evaporation. Thus, the District’s contention that we must expect higher VFA production from this so-called “wet” system is not supported, and is based on a serious misinterpretation of the cited studies.*

**Response:** The APCO agrees with the commenter’s assessment that moisture “is necessary for VFA-producing bacteria to survive and remain productive.” However, what the District actually indicates in the report, after carefully comparing test conditions to dairy process conditions, is that the wet processes in California dairies are best represented by the Hobbs et al studies in which wet manure was tested under conditions very similar to those in the wet California dairy processes; and that the dry processes in California dairies are best represented by the adjusted data from the Koziel et al study, in which dry feedlot areas similar to the dry areas in California dairies were tested. The District has not seen any test data or other evidence to suggest that “by submerging dissolved solids in highly diluted form”, the VFA emissions rates in dairy wet processes can be reduced to a level significantly lower than the Hobbs et al test results indicate.

**25. Comment:** *...the largest error the District makes is in its use of the Hobbs et al study to suggest a surrogate emission factor for these so-called “wet” systems. In the Hobbs study, liquid manure was removed from a slurry pit beneath a barn at a British dairy – no comparable manure management system exists in California – and was placed in a bathtub-sized tank in a laboratory. The slurry was then agitated and VFA concentrations measured in the head space above the slurry. No data*

*necessary to calculate an emission factor were collected; instead, assumptions were made about VFA-to-ammonia ratios based on British ammonia emission factors. Even if the slurry were representative of some part of a California dairy, it could not be used as a surrogate for all parts of the flush system, which varies greatly as it moves from freestall flush to solids separation to the lagoon itself.*

**Response:** As noted in the APCO report, the District carefully compared the actual test conditions to those of the wet processes at California dairies, and found that the test conditions matched those in the dairy wet processes remarkably well, far better than the other valid VFA emissions study, the Koziel et al study, which was used to represent the dry processes.

**26. Comment:** *The VFA emission factor from Hobbs relied completely on a single ratio of ammonia to VOC emissions, which is not consistent with scientific understanding of decomposition biochemistry and dairy process conditions. The paper itself states “we did not find significant correlation between NMVOC emissions and ammonia emissions for the dairy cattle slurry in their studies, as the former were too low.”*

**Response:** As noted in the response to comment 24, the test conditions in the Hobbs study were remarkably similar to the process conditions in the wet processes at California dairies; and with the same materials and conditions, the same decomposition biochemistry would be expected to occur.

In the peer-reviewed paper in the *Journal of Science of Food and Agriculture* in which Dr. Hobbs used the data from his dairy slurry studies to generate emissions factors, he did state “we did not find significant correlation between NMVOC emissions and ammonia emissions for the dairy cattle slurry in their studies, as the former were too low.” As noted in our report, this in no way indicates that the expected relationship does not exist, it only indicates that Hobbs did not have the data from these necessarily limited studies to demonstrate the correlation. Hobbs certainly believed it to be valid when he used the correlation, which had been statistically demonstrated for other manures, to create dairy cattle emissions factors. For the reasons described in the previous paragraph, the District also believes that the correlation is valid as it was applied. It should also be noted that other researchers reviewed in this effort also did not statistically validate all underlying correlations in their studies, and that their data was not rejected on that basis.

**27. Comment:** *The Hobbs data and emissions factor methodology have been used without any review under guiding principle #2*

**Response:** The Hobbs data was also reviewed, and none of the deficiencies cited under guiding principle #2 were found. Under guiding principle #2, indications of invalid data include:

- Sample contamination
- Potential for loss of analyte during sampling

- Improper sample storage
- Potential for loss of analyte during testing
- Miscalibration or calibration drift
- Failure to follow appropriate protocols
- Other uncorrectable errors

In Dr. Hobbs' peer-reviewed article from the *Journal of Science of Food and Agriculture*, an acceptable variability of plus/minus 20% was noted in values below 10 g/m<sup>3</sup>-day and plus/minus 5% for higher measurements. The analytical methods, GC/MS with thermal desorption and a mass selective detector appears appropriate. Several of the deficiencies that might indicate data were invalid (losses during sampling, storage, or analysis) would result in underestimation of emissions. There is no reason to believe that any deficiency that might result in overestimation (contamination or calibration drift) occurred.

**28. Comment:** *Pain et al. attribute only 17% of ammonia emissions to storage (stirred slurry pits and lagoons), with 55% attributed to land spreading and grazing. However, Hobbs applied study ratio to all ammonia emissions.*

**Response:** The APCO reviewed Hobbs use of ammonia emissions from the Pain et al study and found Hobbs application of the ratio in the Pain study to be correct. As noted in the Pain et al report, the majority of British cows are "housed in naturally ventilated buildings and wastes are managed as slurry". Although only 17% of the ammonia emissions are from storage, the slurry VFA to ammonia ratios are also directly applicable to emissions from all British wet dairy processes including storage and land spreading, which represents over two-thirds of the ammonia emissions from specific farm sources. The majority of the housing manure, which represents 28% of the total emissions is also expected in a slurry form as the animal health and welfare regulations in BS 5502 part 40 require that slurry be scraped out of housing passageways and taken to the storage twice per day. According to Pain et al., only 5% of the emissions occurred during grazing, which may at some times be a dry process. However, even in the small percentage of manure deposited during grazing, the moisture content could be fairly high in Britain, with 20 to 40 inches of rain per year. The vast majority of the dairy manure in the U.K is in wet processes, so applying the slurry VFA to ammonia ratios is expected to give a reasonable estimate of VFA emissions for British dairies.

For California dairies, however, only 60%-80% of the manure is captured in wet processes, so the Hobbs data only applies to that portion of the California dairy, as noted in the APCO report.

**29. Comment:** *It is clear that the Hobbs paper is of limited value to us. It does identify that VFA do come from manure slurry in a chamber setup. This is valuable and already understood. However, applying scientific numbers from the Hobbs study to California conditions raises several red flags.*

*Hobbs et al., 2004 made four assumptions in their work:*

- 1. Emissions from manure from grazing and housed livestock are the same as those determined from a stored manure surface*
- 2. Aging waste has a similar reduction in emission rates of NMVOC to that for ammonia*
- 3. Emissions of ammonia, NMVOCs, and odors from manure are a result of decay processes of organic matter*
- 4. Stored solid manures has similar ammonia and NMVOC emissions to those of liquid manure (2-8% dry matter)*

*For the first assumption to be true, grazing and housed animals would need to consume the same diet. Nutrient amounts consumed on a daily basis effect manure composition and subsequent decomposition and decomposition intermediary metabolites. N excretion from cattle can vary by 15-20% based on diet. This potential will alter N emission in the manure system and is not necessarily linked to NMVOC emissions. Evidence is not presented to support assumptions 1,2, and 4. In fact, the manuscript specifically says in 1418 column 2 "We did not find a significant correlation between NMVOC and ammonia emissions for dairy cattle slurry as the former were too low." If in fact the NMVOC emissions are from enteric or feed sources, one does not anticipate that there would be a high correlation between NMVOC and ammonia. The emissions of ammonia in a short-term study is predominantly assumed to be from hydrolysis of urea with only very small amounts coming from the feces. Over time, breakdown of organic nitrogen can yield ammonia. There may be some isolated cases where emissions within a facility or location are correlated. However, ammonia emissions from manure is highly diet dependant.*

**Response:** The commenter state that "*Evidence is not presented to support assumptions 1,2, and 4.*"

*With regard to Assumption 1:* The commenter noted that, "For the first assumption to be true, grazing and housed animals would need to consume the same diet." Variation in diet and the impact on the VFA to ammonia emissions ratio was discussed in the APCO report. The District agrees that variations in diet may result in 15% to 20% variation in Nitrogen excretions. However, the fact remains that no other valid data exists to represent these wet dairy processes, and a possible error of 15-20% in data used to generate an emission factor, does not make the data invalid. Because of the limited availability of research data and other factors, uncertainties of this magnitude in air pollution emission factors are common.

For the reasons described in detail in the response to the previous comment, the District believes that although emissions from manure from grazing and housed livestock are not exactly the same as those determined from a stored manure surface, the District believes there is enough similarity for the VFA to ammonia ratios to be expected to give a reasonable estimate of VFA emissions.

*With regard to assumption #2:* The District agrees with the commenter that the mechanisms for ammonia emissions may vary somewhat with time (as do VFA emissions), and that longer term studies may provide additional data to help us develop a more refined VFA emission factor. However, we think the impact of this variation on the overall emissions would be small since Hobbs made measurements over a period of three full days, and both the ammonia and VFA emissions have been found to decrease significantly over the longer term. Future studies that look at the long-term variation of emissions with time may help us further refine our emission factor.

The issue of the correlation of VFA and ammonia emission rates for dairy manure is addressed in detail in response to comment #26.

*With regard to assumption #4:* The District believes Hobbs is correct in his assumption that “*Stored solid manures has similar ammonia and NMVOC emissions to those of liquid manure (2-8% dry matter)*”. Hobbs collected manure slurries and tested them under conditions very similar to that of the manure storage process he intended to represent, so similar ammonia and NMVOC emissions would be expected. Although this assumption will be important for some manure as Pain et al indicates, the manure is managed as a slurry so it is not relevant to the validity to the use of Hobbs.

The District can not use “zero” when in fact the District know there to be significant emissions and data exists that allows us to quantify it.

**30. Comment:** *For the Hobbs study, measuring VFA emissions off of the headspace would lead to a very high estimate of emissions.*

**Response:** The emissions rates in the Hobbs study appropriately calculated the increase in concentration in the 40 m<sup>3</sup> environmental chamber over time. With no VFAs going into or out of the chamber, the emission rate would simply be the product of the increase in concentration per unit time and the chamber volume. Even if the concentration measurements were high or low (and there is no reason to think they were), the results would not be biased, because it was the ratios of measured VFA to ammonia emission rates, and not the concentrations, that were used to calculate emission factors.

**31. Comment:** *Commenter disputes the statistical analysis of the correlation between NMVOC emissions and ammonia emissions in Appendix 22 of the draft report. The commenter indicates: 1) that the low emissions values in the Hobbs study do not affect the population coefficient of correlation, noting that lowering values by changing units, for example, does not change the population coefficient of correlation; 2) that the uncertainty in the dairy cattle slurry tests was significantly higher than for poultry test; and 3) recommends that the Hobbs data should be removed and the result should be in a dairy VOC emission factor of 13.4 lbs VOC/hd/year, in accordance with guiding principles 5 and 6.*

**Response:** Although the commenter is correct in noting that simply changing the units in an experiment will not change the population coefficient of correlation, the reason the population coefficient ( $\rho$ ) does not change with changes in units is because such changes have the same impact on the numerator of the calculation ( $C_{xy}$ ), as in the denominator of the calculation ( $\sigma_x \sigma_y$ ).

$$\rho = C_{xy} / \sigma_x \sigma_y$$

Converting from inches to feet, for example, would reduce both the numerator and denominator by a factor of 144, and not change the resulting coefficient. In real world chemical testing, however, attempting to measure smaller quantities does have an impact on the level of correlation that can be determined. When smaller quantities are measured in chemical tests, the variation in these measurements (as represented by  $\sigma_x$  and  $\sigma_y$ ) represents a greater portion of the quantity measured. The measurement values in the numerator used in calculating the coefficient are reduced when smaller quantities are measured, but the factor in the denominator ( $\sigma_x \sigma_y$ ) is not reduced proportionally, resulting in lower correlation coefficients. It is, in fact, more difficult to statistically demonstrate correlation when the measured values are lower. (Dr. Hobbs, in his 7/5/05 conversation with District staff, stated that he believed more test runs would be required to demonstrate the correlation.)

The commenter also noted that, contrary to the language Appendix 22, that the level of uncertainty as a percentage of the measured values for dimethyl sulfide tests in poultry tests (approximately 35%) is significantly less than the level of uncertainty as a percentage of the measured values for VFAs from dairy slurry tests (approximately 50%). The District agrees with the commenter that this difference could be viewed as significant and will remove the statements that the "VFA data from the dairy studies was not significantly less accurate than the VFA data from poultry studies" and that "the reported level of uncertainty as a percentage of the measure value was similar between the two test", from Appendix 22.

The District disagrees with the commenter's contention that the use of the Hobbs data is in any way inappropriate in the absence of a statistically demonstrated VFA to ammonia correlation, or that it violates guiding principle 5 or 6. Although Dr. Hobbs did state that "we did not find significant correlation between NMVOC emissions and ammonia emissions for the dairy cattle slurry in their studies, as the former were too low." As noted in our report, this in no way indicates that the expected relationship does not exist, it only indicates that Hobbs did not have the data from these necessarily limited studies to demonstrate the correlation.

Guiding principles 5 and 6 indicate that "NA" or "TBD, >0" should be reported when no valid source quantitative data that can be linked to dairy processes is available. These principles do not require, however, that every underlying correlation must be demonstrated statistically in every study. (In fact, the District doesn't believe this was accomplished for any study we reviewed.) Principles 5 and 6 only require that valid



source of quantitative data be used to develop emission factor values. For the emissions from wet dairy processes, the Hobbs test data does provide valid quantitative non-zero data, and the applicability of the data to dairy processes has been well-documented by comparing the actual test conditions to those of California dairy processes. It would not be appropriate or consistent with any guiding principle to call those significant quantities of VFA emissions zero.

**32. Comment:** *Air emissions scientists are in near-unanimous agreement that the Hobbs study is useless in determining any kind of emission factor for California dairies. We incorporate by reference numerous letters provided to the District on or about the time of the July 11, 2005 workshop.*

**Response:** On the contrary, many scientists were fully supportive of the use of the Hobbs study in estimating VFA emissions, as shown in the statements below:

David A. Grantz, PhD stated, *"...I believe that the slurry studies reported by Hobbes et al. do provide a strong indication that VFAs are significant components of the emissions from wet dairy manure. Most of the waste on a California dairy (both Viewpoint 2 and your draft report assume 60%, though this may be higher) is handled in a wetted condition. The Hobbs data, which were peer reviewed and were explicitly used by the authors to calculate an emission factor, provide a number that can be used as an estimate for emissions from this aspect of California dairies. As noted, it is unlikely to be exact. In the semi-quantitative mode in which I would prefer to use these data, small adjustments for temperature of the slurry and starch content of the feedstuff, become relatively minor...At this time it does not appear prudent to accept an estimate much lower than the Hobbs et al. without concrete data to support it. No other acceptable data for VFA emissions from wetted manure have been presented."*

Michael Byers, PhD, stated, *"VFA's are major components of odors on dairy enterprises, as well as being VOC's, and are found in sources throughout dairies – fermented feeds, cows, moist wastes. The approaches used in the current report make common sense, and capture the essence of feed bunk, ruminal (cud chewing), anal gases, and moist waste handling VFA-emissions...The current estimates of enteric and waste sourced VFA-VOC emissions provides an excellent starting point and a defensible base for further refinement."*

James Morris, PhD, P.E. & David Mager stated, *"We agree with the APCO (page 19) that the temperature and moisture conditions of Hobbs emulate those found on flush dairies in the Central Valley."*

John Shears, a visiting research fellow stated *"Numerous, peer-reviewed journal articles indicate that VFAs can constitute a significant portion of the total VOC emissions released by dairies. Because VFAs have not been addressed in the California research, the APCD has had to rely for its VFA data on the study by Hobbs et al. while this study was conducted in England, it is the best source of*

*information currently available on the contribution that this important constituent can make to the total emissions of VOCs.”*

### **33. Comments:**

- *While the Hobbs study itself is flawed and is not representative of actual emissions from even British dairies, the District further compounds the errors by failing to follow its own “guiding principle” 3(a). This principle suggests the APCO shall carefully consider meteorological conditions, manure moisture content, feed, etc., when considering out-of-state data. The startling differences in British climate (the U.K. dairy tested by Hobbs is at approximately the same latitude as Alaska) and California feed (primarily corn silage and commodities) versus U.K. dairy feed (grass) were substantially ignored in the June 27 report. The report fails to support the startling contention that the 19th century manure management technology used in British dairy barns (feces and urine drops through slots in the floor where it is stored in a pit for up to six months) is comparable to the daily flushing of concrete lanes, solids separation and anaerobic treatment lagoons used in California dairies.*
- *The District’s proposed emission factor for process emission VFAs lacks adequate scientific basis*
  - *The District uses an unrepresentative British laboratory study to determine emissions of 7.2 pounds from “wet” processes on dairies*
    - *The study used material from a “slurry pit” at a British dairy as the test material. California dairies do not use British-style slurry pits.*
    - *Manure management at California dairies is entirely different than the below-barn slurry pit systems used on British dairies.*
    - *Because of these differences, material gathered from a British slurry pit has substantial, important differences from California freestall/flush/separator/lagoon systems.*
  - *The study could not be expected to produce an accurate emission factor for even British dairies*
    - *Even if the emissions estimate from the British study were accurate, the District fails to take into account the extreme difference in climate between California and Britain, where cattle are housed for several months per year to avoid inclement weather*

**Response:** The District does not agree that the Hobbs study is flawed, or that we misapplied guiding principle 3(a). The test conditions in the Hobbs laboratory were carefully compared with those in California dairies as noted in the report. The District did not ignore differences in meteorology, moisture content, or diet. For wet processes, of course, the key “climate” related issue is temperature, and the temperature in the Hobbs laboratory study closely matches the average temperature in the California wet processes remarkably well. Potential differences in diet were also considered. While difference in diet may have some impact on VFA emissions, the fact that British dairy cattle may eat more grass, with lower non-fiber

carbohydrate content; and less corn silage, with a higher non-fiber carbohydrate content, would be likely to result in a low, rather than high, estimate of VFA emissions. With additional research, the District may be able to further refine the emission factor to account for these types of differences. In summary, the District believes that, in the absence of valid California VFA test data for wet dairy processes; the comparisons of the manure sources, test temperature, moisture content, and pH fully support the use of the Hobbs data for wet California dairy processes.

**The following comments were made regarding the use of Mitloehner data:**

**34. Comment:** *The most compelling problem here is that Dr. Mitloehner, the lead researcher in the study, has stated repeatedly that the District is misusing and misinterpreting this data. Other scientists also noted serious problems with using this data. Dr. Julia Lester put it best in her letter of July 11:*

*"It is not standard practice to accept test results that have been disavowed by the tester and that have been presented without appropriate blank, null case (empty chamber) and inlet measurements."*

**Response:** Dr. Mitloehner has asked us to clarify that the APCO found the problems with his VFA data to be correctible, and we have done that in the report. The APCO strongly disagrees with Dr. Lester's quote, on two fronts. First of all, the test results were never "disavowed" by Dr. Mitloehner. As stated above, he has asked the District to clarify that we have found the issues with his data to be correctible; he has not said that his data is invalid. In addition, contrary to Lester's statement, Dr. Mitloehner's own work plan submitted to the District claimed that his VFA data COULD be used to generate VFA emission factors. The District analyzed the data, and agrees with Mitloehner's work plan. See the report for the complete discussion.

In addition, many scientists fully supported the use of Dr. Mitloehner's data as shown in the statements below:

David A. Grantz, PhD, stated " ...All measurements indicated high concentrations of VFAs (range 185-515 ppb) with an average of 350 ppb. I believe that these data are much better and more instructive than Dr. Mitloehner believes them to be. The major limitation of the chamber studies was absence of an inlet concentration. While the most likely inlet concentration of VFAs is 0 ppb due to the presence of a HEPA filter at the inlet, and the stickiness of VFAs reported to the DPAG, a more conservative approach was developed for determining inlet concentration, semi-quantitatively, using available data... In your draft report, you have chosen to use this method, and to incorporate a VFA emission component calculated in this way. Although viewpoint 2 did not include this value, I believe that it is reasonable to do

so. These are data collected using appropriate techniques under California dairy conditions.”

Michael Byers, PhD, stated, “*VFA’s are major components of odors on dairy enterprises, as well as being VOC’s, and are found in sources throughout dairies – fermented feeds, cows, moist wastes. The approaches used in the current report make common sense, and capture the essence of feed bunk, ruminal (cud chewing), anal gases, and moist waste handling VFA-emissions... The current estimates of enteric and waste sourced VFA-VOC emissions provides an excellent starting point and a defensible base for further refinement.*”

James Morris, PhD, P.E. & David Mager stated “*We agree with the APCO’s (page 17) in utilizing the data from Mitloehner and making adjustments for the lack of analyzing the inlet gas.*”

**35. Comment:** *The project scientists involved in the chamber studies at UC Davis have completed the analysis of all compounds and a full report will be released in September 2005. The results are shown below:*

- *A mid lactating cow produces 299.54 lbs/cow/yr of total organic gases,*
- *99.36 % of the TOG is methane (297 lbs/cow/yr),*
- *No ethane was detected,*
- *0.54% of the TOG is reactive (equals 1.63 lb/cow/yr) and is considered reactive VOC,*
- *0.04 % of the TOG is acetic acid (using PTR/MS)*

*Our final data suggest that the numbers that I reported in April for VOCs were somewhat higher. As I stated during the April meetings, we intentionally and conservatively erred on the high side with our preliminary report. The most common VOC we have found (aside from the nonreactive acetone) were methanol, acetic acid, dimethylsulfide, and trimethylamine. These made up about 74% of the total VOCs.*

**Response:** Based on the new information provided above by Dr. Mitloehner (see Appendix 26), the APCO has revised the emissions from this category (Category 1: Emissions from Cows and Feed in Environmental Chamber (Except Volatile Fatty Acids)) from 2.7 lbs/hd-yr (based on previous data from Dr. Mitloehner) to 1.4 lbs/hd-yr. The calculation of the change is shown below:

Since VFAs have been quantified elsewhere, acetic acid will be subtracted out from the 1.63 lb/hd-yr emissions.

$$1.63\text{lb}/\text{hd} - \text{yr} \times (1.63\text{lb}/\text{hd} - \text{yr} \times 0.04) = 1.56\text{lbs}/\text{hd} - \text{yr}$$

Since other VOC tests by Dr. Mitloehner using EPA Method TO-15 had shown that emissions from fresh excreta in the test chamber represented approximately 10% of emissions, the 1.56 lbs/hd-yr will be adjusted downward by 10% to 1.4 lb/head-yr, to obtain a value for enteric and feed emissions without the excreta.

**36. Comment:** *The District's proposed emission factor for VFAs (ie acetic acid) from enteric fermentation (based on extrapolated data from my study) is approx. 64 times higher than the highest concentration we have measured with the PTR/MS. The discrepancy between both methods (derived from the same study) highlights the great level of uncertainty with respect to quantification of VFAs. In my view, this uncertainty can be addressed by conducting additional VFA studies designed specifically for the purpose of emission rate quantification,*

**Response:** The District would expect the variability, as Dr. Mitloehner states in his letter dated July 25, 2005 (Appendix 26) that "the PTRMS results must clearly be taken as a lower limit on the acetic acid fluxes". Acetic acid was detected and quantified "despite the fact the PTRMS was not optimized for VFA analysis" and despite the "difficulties in detecting VFAs with the PTRMS due to their stickiness, or tendency to adsorb or condense onto surface." Dr. Mitloehner continues on to say that "this is a typical problem for many analytical systems, and the PTRMS is generally superior over most other systems due to the extensive use of Teflon surfaces in contact with the sample and short residence times in the plumbing. VFAs are partly removed in the chamber tubing and plumbing before actually reaching the PTRMS." Based on this, it is very possible to expect the high variability between the two types of VFA measurements (PTRMS compared with sorbent tubes).

**37. Comment:** *It appears that the California researchers have become advocates rather than researchers – Mitloehner also argued against using the 12.8 lb-VOC/head-year number three or four years ago, and is now attacking Hobbs study. Scientists need to be objective.*

**Response:** The District made no effort at this time to either confirm or refute the allegations in this comment.

**38. Comments:**

- *The use of the VFA concentration data from Mitloehner et al. study to arrive at an emission factor for enteric fermentation is scientifically invalid because vital information for the emission factor is missing (background concentration) and breakthrough issues occurred.*
- *Although the District has attempted (to correct) for the lack of the inlet measurements, the fact remains that other measurements, such as of the empty chambers was not conducted for the Mitloehner study. It is not standard procedure to accept test results that have been disavowed by the tester and that have been presented without appropriate blank, null case (empty chamber), and inlet measurements.*

- *The District “created” the necessary additional data to perform calculations through a series of assumptions which are, in effect, “guesses.”*
- *The analysis at the bottom of page 17 of the draft report indicates that you have attempted to use the VFA relative concentration data collected from the Mitloehner study to derive total VFA emission data for enteric fermentation from cows. You attempted to correct perceived deficiencies in our study, specifically the absence of inlet data. While I can appreciate the interest in attempting to make use of existing data, I am not able to conclude that application of the ratio of inlet and outlet data from other VOC compounds measured in our study can be used to predict inlet concentration for the VFAs due to their completely different chemical nature (especially polarity, water solubility, and reactivity).*

**Response:** The above comments address the APCO's use of Dr. Mitloehner's VFA tests to quantify the VFA emissions from cows and their feed troughs. In particular, the following issues have been raised:

- No inlet (background) data was available. The APCO found the lack of inlet data to be a correctible problem. Dr. Mitloehner presented inlet/outlet results of several VOC compounds simultaneously with his release of the VFA data. The inlet-to-outlet ratio was very similar for every one of those known VOCs. The APCO finds it very reasonable to assume that the inlet/outlet ratio for VFAs is similar, or smaller, to these other VOCs. If smaller, which the likelihood of is discussed in the report, this correction can only underestimate VOC emissions.
- Breakthrough occurred. It is true that Dr. Mitloehner reported that some VFA sorbent tubes became saturated with VFAs, or were channeled (such that VFAs passed through without being adsorbed), and that breakthrough occurred. However, breakthrough can only result in an underestimate of emissions, because the VFAs that escaped were not measured.

The net result is that the APCO found the potential problems with the Mitloehner data to be correctible, and further found that the corrections would tend to underestimate emissions. Since the District is certain that the emissions exist, we cannot call them zero, so we must use the Mitloehner data.

### **39. Comments:**

- *None of the viewpoints in the DPAG final report recommended an EF based on Dr. Mitloehner's VFAs from enteric and feed emissions. To use unreleased scientific data without the concurrence of the principle researcher directly contradicts scientific protocol and tradition.*
- *For now, the commenter (Dr. Mitloehner) requests that the following clarifications be made to the discussion of our study on page 17 of the draft study, under the subheading; “Enteric and Feed VFAs”*

*“Dr. Mitloehner and his collaborators from USDA-ARS and ISU measured VFA emissions from dairy cows, feed, and animal excreta for the purpose of determining the relative concentration of VFA components. ... Although Dr. Mitloehner and his collaborators advised the DPAG and the APCO that the use of the VFA concentration data is scientifically invalid for determination of an emission factor because of the variation in the data and the fact that inlet measurements were not performed, the APCO determined that the lack of inlet VFA data was a correctible problem.”*

**Response:** The report will be updated to include a specific reference that the APCO found the lack of inlet data to be a correctible problem, as Dr. Mitloehner requests.

**40. Comment:** *The UC Davis research team and other scientists have said the District calculations have no scientific basis*

**Response:** The District is not aware of any scientists that state our calculations have no scientific basis.

**41. Comments:**

- *The VFA subset data from the preliminary work done by Mitloehner, resulted from a “scoping” exercise to determine the relative concentration of the various components of VFA; it was not designed to accurately determine total VFA emissions or used to arrive at an enteric VFA emission factor. This analysis should be relied upon only to demonstrate the proportion of various components of VFA, for example, that acetic acid constitutes the vast majority of VFA.*
- *These (Mitloehner and Hobbs VFA studies) laboratory studies were not designed to produce an emissions factor for VFAs for California dairies.*
- *It is important to note that when the VFA study results from Dr. Trabue’s and Dr. Koziel’s laboratories are released, they will not provide a sufficient sound basis for an EF. Using assumptions drawn from emission data from studies of other VOCs as a substitute for such specifically designed studies is not, in my view, scientifically reliable.*
- *The District uses preliminary, partial data from the University of California, Davis as a basis for its VFA calculations.*
- *The UC Davis research team reported no emissions factor for VFAs and instead said that the data was not sufficient for calculating an emission factor.*

**Response:** The above comments each claim that the Mitloehner VFA testing, which the District relied upon to determine emissions of enteric VFAs, cannot be used to determine an emissions factor. While the APCO has explained above why

we believe we can and must use the data, we must also point out that, contrary to statements of the principle investigator and others, Mitloehner's VFA sampling was intended to be used to develop VFA emissions rates. Appendix 24 of the report is a copy of the relevant work plan, prepared by Dr. Mitloehner and his collaborators. Page 5 clearly states that the data is to be used "...to estimate emission rates of VFAs from dairy cattle."

**42. Comment:** *For Category 1 of the draft report, "Enteric", emissions (measured from Cows and Feed in an Environmental Chamber), is based on a "TO-15" analysis known to miss a number of important VOCs. Some of those VOCs were measured by alternative methods and should have been included in this factor, and some, such as ethanol, were missing entirely.*

**Response:** The category 1 "enteric" emissions are actually based on Dr. Mitloehner's subjective interpretation of the relative "peaks" from Dr. Goldstein's PTRMS tests, not from TO-15. However, the APCO agrees that ethanol was entirely missed, and for that reason we suspect that the estimate is an underestimate. However, in the absence of data with which to correct the shortcomings of the test method, we are unable to make an estimate of how much of an underestimate to expect, so no correction was attempted.

**43. Comment:** *The existing data from California facilities is a good start to identify emission sources, but the projects suffer from insufficient scoping prior to sample collection to identify all compound families of importance in the emissions estimate. One must use incredible caution when attempting to assemble literature values from around the world into a process based emissions estimate specific to California dairies.*

**Response:** The District agrees that California studies are a good place to start, and we believe we have used all possible relevant California data. We also stated repeatedly in our report that the various California tests that we used to arrive at an emissions factor came up short in identifying all possible compounds, and so we believe that the results are an under-estimation of dairy VOC emissions. That is why we looked elsewhere for data, and carefully analyzed the transferability of the data, as is thoroughly discussed in the report.

**Specific comments were received regarding the use of the Schmidt data:**

**44. Comments:**

- *For Category 2 of the draft report, Amines, is based on the Schmidt study, which is known to have a number of analytical shortcomings and only measured ethylamines. Other studies report many other types of amines from dairies, and should have been considered in this factor.*



- *While all members of the DPAG agreed on Category 3 of the draft report, VOCs from miscellaneous dairy processes, it nevertheless underestimates emissions due to the above-mentioned analytical shortcomings of the Schmidt study.*

**Response:** The District agrees that the estimate is likely an underestimate. However, in the absence of data with which to correct the shortcomings of the test method, we are unable to make an estimate of how much of an underestimate to expect, so no correction was attempted.

- 45. Comment:** *Of the California researchers, only Dr. Chuck Schmidt conducted work that was intended to establish an emission factor of a subset of VOCs known as Volatile Fatty Acids (VFAs).*

**Response:** On the contrary, Dr. Mitloehner's VFA sampling was also intended to be used to develop VFA emissions rates. Appendix 24 of the report is a copy of the relevant work plan, prepared by Dr. Mitloehner and his collaborators. Page 5 clearly states that the data is to be used "...to estimate emission rates of VFAs from dairy cattle."

- 46. Comment:** *Schmidt only attempted to measure one of the many VFA compounds Dr. Mitloehner identified in dairy emissions, and the method he employed is not suitable for VFA detection. The detector probably never saw any of the VFAs because they probably adhered to the tubing leading up to the detector. We agree with the APCO (page 16) that the detector/sorbent tube needs to be the first site the airflow comes in contact with and to base the VFA number on the detection limit of the Schmidt methodology which just looked at a single VFA compound is inappropriate.*

**Response:** The District agrees that the sampling method used in the study is not appropriate for measuring VFA emissions.

**47. Comments:**

- *If none of the projects that monitored commercial dairy operations had attempted to detect VFAs, we might have been able to accept the fact that they had been missed by all of us. However, Dr. Schmidt's study of a Merced County dairy for the CARB specifically included sampling analysis for VFAs. He detected trace amounts, but much less than other components of VOCs. Schmidt's data measured at a commercial California dairy was disregarded in the DPAG report because the sample was drawn through a short length of tubing between the flux chamber and the sampling point. While it is quite likely that the VFA will absorb on surfaces such as the inside of sampling tubes, it is going to be difficult to defend the position that 75% of the VOCs emissions were trapped in a few feet of tubing and therefore, not detected in this study.*

- *The basis for the large VFA component of the proposed emission factor is all from lab work. If field monitoring data had supported the lab simulations, the conclusions regarding VFAs would be validated. The fact that a barely detectable trace was found in the field monitoring at a California dairy makes it very difficult to accept the use of the laboratory data for such large component of the EF.*

**Response:** According to the Technical Memorandum "Results of the Dairy Emission Evaluation Using Flux Chambers" dated April 2005, VFA results were reported as not detected, Non-detect (ND). Nowhere In the report does it state there were trace amounts of VFAs measured. In the absence of VFA data from the Schmidt tests, Dr. Lester attempted to use analytical limits of detection to estimate VFA concentration (Lester VFA Emission Rate Technical Assessment - Appendix 15). Dr. Jacek Koziel (VFA researcher at Texas A&M University) stated that, "VFAs have a high affinity for adsorption to any surfaces (even stainless steel, Teflon or glass). Adsorption to tubing can result in underestimation of measured concentrations." The APCO also reviewed an e-mail from Dr. Alan Goldstein (researcher at University of California at Berkeley) indicating that " *Volatile fatty acids, phenols, peroxides... may have a tendency to condense or be absorbed by many of the materials typically used in sampling lines... Therefore, these compounds often can only be detected if at sufficiently high concentrations, and then only qualitatively, as these loss processes often do not occur at correctable rates.*" Based on these expert opinions, the APCO concluded that the non-detect values in the Schmidt Study could be the result of the expected sampling bias, and therefore, it is not appropriate to use the analytical limits of detection from these tests to estimate VFA emission factors.

Also, one statement above, that "*it will be difficult to defend the position that 75% of the VOC emissions were trapped in a few feet of tubing*", is not correct. In fact only 39%, not 75%, of the VFA emissions are being allocated to the non-enteric dairy processes, and as stated above, the scientists that have expressed an expert opinion believe that the losses in the tubing and sampling chamber cannot be quantified, and cannot be corrected for.

**48. Comment:** *Volatile Fatty Acids (VFA), is most certainly a significant underestimate as this report clearly notes. Because VFA are likely the most notable VOC emissions from dairies, and given all of the data indicating higher VFA levels, this component should be adjusted to reflect potential and probable greater emissions.*

**Response:** The District agrees that the estimate is likely an underestimate. However, in the absence of data with which to correct the shortcomings of the test method, we are unable to make an estimate of how much of an underestimate to expect, so no correction was attempted.

**49. Comments:**

- *CARB and the District sponsored source testing at a San Joaquin dairy by Dr. Schmidt, using sampling and analytical methods approved by USEPA. The District is giving no consideration to the results or implications of Schmidt's VFA testing because "the non-detect values of Schmidt could be the result of expected sampling biases..." The District cites concerns by 2 other researchers on the potential for underestimation due to losses in the sampling system, but there is no evidence that significant VFAs are lost in the USEPA approved system to the extent that the data should be considered invalid under guiding principle 2.*
- *At the same time, the District dismissed a study done on a representative commercial California dairy in Merced County, in which a researcher under contract with the California Air Resources Board – using a U.S. Environmental Protection Agency-approved sampling and analysis method – also measured process emissions of VFAs.*
- *District is assuming that an EPA-approved method would fail to detect VFAs at over 17 times the detection limit.*
- *Schmidt's work, using a U.S. Environmental Protection Agency-approved method, found no **detectable** levels of VFAs on a Merced County dairy during a 2004 study. The APCO chose to reject this study claiming it was flawed and instead supplanted this work with other data drawn from a United Kingdom study and partial, preliminary data from a UC Davis study.*
- *CARES does suggest an alternative emission factor for "Volatile Fatty Acids" of 0.7 lbs per cow per year. This number is supported as a function of the detection limit used in the Schmidt study, although it is probably an overestimate as this factor is based on the assumption that VFAs were measured at the detection limit.*

**Response:** The District believes that the sampling mechanism failed to deliver adequate quantities of VFA to exceed the detection limit of the analytical equipment. Dr. Jacek Koziel (VFA researcher at Texas A&M University) himself stated that, "VFAs have a high affinity for adsorption to any surfaces (even stainless steel, Teflon or glass). Adsorption to tubing can result in underestimation of measured concentrations." The APCO also reviewed an e-mail from Dr Alan Goldstein (researcher at University of California at Berkeley) indicating that " Volatile fatty acids, phenols, peroxides... may have a tendency to condense or be absorbed by many of the materials typically used in sampling lines... Therefore, these compounds often can only be detected if at sufficiently high concentrations, and then only qualitatively, as these loss processes often do not occur at correctable rates." Based on these expert opinions, the APCO concluded that the non-detect values in the Schmidt Study could be the result of the expected sampling bias, and therefore not appropriate to use the analytical limits of detection from these tests to estimate VFA emission factors. This deficiency in the sampling method constitutes "evidence

that sample collection procedures may have resulted in the potential for significant loss of analyte” as described in Guiding Principle 2b, and, as Dr. Goldstein indicates, this deficiency is not correctable in this case. Therefore, the Schmidt VFA data was considered invalid and rejected, consistent with Guiding Principle 2b.

Although an EPA approved flux chamber was used as the sampling device and several EPA approved test methods were used, none of these methods were specifically “EPA” approved to measure VOC emissions from dairy operations. Also, the test method used in Dr. Schmidt’s study to measure VFAs from the dairy operation was not an EPA approved method for measuring VFAs. This method was specifically designed and written for the sampling and analysis of formaldehyde in ambient air utilizing solid adsorbent followed by high performance liquid chromatographic detection.

**50. Comment:** *The District should not be invalidating one study based on principles it is not applying to another study on which it is relying.*

**Response:** The District is not invalidating any study based on principles it is not applying to other studies. The Schmidt VFA data was found to be invalid based on Guiding Principle #2 because the potential for loss of analyte during sampling of sticky VFAs with lengthy sampling tubes was well documented (Reference e-mails from researchers Koziel and Goldstein in Appendices 17 and 7 respectively.) This principle was also applied to other data sets (See response to comment 27), and the deficiencies noted in guiding principle #2 that would indicate the data was invalid were not found.

### **Specific comments on dairy emissions:**

**51. Comment:** *Most prevalent VFAs are infinitely soluble in water.*

**Response:** The District agrees that VFAs are soluble in water, but emissions of these substances still occur. Based on Raoult’s law, we would expect the partial vapor pressure of each water soluble VFA (which is a key factor in determining emission rates of the liquids in solution) to be equal to the product of the mole fraction of the VFA in the liquid and the vapor pressure of the pure VFA. In other words, for a given soluble VFA, as the concentration of the VFA increases, the emission rate also increases.

**52. Comment:** *California researchers have provided significant new data that can be used to establish an interim emissions factor of 3.1 pounds per cow per year.*

- *The work was performed by two universities and the California Air Resources Board using standard source testing methods and methodologies approved, funded and overseen by regulators.*
- *The studies were, by far, the most comprehensive research ever performed on VOC emissions from dairies, including environmental chamber studies, field*

*measurements of surface emissions from representative dairy processes and upwind/downwind sampling of air emissions.*

- *The studies went beyond standard source-testing methods to include methods that capture even more VOC emissions than the standard methods.*
- *The studies provided important, useful information for determining the main sources of VOC emissions within the dairies, a critical basis for control strategies.*
- *This emission data forms a sound basis for regulation, far superior to the current 12.8 emission factor, as it is based on measured data and allocates those emissions to processes within the dairy, providing information necessary to develop control strategies.*

*The 3.1-pound emission factor suggested above – while significantly different than the APCO's proposal – represents the only scientifically and legally supportable basis for an emissions factor at this time. It also represents a significant improvement over the current 12.8 emission factor currently in use, as such factor is not based on measured data or experiments at all and cannot be said to accurately reflect emissions from California dairies. Because the current emission factor amounts to a guess, it can't be used to determine the source of emissions from dairies, that is, whether they come from animals or waste management systems, and if the latter, which of those systems and in what amounts. As such, the existing emission factor of 12.8 pounds is limited in its utility both in determining permitting thresholds and in determining appropriate emissions controls.*

**Response:** As is clearly explained in the report, the APCO believes that our emissions factor of 19.3 lb VOC per head per year is a significant underestimate, so of course we completely disagree that 3.1 lb/head-yr is at all realistic. As is fully explained in our report, the California tests completely miss important dairy processes and important VOC components. It's ridiculous to claim that the California tests completely represent VOC emissions from dairies, and large parts of our report explain what we believe to be missing and our attempts to fill some of the gaps with other data. However, we agree that reasonable emission factors developed from the California tests and other contemporary tests is far superior to the 12.8 lb/head-yr used in the past.

**53. Comment:** *The District has claimed that the Texas factor cannot be considered to corroborate the CARES emission factor because the soil on the Texas lot was relatively dry. The District has provided no evidence to support this contention, which in fact is contradicted by both the Schmidt study and the chemical nature of VFAs, which are highly soluble in water and would be expected to emit at higher levels from drier surfaces.*

**Response:** Evidence is provided under Category 5: Volatile Fatty Acids (VFAs) of the report, which shows six studies highlighting the affect of manure moisture content on VFA emissions.

**54. Comment:** *According to Rabaud et al. (California dairy air sampling) "lagoon was not a large source of odorous compounds"*

**Response:** It is our understanding that Rabaud et al measured some concentrations but did not obtain data that could be used to determine actual emissions rates for dairy processes. Guiding principle #2 prevents us from using this study to determine an emission factor. Because lagoons often cover several acres, actual VFA emission rates may be significant even though the measured concentrations and emissions flux rates are very low.

**55. Comment:** *California researchers agreed that the work done in California over the past 3 years should have detected and identified the major sources and it is unlikely that any large component of the dairy emissions would not be indicated by at least one of these studies.*

**Response:** The District does not agree with this statement, for many reasons. First of all, the report indicates several major processes for which no emissions information has been gathered. Some of those "components" can be expected to be amongst the most significant sources of emissions on a dairy. For instance, land application is expected to be one of the most significant sources of VOC emissions, and composting of other organic matter is well known to be a very significant source of VOC emissions.

In addition, the District believes it to be a certainty that VOC "components" are missing from each of the tests reviewed. Many of the missing VOC components are detailed in our report, as are statements from one of the researches that it would be "naïve" to expect that PTRMS captured everything, and PTRMS is the most comprehensive test used to date. Finally, there is significant evidence that unspciated and unquantified VOCs do exist because every test that is performed to attempt to quantify "total VOCs" returns a very high result (from 2 times to 40 times the District's current estimate of 20.6 lb/head-yr). So far, these "total VOC" tests have been found to be suspect for a number of reasons, and the results are not used here. However, we believe that it would be premature to dismiss the likelihood that there are many unknowns about dairy VOC components and quantities of emissions, and it is completely illogical and unscientific to suggest otherwise.

**56. Comment:** *Although it was also agreed to by the DPAG in a compromise, Category 4 of the draft report regarding VOCs from lagoons and storage ponds is a major concern. Lagoons are known to emit large quantities of volatile fatty acids and phenols, neither of which were measured by any of the four California studies. We believe that the emission factor for waste lagoons is therefore vastly underestimated.*

**Response:** The District agrees that the estimate is likely an underestimate. However, in the absence of data with which to correct the shortcomings of the test method, we are unable to make an estimate of how much of an underestimate to expect, so no correction was attempted.

**57. Comment:** *Phenols are expected to exist in dairy emissions, and some literature indicates that phenol emissions are among the more significant VOC emissions from dairies. Calculations derived from the peer-reviewed Hobbs study should be used to capture non-enteric phenols as recommended in the DPAG's report viewpoint 3.*

**Response:** Because no information was provided to the APCO regarding the formation of Phenols and the relationship to diet and process conditions, the APCO chose to report the Phenol emission factor as "TBD, >0" at this time. The APCO believes that further research is needed in this area and will work with industry, scientific community, and the public to explore ways to complete this data.

**58. Comment:** *Category 7 & 8 of the draft report: Land Application, Food Storage, While data may not be available to quantify VOCs emitted from land application, feed storage, settling basins, composting, and manure disturbances, we urge you to consider using a temporary value, as we are confident that it is not zero. However, if you do decide to leave it as zero please describe what efforts your agency will pursue to quickly quantify emissions from these sources.*

**Response:** Although it is apparent that a significant quantity of VOCs can be emitted during land application, feed storage, settling basins, composting, and manure disturbance, the APCO believes that It may be premature to calculate an emission factor based on the limited amount of data regarding emissions from these sources at this time. Therefore, the APCO will consider the emissions from these sources to be of the category "TBD>0". The APCO believes that further research is needed in this area and will work with industry, scientific community, and the public to explore ways to complete this data.

**59. Comment:** *Based upon the American Society of Agricultural Engineers 2005 ASAE D384.1 numbers for per animal output and adjusting for moisture content, the baseline emissions of VOCs from composting of a cows manure would be 18.3 pounds of VOC per 1400 pound lactating cow/year – just for composting of manure - and it is listed as "TBD, > 0" in the table on page 25.*

**Response:** The District considered using this data but because the emission factor was based on co-composting (human and green waste), the APCO felt that the results were not transferable. The APCO believes this represents an underestimation and this is an area where we encourage future research.

**60. Comment:** *It is extremely troubling that a substantial portion (roughly 75%) of the proposed 20.6 IEF is based on incomplete, preliminary data and slurry study conducted outside the US and is not supported by many recognized, leading air quality scientists.*

**Response:** The use of the data is described in the report.

**61. Comment:** *75% of proposed EF is based on the type of analysis and studies that would not be accepted for determining emission factors for the permitting of sources of any other industry.*

**Response:** On the contrary, this is exactly the kind of analysis accepted for developing an emissions factor for permitting purposes on any source.

**Comments related to policy issues:**

**62. Comment:** *Non-defensible emission factors will almost certainly divert public and private resources from other, more productive, dairy control programs.*

**Response:** The APCO is obligated to determine an appropriate emissions factor for dairies and has analyzed all best available research by using guiding principles. The emission factors used in this report come from available research specifically related to dairy VOC emissions. In addition, the emission factor in this report most probably represents an underestimate of the total emissions coming from dairy operations, because in many instances there was not enough information to establish an emission factor for all parts of the dairy operation. The emission factor will be used to establish permitting levels for dairy operations in the valley and is not intended as a control measure. There will be future workshops by the District, where public participation is encouraged, to establish what types of reduction controls are best that take into consideration the overall effectiveness of VOC reductions and costs.

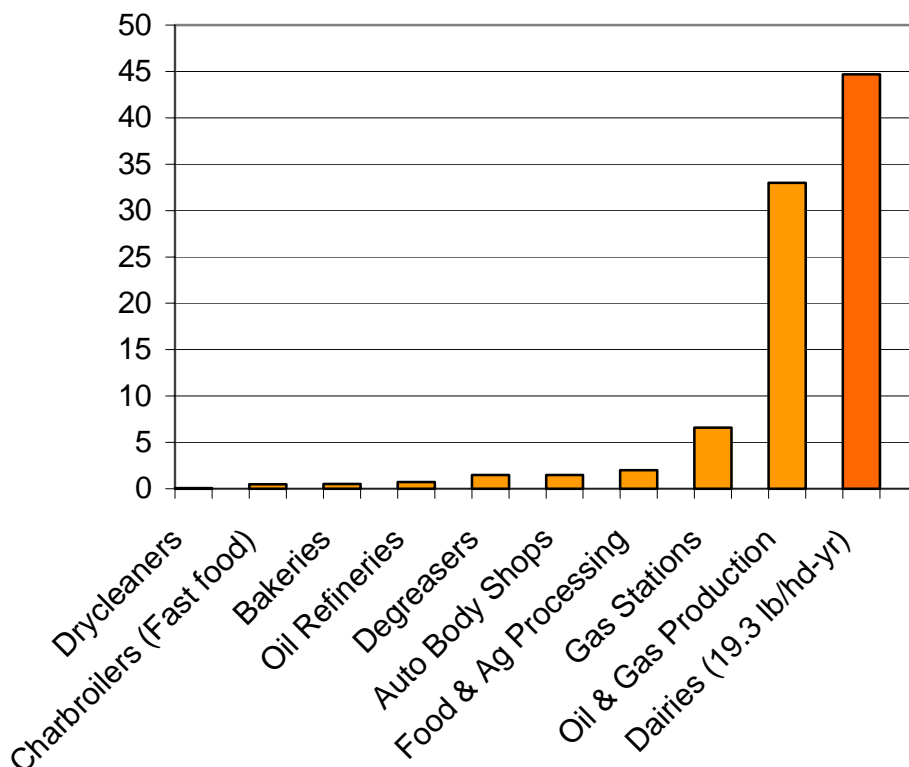
**63. Comment:** *The District should look at the overall pollution picture before passing new rules and regulations that can cause more harm than good.*

**Response:** The District has been working for over thirty years with a variety of industry in the San Joaquin Valley to effectively reduce air emissions that cause public health problems. Because most District activities are directed towards attaining health-based air quality standards in the SJVAB, protection of public health is the driver for District activities. The District develops ozone and particulate matter attainment plans to meet federal and state ambient air quality standards. In these plans, the VOC emission reductions anticipated from dairies will help our valley achieve cleaner air and is only one part of the air pollution puzzle.

The types of industries that have District permits and utilize technology to reduce air emissions include stationary sources such as dry cleaners, gas stations, print shops and oil and production, etc. Overall, dairy operations are a significant source of VOC emissions in the San Joaquin valley, and with the projected numbers of dairies coming into the valley, their contributions will be increasing. The graph below illustrates the amount of emissions stemming from various stationary sources.



### VOC Emissions (tons/day)



**64. Comment:** *In order to combat our ozone pollution it is imperative that your agency accurately quantifies ALL emissions coming from valley dairies-without dismissing available data or ignoring dairy processes, such as manure land application. It would be a disservice to the residents of this valley not to quantify ALL emissions.*

**Response:** The VOC data for some dairy processes are not currently available and cannot be quantified presently, however, the District will look towards future research to quantify emissions from dairy operations.

**65. Comment:** *The uncertainty of new regulations has created a tremendous hardship for us as we try to comply with the new regulations but have an unclear picture as to what they are. How can we comply with new regulations that have yet to be determined?*

**Response:** The District is currently in the rule development phase to develop emission controls for confined animal facilities that include dairy operations. The District strives to adopt rules that minimize administrative burden and maximize efficiency. The rule development process will allow for input from the public and will take into account the overall emissions reductions, cost effectiveness and socioeconomic impacts of the rule. Workshops for this rule are anticipated to occur in September 2005 with adoption of the rule anticipated to be complete by July 2006. The District encourages public participation, suggestions and comments during the rule development phase.

**66. Comment:** *It is irresponsible to continue to target agriculture while ignoring the larger issue at hand – emissions from automobiles and the effects of the explosive urbanization in the San Joaquin Valley.*

**Response:** As mentioned above, the District has been regulating a variety of stationary sources for a number of years. Historically, agricultural sources have been exempt from air regulation, but recent law required the District to issue permits to large dairy operations and to develop future rules. Dairy operations are one of the last large sources of VOC emissions in the air pollution puzzle.

With a variety of state and federal agencies implementing air pollution reduction programs, it can be difficult to understand the mission and jurisdiction of each organization.

Local air pollution control districts, such as the San Joaquin Valley Air Pollution Control District (District), develop plans and implement control measures in their areas. These controls primarily affect stationary sources such as factories and plants.

The federal government, primarily through the Environmental Protection Agency, sets standards, oversees state and local actions, and implements programs for toxic air pollutants, heavy-duty trucks, locomotives, ships, aircraft, off-road diesel equipment, and some types of industrial equipment.

State government, through the Air Resources Board and Bureau of Automotive Repair, sets more stringent state standards, oversees local actions, and implements programs for motor vehicle emissions, fuels, and smog checks.

Local cities and counties are responsible for implementing air friendly community planning that promotes pedestrian traffic, commute alternatives and cleaner transit fleets.

While their jurisdiction and specific programs may vary, all of these organizations share a common goal: to work cooperatively in establishing comprehensive air quality control programs to benefit all California residents.

**67. Comment:** *As you are well aware, the San Joaquin Valley is facing a public health crisis, fueled by the pollution in our air, particularly ozone pollution. Dairies have been documented, even in the District's own report, to be significant source of VOC emissions.*

**Response:** Based on the dairy emission factor in this report, dairy operations are the valley's largest combined source of VOC emissions.

**68. Comment:** *Whatever emission factor is finalized, the District should come up with pollution mitigation techniques.*

**Response:** Rule development is underway for controlling emissions from confined animal facilities. The rule will identify and apply Best Available Retrofit Control Technology (BARCT) for existing dairy operations.

**69. Comments:**

- *Discounting the use of California research data is not acceptable. The District has failed to meet the settlement agreement obligation.*
- *The terms of the settlement agreement speak to dairy emissions studies as UC Davis, Fresno State University, the California Air Resources Board, and the USDA Panel on VOCs, and instructed DPAG to use those sources when developing a VOC emissions factor. We note that you are also instructed (by the settlement) to base your determinations on the "best available science", and best available science would be the California studies because they would better represent California dairy conditions than lab bench studies in European countries.*

**Response:** The APCO agrees that the settlement requires the use of the "best available science", and the entire report provides the background as to why we believe we have indeed used the best available science. However, the settlement does not say that the California studies are the best science, nor does it limit the APCO's review to the California studies. In fact, the settlement specifically says that the APCO must discuss any other science he relied upon in developing the emissions factor, and the report and public workshop were used to do just that. As an aside, we were unable to locate any VOC emission factor developed by the USDA Panel on VOCs, so their effort was NOT a part of our analysis.

Additionally, the Hobbs report was presented to District staff at a DPAG meeting. The settlement agreement states "DPAG shall allow all parties to provide meaningful input into the manner in which the District implements its Dairy permitting program. Therefore, the DPAG and the APCO was required to consider the Hobbs study.

**70. Comment:** *Throughout the June 27 report, the District points to limitations in standard source testing methods and the individual study parameters. The District*

*fails to note that these methods were approved by regulatory agencies in the first place and are, in many cases, the same methods used for testing other sources. For example, the District has pointed out "limitations" with EPA method TO-15 for testing sources, but fails to note that the same limitations apply to using this method on any other source. More importantly, the District had every opportunity to comment and suggest alternative testing methods during the period that the studies were being developed through Fresno State University, California Air Resources Board and University of California. If the District had serious reservations with the design of the studies and the recommended (standard) collection and analytical methods, it should have suggested changes in the study designs. Unfortunately, rather than identifying these issues scientifically and proactively, the District has chosen to attempt to pick apart the studies and manipulate the results by introducing its own additional calculations, created data and assumptions, and inappropriate data from studies not representative of California dairies.*

**Response:** It is vitally important to remember that the dairy VOC tests that are being questioned here were ground-breaking work. They were, collectively, the first, intensive effort to quantify and speciate VOC emissions from dairies. At the time the relevant research was planned, the District (and the scientists themselves) simply did not have the knowledge base to make certain that the test designs were thoroughly adequate. All parties involved in the DPAG process learned enormous amounts of information about VOC emissions from dairies, and about the difficulties involved in testing for them. The District learned, largely from various of the California researchers, the limitations of the TO-15 tests (a very small subset of VOCs, designed for industrial combustion processes), the inadequacies of total VOC tests using South Coast method 25.3 (apparently errant analyses), the "stickiness" of the VFAs that limit the ease of testing, and many other dairy-VOC related facts. Because of those experiences with DPAG, all parties, including the scientists and the Air District, are better prepared to improve the design of future dairy tests to capture and measure dairy VOCs.

To insinuate that the science of measurement of dairy VOCs (or ANY science that is as rapidly evolving) could be expected to be completely understood by ANY party merely demonstrates a lack of understanding of the scientific world, as does the implication that poor science should be used, at the expense of public health, merely because some regulatory body approved a testing work plan.

#### **71. Comments:**

- *VFAs are low in reactivity and I question the reductions of VFA's. Efforts need to be focused on VOC emissions that actually form ozone.*
- *Commenter disagrees with District staff's contention that reactivity of the various gasses that may occur on a dairy farm was not subject to consideration. An assessment of relative contribution to ozone formation is certainly important.*

**Response:** The proposed emissions factor includes only VOCs that are considered by federal law [40 CFR 51.100 (s)] to be photochemically reactive, and therefore contribute to the formation of ozone. The law defines those compounds that are to be considered, and those that are not to be considered (due to “negligible reactivity”), when determining emissions of VOCs.

VFAs are the dairy compounds that are mentioned most frequently when questions of reactivity arise. However, most VFAs are not low in reactivity based on the maximum incremental reactivity scale (MIR), which indicates the photochemical reactivity potential to combine with NO<sub>x</sub> to form ozone. For example, propionic acid has a MIR reactivity of 0.79 (one pound of propionic acid has the potential to make 0.79 pounds of ozone), while benzene, another regulated compound, has a MIR reactivity of 0.81. Acetic acid is the only VFA that is lower in reactivity than propionic acid, while the rest that are identified on the MIR scale are above propionic acid. Even acetic acid's reactivity is higher than other VOCs commonly regulated by the District (propane, for example). In addition, federal law does not include acetic acid in the list of compounds that can be considered “to have negligible photochemical reactivity,” and the APCO therefore cannot, by law, exclude them from the VOC emission factor.

To suggest otherwise is to suggest that the District break the law, and that is not something we can do.

However, the District HAS excluded large quantities of compounds from our proposed emission factor that ARE listed as having negligible photochemical reactivity under federal law, and under our own implementing regulations. For example, some researchers have reported large amounts of acetone as being emitted from dairy operations. Acetone is reactive, and is known to contribute to the formation of ozone. However, federal law has drawn the “negligible reactivity” line at a place that defines acetone as having “negligible” reactivity, and we have therefore excluded acetone from our VOC emission factor. VFAs have higher reactivity than acetone, and federal law in fact considers them to reside above the “negligible reactivity” line, and VFAs therefore must be counted when determining emissions of VOCs.

## **72. Comments:**

- *We should receive emission credits for using by-products we feed to cows, which would otherwise decompose into the air or ground. The cleansing effect upon the air from plants that are grown for use by the cattle should be considered*
- *Alfalfa, a major crop fed to cows, acts as an air purifier. The positive effects of this crop should negate the effects from other processes.*
- *Trees help purify the air that we breathe and a simple solution would be to plant more trees at dairies.*

**Response:** The District's Extreme Ozone Demonstration Plan includes a measure for future study in the area of research, education and outreach regarding the role of urban landscapes and agricultural land use on the effects of ozone air quality.

**73. Comments:**

- *The Dairy industry always wants better science so that they can delay the EF and will always find another scientist to negate the work done. To them sound science is what sounds good.*
- *With all due respect, politicians, dairy lobbyists and attorneys need to step aside and let the scientists and Air District staff do their work.*

**Response:** Comments noted.

**74. Comments:**

- *The District should remove all enteric emissions from the EF because the Clean Air Act was not founded to include natural processes. It was designed to regulate facility and processes only and not living, breeding or breathing, eating, animals.*
- *More than 53 percent of the District's proposed emission factor involves so-called enteric emissions of VOCs or VFAs, or emissions of the same from feed. By the District's own rules, 23 such emissions are not defined as "air contaminants" as they are clearly not "caused by man." Defining such emissions as "caused by man" would imply that emissions from any plant or animal or other living thing falls under the regulatory auspices of the District. Simply on the basis of lack of legal authority, the District should not include enteric emissions in its proposed emission factor. However, should the District eventually obtain such authority to regulate these emissions and include them in permitting and control technology decisions, serious scientific issues remain with the current estimates.*
- *The District lacks legal authority to regulate enteric emissions and other natural emissions from animals and plants*
- *Enteric emissions, by definition, are those that are generated by the cow's digestion system, which are emitted as gas directly to the atmosphere. Such emissions are not subject to the District's authority pursuant to its own rules.*

*Rule 1020 sets forth the definitions, which are used throughout the District's rules and regulation. Rule 1020 provides that emissions mean "air contaminants".*

*Emission: the act of passing into the atmosphere of an air contaminant or gas stream which contains an air contaminant, or the air contaminant so passed into the atmosphere.*

*Importantly, “air contaminants” is defined to only include those contaminants “caused by man”,*

*Air Contaminants: any discharge, release, or other propagation into the atmosphere directly or indirectly, caused by man and includes, but is not limited to, smoke, charred paper, dust, soot, grime, carbon, noxious acids, fumes, gases, odors, or particulate matter, or any combination thereof.*

*Clearly enteric emissions, fresh manure and fresh urine are not emissions caused by man. They are caused by the cow, therefore, enteric emissions fall outside of the Districts definition of “emissions”. The inclusion of enteric emissions, as well as emissions from manure and urine is inconsistent with and violates the Districts own rules and regulations and is therefore unlawful.*

*The Districts rules, including rules 2510, 2201, and 2520 are limited in their applicability to “emissions” and “air contaminants”. For example, “source operation” as that term is defined in 1020 is the “last operation preceding the emission of any air contaminant”. The referenced “operation”, which is defined in rule 1020 as the physical and chemical reaction must be read to mean a physical or chemical action caused by man. Similarly, “major source” is defined in rule 2201 as those sources whose “emissions” exceed the specified thresholds. The only emissions that can be counted towards determining the major source threshold are those emissions which are those that are caused by man and non-fugitive. Likewise, the District cannot count those emissions not caused by man towards any other permitting threshold, including those in Health and Safety Code Sections 40724.6 and 42301.16.*

**Response:** The District disagrees. The federal Clean Air Act includes all emissions associated with a permitted stationary source, as does our own Rule 2201, “New and Modified Source Review.” The Clean Air Act further defines stationary source [section 302 (z)] as “any source of an air pollutant except those emissions resulting directly from an internal combustion engine for transportation purposes or from a nonroad engine or nonroad vehicle as defined in section 216.” Clearly, cows are not engines or vehicles, and therefore are to be counted.

In addition, SB 700 defines an “agricultural source of air pollution” as a source of air pollution or a group of sources on contiguous property, and specifically includes any “confined animal facility” in the definition. Since the cows are an inherent part of the CAF (in the absence of the cows, there’d be no CAF), and have been demonstrated to be sources of emissions, the emissions from the cows are necessarily included in the emissions from the CAF.

The comment that regulated emissions are somehow limited by our District definition of “air contaminant” so that enteric emissions are excluded is also fallacious. The argument made is that the definition says that emissions must be caused by man, and clearly emissions from cows are not caused by man. However, the District disagrees. In the absence of man, there would be no dairy and there would not be emissions from cows. The emissions from the 2.5 million cows in the San Joaquin Valley would not exist if not for man.

This situation is analogous to nearly everything the District regulates. Consider the emissions of solvents from a can of paint that is left open at a manufacturing facility. The air district regulates those emissions through permitting and emissions control regulations. Clearly, no man is actively causing those emissions – it’s just an open can of paint, and the natural process of evaporation is doing the rest. However, man caused those emissions to occur by bringing the can of paint to the facility, and opening it, just as man is causing the cow’s enteric emissions by bringing the cow to the dairy and feeding it. In fact, we fail to see the difference in ability to regulate the enteric emissions from the cow, the emissions from fresh manure, and the emissions from manure that has been sitting in the corral for a month. The final commenter above would illogically have the first two exempt from regulation and third subject to regulation.

## Guiding Principle comments

### 75. Comments:

- *The District’s use of the “guiding principles” is problematic for several reasons:*
  - *First, the “guiding principles” appeared after the DPAG process and thus do not reflect the recommendations of DPAG. These “principles” in fact appear to have been created after District staff had deliberated and drawn conclusions over the evidence presented to DPAG, and as such, the conclusions guide the principles, not the other way around;*
  - *Second, the guiding principles are biased to dismiss evidence that in the District’s view alone may represent an underestimate of emissions but there are no corresponding principles to prevent overestimates. In effect, this biases the overall process toward overestimates; and*
  - *Third, the District misapplies its own guiding principles.*
- *The District ignores its own “guiding principles” in accepting the British study while ignoring a more representative study on a California dairy.*

**Response:** The guiding principles are consistent with quality assurance procedures used in environmental testing, and there is no “bias” in the issues that they address. The guidelines address the issues that commonly result in underestimation in chemical analysis (sampling losses, analytical losses, etc.), as well as the issues that result in overestimation (contamination, calibration drift, etc). Furthermore, the



application of the guiding principles in the report often resulted in lower values than might otherwise have been determined (e.g. the guiding principles led to using zero value for phenols). In reviewing the application of the guiding principles in the report, the APCO also found no instances where the guiding principles were misapplied.

**Some feel that the recommended emissions factors are unlikely to be underestimates.**

**76. Comments:**

- *In all categories of emissions discussed in the report, the District asserts that every one of the emissions estimates are underestimates. To make this startling assertion, the District had to ignore numerous statements and submission throughout the records – including several statements by the researchers themselves – that indicate that the reported values are actually likely to be overestimates.*
- *Dr. Charles Krauter studies were able to roughly isolate some emissions from the lagoon versus the rest of the dairy. Dr. Schmidt as part of the above study also measured surface flux on the lagoon. Based on an average of these results, the APCO has proposed an emission factor of 1.0 lbs. VOC per cow per year for “Lagoons and Storage Ponds.” CARES concurs with this emission factor with the caveat that there was a substantial difference between the results reported by Krauter versus the Schmidt results (more than order of magnitude). Schmidt’s measuring method was more sensitive and able to isolate emissions only from the lagoon. In contrast, Dr. Krauter’s method was not able to isolate lagoon-only emissions and may have been confounded by emissions from other sources on or off the dairy. Therefore, CARES believes it is likely that the Schmidt lagoon results are more accurate and as such, averaging them with the Krauter number probably results in an overestimate for retention pond emissions. CARES believes additional source testing of lagoons will demonstrate that this emission factor should be lowered.*
- *In repeated spoken and written comments to the DPAG, Dr. Frank Mitloehner explained that he was erring slightly high in his estimates of dairy emissions in the UC Davis environmental chamber. In some cases, this came about by reporting the highest amounts of emissions from an experiment, as opposed to the mean values, Dr. Mitloehner reported to the group. These statements were not included in the June 27 report, or in any District-prepared written documents. In fact, the report continues to assert that the numbers are an overestimate, and completely fails to mention Dr. Mitloehner’s statements to the contrary.*
- *Similarly, both Drs. Krauter and Schmidt reported to DPAG that certain conditions specific to their study were likely to introduce high biases into their work. For example, both conducted their studies during warm summer months*

*during the day when dairy activity is highest and when air emissions are presumed to also be at a maximum. Both noted that for determining an emission factor, these results were extrapolated to cover all seasons, day and night and as such, likely were producing at least a slight overestimate and possible a large overestimate. In addition, Dr. Schmidt reported that the method he used to identify which samples to analyze introduced a slightly high bias because they chose to analyze samples which were likely to contain the most emissions (to ensure that quantifiable results would be measured).*

- *Reporting only the asserted “underestimates,” while failing to include statements from scientists regarding potential overestimates establishes a pattern of bias on the part of District staff. Further, failing to explain that these methods are standards used for testing other sources and were indeed approved by regulators prior to commencing the dairy studies, also suggests bias on the part of District staff. CARES would urge the District to take a more neutral view, reporting both information that may suggest overestimates or underestimates.*

**Response:** The District agrees that Dr. Mitloehner indicated that his enteric VOC estimates might overestimate emissions. Enteric VOC emissions have since been adjusted downward to reflect Dr. Mitloehner’s more recent lower numbers.

The District found the Schmidt and Krauter data for lagoons and storage ponds to be equally valid, and therefore used an average of the two values.

Although the District does not have specific data to determine whether dairy activity and diurnal and seasonal differences may have resulted in some overestimations, we agree that these factors may affect emissions. With additional research, we may be able to account for some of these differences.

Your comment that:

“Dr. Schmidt reported that the method he used to identify which samples to analyze introduced a slightly high bias because they chose to analyze samples which were likely to contain the most emissions (to ensure that quantifiable results would be measured).”

will be included in the appropriate evaluation section of the report.

For the reasons noted in the APCO report, however, (e.g. the absence of important chemicals form test standards, and the use of TBD >0 for several dairy processes), many of the values used are very likely to be underestimates and not overestimates.

## **77. General Comments:**

**A large number of comments were received that indicated that the commenters believed the dairy emissions factor should be lower than 20.6 lb/head-yr. Examples of such comments:**

- *We recommend that you adopt the 5.8 lb/hd-yr EF as recommend by Viewpoint 1 of the DPAG report.*
- *Adopting an EF that is falsely high and not scientifically sound does not benefit anyone and prevents us from reaching our true goal of improving air quality in the Valley and will preserve the Districts credibility and will allow Dairy producers to invest their finite resources on mitigation practices that provide the most benefit to air quality.*
- *In reference to VFAs we feel that the number is way to high. We do feel, however, that VFAs are being produced on the dairies and that sound science should be used to further study this group. More effort should be focused on establishing the correct number as well as establishing the most significant contributors to the group.*

**A number of comments were received that indicated that the commenters believed the dairy emissions factor should be higher than 20.6 lb/head-yr. Examples of such comments:**

- *In your report it is disappointing that the proposed factor is based on the lowest recommendations on a majority of the eight components. We believe that components one through eight are underestimated. It would be a disservice to valley residents not to include all emissions.*
- *We strongly believe that a higher emissions factor of 35-40 pounds/hd – based on existing research- is a more accurate measure of the VOCs being emitted from Valley dairies.*
- *The District should err on the side of protecting public health. There is concern that an underestimate of the emission factor will affect public health. Keep in mind that 18% of children in Merced have asthma.*
- *If we set the emission factor number as TBD, then it would mean waiting for a very long time before a new dairy emission factor number(s) would be accepted.*

**A number of comments were received that are generally supportive of the District's report and its approach and conclusions:**

- *When all aspects of the report are considered, it is my strong opinion that the total emissions of 20.6 lbs/hd/yr is a good indication of where dairy emissions research stands at this time.*

APCO's Determination of VOC Emission Factors for Dairies  
Summary of Comments and Responses

- *The APCO has judiciously utilized data from the four California research projects along with published, peer reviewed research and, where research is totally lacking, he has logically indicated To Be Determined (TBD) and not assigned a factor.*

**Response:** The above comments are reiterated here only to show the wide range of comments received. The APCO does not believe it necessary to specifically respond to any of the above general comments, as any supporting arguments are detailed and addressed above.