

Dispersion Modeling-Based Odor Assessment

LeSaffre Yeast Corporation
Oakland, California
Facility #B2975

Acetaldehyde Emissions from Fermentation Vessels



BAY AREA
AIR QUALITY
MANAGEMENT
DISTRICT

Toxic Evaluation Section
Bay Area Air Quality Management District
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1. Background

The Bay Area Air Quality Management District (BAAQMD) has completed a dispersion modeling-based assessment of odorous acetaldehyde emissions from five fermentation vessels that are used for nutritional yeast production at the LeSaffre Yeast facility located in Oakland. This assessment, which is an update to a previous BAAQMD report on this topic dated June 12, 2002, provides results both for annual average estimated emission rates and maximum one-hour measured emission rates. This report summarizes the methodology and results of this assessment.

2. Summary of Methodology

The EPA's ISCST3 dispersion model was used to determine whether emissions from the facility would likely result in short-term ambient air concentrations that exceed a published odor detection threshold for acetaldehyde. An odor threshold of 90 $\mu\text{g}/\text{m}^3$ was used in the analysis, as reported by EPA (<http://www.epa.gov/ttn/atw/hlthef/acetalde.html>). It should be noted that some individuals might be able to detect the scent of acetaldehyde well below this level (odor thresholds less than one microgram per cubic meter are reported elsewhere in the literature).

2.1 Emission Rates

The following three emissions scenarios were included in the odor assessment:

- (1) The annual average acetaldehyde emission rates extracted from the BAAQMD permit Data Bank as follows: Fermenter 1: 0.091 g/s (6315 lb/yr), Fermenter 2: 0.121 g/s (8395 lb/yr), Fermenter 3: 0.056 g/s (3906 lb/yr), Fermenter 4: 0.060 g/s (4161 lb/yr), and Fermenter 5: 0.089 g/s (6205 lb/yr). The total facility emissions modeled were 28,981 lb/yr.
- (2) The maximum hourly acetaldehyde emission rates estimated by the BAAQMD for 8/11/02 as follows: Fermenter 1: 0.0184 g/s, Fermenter 2: 0.4084 g/s, Fermenter 3: 0.258 g/s, Fermenter 4: 0.0184 g/s, and Fermenter 5: 0 g/s. Emissions during this period were dominated by stock-yeast production. [The BAAQMD measured acetaldehyde emissions from one fermenter on this day. Acetaldehyde emissions from the other fermenters were estimated by applying a factor to the total VOC measured by LeSaffre. The maximum emissions were based on two consecutive 30-minute samples collected at 8:00 and 8:30 am].
- (3) The maximum hourly acetaldehyde emission rates estimated by the BAAQMD on 8/29/02 as follows: Fermenter 1: 0.130 g/s, Fermenter 2: 0.083 g/s, Fermenter 3: 0 g/s, Fermenter 4: 0.075 g/s, and Fermenter 5: 0.162 g/s. Emissions during this period were dominated by trade-yeast production. [The BAAQMD measured acetaldehyde emissions from one fermenter on this day. Acetaldehyde emissions from the other fermenters were estimated by applying a factor to the total VOC measured by LeSaffre. The maximum emissions were based on two consecutive 30-minute samples collected at 3:00 and 3:30 pm].

2.2 Dispersion Modeling

The highest hourly average acetaldehyde air concentrations were predicted using the ISCST3 dispersion model. Source inputs were based on stack parameters and building dimensions provided by the facility. Wind direction-specific building dimensions used for addressing aerodynamic downwash influences were generated using U.S. EPA's BPIP Program. Meteorological inputs were generated from sequential on-site surface wind data and upper-air data collected at the Oakland International Airport for the year 1981 using EPA's PCRAMMET meteorological preprocessor. Receptor inputs consisted of a rectangular grid of receptor points spaced at 30-meter intervals within the modeling domain. Terrain elevations for sources and receptors were extracted from U.S. Geological Survey (USGS) 30-meter Digital Elevation Models.

3. Summary of Results

The highest one-hour average incremental ground-level ambient acetaldehyde air concentration was $312 \mu\text{g}/\text{m}^3$ for the annual average emissions scenario; $361 \mu\text{g}/\text{m}^3$ for the 8/11/02 stock-yeast maximum one-hour emissions scenario; and $320 \mu\text{g}/\text{m}^3$ for the 8/29/02 trade-yeast maximum one-hour emissions scenario. These one-hour impacts range from about $3\frac{1}{2}$ to 4 times higher than the $90 \mu\text{g}/\text{m}^3$ odor threshold.

Based on the annual average emissions scenario, one-hour average concentrations in excess of the odor threshold were predicted to occur at one or more receptor location for 951 of 8760 hours of the year (about 11 percent of the time). (It should be noted that, because emissions do not occur on a uniform temporal basis, the highest one-hour average concentration would likely be higher, but the frequency at which the odor threshold is exceeded would be decreased).

The spatial extent of 1-hour concentrations above the odor threshold is given (for the annual average emissions scenario) in the attached figures for both the highest 1-hour concentration and the 10th highest 1-hour concentration.

Odors are detected based on peak (e.g., 3-minute) rather than average air concentrations. Although the ISCST3 model cannot estimate pollutant concentrations for averaging periods less than one-hour, peak concentrations can be estimated from hourly concentrations using a power law relationship. Peak (3-minute) to mean ratios range from 1.65 to 4.47 depending on atmospheric stability categories (Wang, J., Skipka, K., *Dispersion Modeling of Odorous Emissions*, Proceedings of 86th Annual AWMA Meeting, 1993).

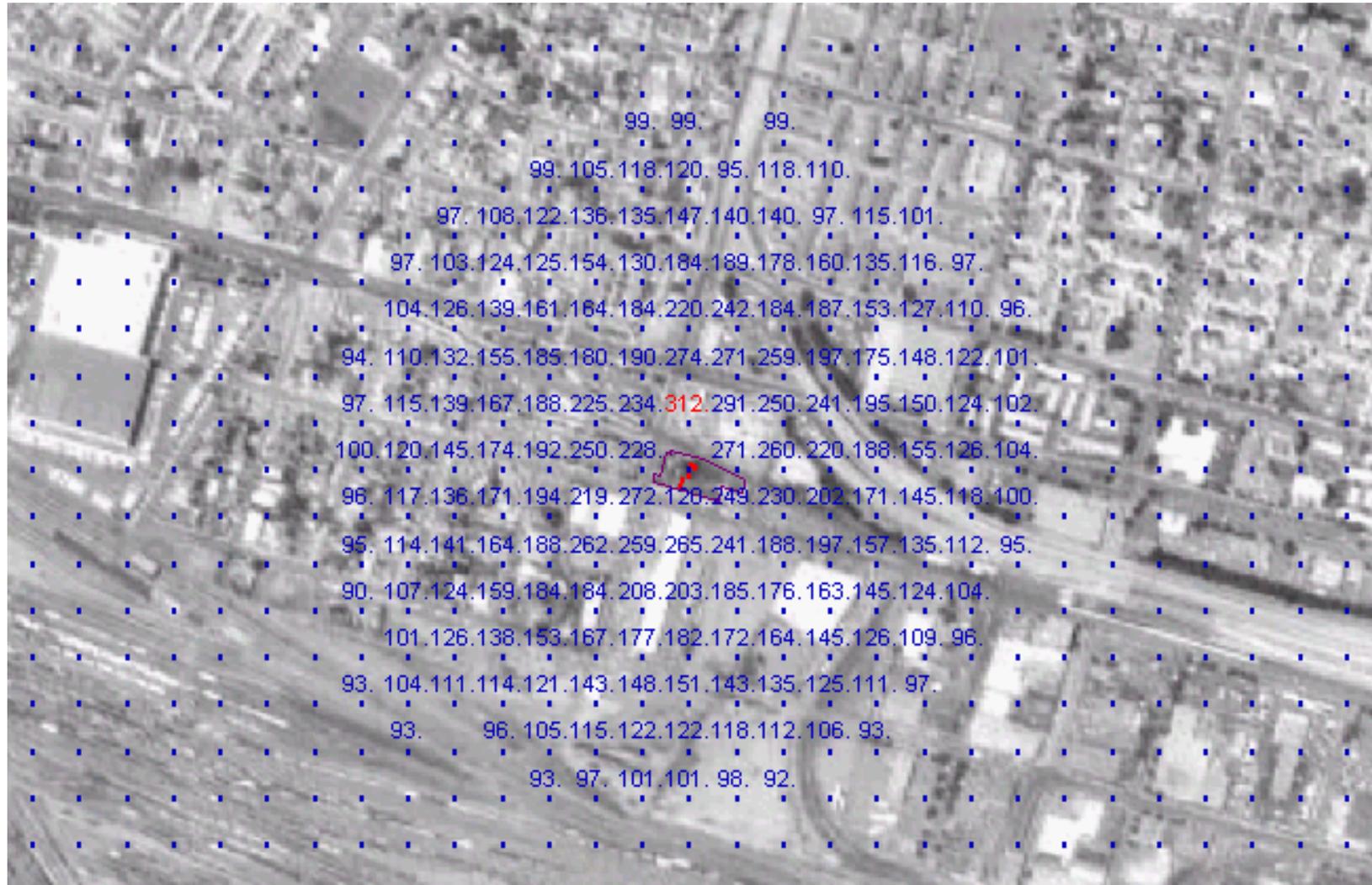
The highest overall one-hour average acetaldehyde air concentrations occurred during Turner Stability Class "C". The appropriate peak to mean ratio for this Stability is 2.71. The estimated highest peak 3-minute concentrations are therefore: 312×2.71 , or $846 \mu\text{g}/\text{m}^3$ (9.4 times higher than the odor threshold) for the annual average emissions scenario; 361×2.71 , or $978 \mu\text{g}/\text{m}^3$ (10.9 times higher than the odor threshold) for the 8/11/02 stock-yeast peak emissions scenario; and 320×2.71 , or $867 \mu\text{g}/\text{m}^3$ (9.6 times higher than the odor threshold) for the 8/29/02 trade-

yeast peak emissions scenario. These three-minute impacts range from about 9.4 to 10.9 times higher than the $90 \mu\text{g}/\text{m}^3$ odor threshold.

4. Conclusion

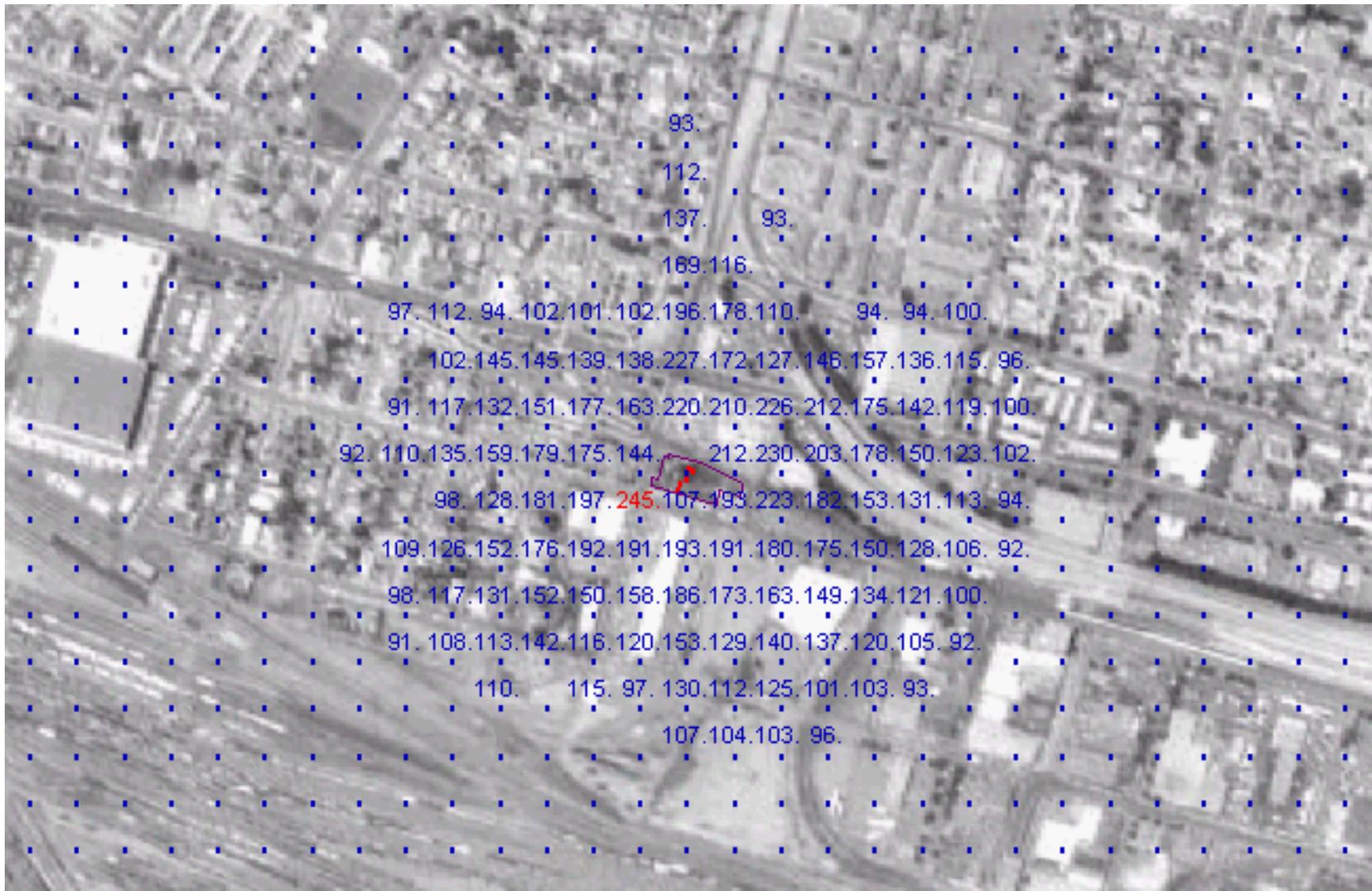
The dispersion modeling analysis completed indicates that emissions from the LeSaffre Yeast facility result in peak acetaldehyde air concentrations that may be over ten times the $90 \mu\text{g}/\text{m}^3$ odor detection threshold.

LeSaffre Yeast Maximum 1-Hour Average Acetaldehyde Ambient Air Concentrations



Concentrations posted are highest ISCST3 model-predicted 1-hr values in micrograms per cubic meter using 1981 Oakland Airport Meteorological Data. Receptor locations with concentrations equal or greater to $90 \mu\text{g}/\text{m}^3$ are shown. Acetaldehyde emissions were assumed to be emitted uniformly throughout the year from each fermenter based on the following annual emission rates: Fermenter 1: 6315 lb/yr, Fermenter 2: 8395 lb/yr, Fermenter 3: 3906 lb/yr, Fermenter 4: 4161 lb/yr, and Fermenter 5: 6205 lb/yr. The total facility emissions modeled were 28,981 lb/yr. Note that the maximum 1-hr concentrations would be higher if the maximum 1-hr emission rate exceeds the annual average 1-hr emission rate.

LeSaffre Yeast 10th Highest 1-Hour Average Acetaldehyde Ambient Air Concentrations



Concentrations posted are 10th highest ISCST3 model-predicted 1-hr values in micrograms per cubic meter using 1981 Oakland Airport Meteorological Data. Receptor locations with concentrations equal or greater to 90 µg/m³ are shown. Acetaldehyde emissions were assumed to be emitted uniformly throughout the year from each fermenter based on the following annual emission rates: Fermenter 1: 6315 lb/yr, Fermenter 2: 8395 lb/yr, Fermenter 3: 3906 lb/yr, Fermenter 4: 4161 lb/yr, and Fermenter 5: 6205 lb/yr. The total facility emissions modeled were 28,981 lb/yr. Note that the maximum 1-hr concentrations would be higher if the maximum 1-hr emission rate exceeds the annual average 1-hr emission rate.