Scientific Research and Consulting

MEMORANDUM

TO: Marc Byers, Byers Scientific & Manufacturing
FROM: Sarah Foster, CPF Associates, Inc.
DATE: October 4, 2016
RE: Screening Health Assessment of Byers' Waterless Vapor Phase Odor Control Technology

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INTRODUCTION AND SUMMARY

Byers Scientific & Manufacturing has developed a novel waterless vapor phase odor control technology which releases an Ecosorb® odor control product in gaseous form. Byers requested CPF Associates to conduct a health assessment of this system to determine whether its potential air impacts would be protective of public health. This memo describes the health assessment and its conclusions.

The application scenario evaluated in this study was defined by Byers. It assumed that Ecosorb® 607, an odor control product, would be fed into the vapor phase odor control technology at a rate of three gallons per day and, once volatilized, would be distributed as a gas along a 1,500 foot pipe, with air flow generated by a fan set at roughly 300 cubic feet per minute. The product would be released from holes assumed to be spaced at nine foot intervals along the length of the distribution pipe. The composition of Ecosorb® 607 was provided to CPF by its manufacturer, OMI Industries.

The assessment was a screening-level evaluation that relied on highly conservative, health-protective assumptions. These assumptions are expected to greatly overestimate potential ambient air concentrations, exposures and risks.

The assessment showed that operation of the Byers-defined application scenario would not pose public health concerns. Potential worst-case air concentrations calculated in the immediate vicinity of the distribution pipe were well below available health-protective inhalation criteria.

SCREENING HEALTH ASSESSMENT

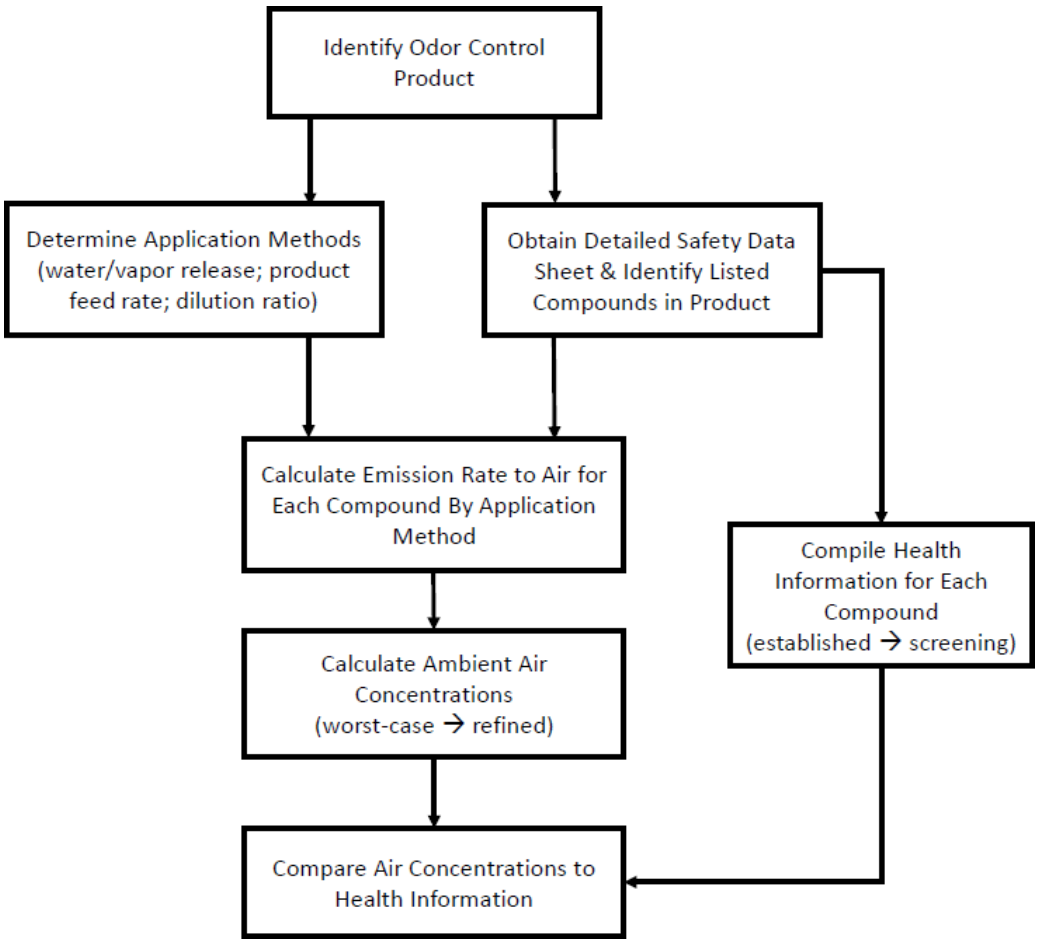
Methodology

CPF has developed a methodology to evaluate odor control product use at landfills and other potentially odiferous facilities. This methodology is based on well-accepted risk assessment principles and has been used to objectively assess more than one dozen odor control products delivered using a variety of application systems.

A flow chart of the methodology is provided in Figure 1. Broadly defined, the methodology combines information about odor control product composition, odor control application methods, health effects information and modeled ambient air concentrations to evaluate the potential for health concerns via inhalation. Consistent with standard risk assessment practice, the methodology can be applied in a

stepwise fashion of increasing refinement, as warranted. The initial screening-level evaluation employs highly conservative, health-protective assumptions expected to greatly overestimate potential air concentrations, exposures and potential risks. If the screening-level evaluation demonstrates a negligible potential for health concerns, then no further assessment is needed. If not, more refined evaluations can be performed to further evaluate an odor control system under more realistic conditions.

Figure 1
Odor Control Product Health Assessment Methodology



Assessment of Byers Vapor Phase Odor Control System

Application Method

In this assessment, a screening-level evaluation was conducted of an application setup defined by Byers. It was assumed that an Ecosorb® odor control product would be fed into the vapor phase odor control technology at a rate of three gallons per day and, once volatilized, would be distributed as a gas along a 1,500 foot pipe, with air flow generated by a fan set at roughly 300

cubic feet per minute. The product would be released from 166 holes, each roughly 3/16" in diameter, spaced at nine foot intervals along the entire pipe length.

Odor Control Product

The odor control product evaluated was Ecosorb® 607. Its composition was provided to CPF by its manufacturer, OMI Industries.[1] The product is comprised of two polysorbate surfactants and a blend of citrus and pine oils with the remainder being water. Both polysorbate surfactants are widely used in hundreds of industrial, consumer, medicinal and personal care products.

Emission Rates into Air

Emission rates into air for the product as a whole and its constituents were calculated based on the application setup described above and the Ecosorb® 607 composition. The method for calculating emission rates was very conservative, in order to ensure that potential air impacts would be overestimated. First, it was assumed that 100% of the product would be volatilized in the odor control technology and transported down the distribution pipe. Second, each constituent in Ecosorb® 607 was assumed to be present at the maximum percentage provided by OMI. Third, the calculated emission rates from one dozen holes were summed and the resulting cumulative emission rates were then assumed to be released from one hole, rather than dispersed along a roughly 100 foot length of pipe. This assumption will overestimate potential air concentrations very close to the pipe. The rate of release of volatilized material was assumed to be equally divided among all 166 holes in the distribution pipe.

Ambient Air Concentrations

Potential worst-case air concentrations were calculated in the immediate vicinity of the distribution pipe using a screening-level box model. This type of model calculates air concentrations within an enclosed, fixed volume (i.e., a box) through which air is assumed to flow at a constant rate and emissions are assumed to be well mixed. The resulting air concentrations will be overestimated, and thus health protective, because the model does not take into account dispersion, atmospheric reactions or settling (deposition) of the emissions. All of these processes, which naturally occur in the outdoor environment, would result in lower concentrations than those modeled.

For this assessment, the box was defined to estimate worst-case potential air concentrations that might occur in the immediate vicinity of the distribution pipe (i.e., within roughly 15 feet). It was assumed to be 15 feet (4.57 m) high by 15 feet (4.57 m) wide, with air flowing through this cross-section at a velocity of 1 mile per hour (0.447 m/sec), representative of a calm wind speed. Air concentrations would be lower if a larger box and higher wind speed were used.[2]

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[1] The percentages of each polysorbate surfactant and the citrus/pine oil blend in Ecosorb® 607 are a proprietary trade secret, however, they were provided to CPF for the purposes of this analysis. In accordance with a Confidentiality Agreement, this composition is not specifically provided in this memo. Additional information such as a Safety Data Sheet may be obtained from OMI Industries.

[2] The equation for calculating air concentrations in the simple well-mixed box model is: $Ca = (ER*1{,}000)/(H*W*V)$, where Ca = Air concentration (mg/m^3), ER = Emission rate (g/sec), 1,000 = Conversion factor (1,000 mg/g), H = Box height (4.57 m), W = Box width (4.57 m), and V = Air velocity through box (0.447 m/sec).

Health Criteria for Odor Control Product

The next step in the assessment involved compilation of available health criteria for the odor control product and its constituents. These criteria reflect concentrations in air (in mg/m^3) or average daily intakes (in mg/kg body weight/day) that are considered to be protective of public health. They are developed by regulatory agencies and public health scientists based on scientific information about the toxicity of chemical substances. When these values are derived, safety factors are generally incorporated to ensure that they are protective of human health.

Numerous information sources were searched to identify available health effects criteria.[3] Criteria were able to be identified for all constituents in Ecosorb® 607, for the listed constituent itself, for a component in the constituent or for a structurally similar compound. For example, for the blend of pine and citrus oils, dominant components in orange, lime, lemon, tangerine, grapefruit and pine oils were identified from published studies, and then acute short-term inhalation criteria were compiled as available for each of these. Among the dominant components, acute short-term inhalation criteria were available for limonene, α-terpineol, and α- and β-pinene. The lowest among these three criteria (59 mg/m^3) was selected to evaluate the entire oil blend.

In addition to identifying criteria for constituents in Ecosorb® 607, the results from an acute inhalation toxicity study conducted for Ecosorb® 606 were used to derive an inhalation criterion for the product as a whole. Ecosorb® 607 is very similar to Ecosorb® 606, the only difference being that the citrus/pine oil blend is present at a slightly lower level in Ecosorb® 606 compared to Ecosorb® 607. The acute inhalation toxicity study examined the occurrence of adverse effects on rats exposed to the product at a high concentration in aerosolized form (2,220 mg/m^3) for four hours. Observations of the test animals for 12 different health endpoints (ranging from lacrimation to tremors to death) were tabulated during the exposure period and for 14 days after the exposure ceased. No adverse effects were observed at the tested air concentration. This no observed adverse effect level (NOAEL) was divided by an uncertainty factor of 100 to derive the criterion for this assessment.[4]

Compare Air Concentrations to Health Information

The potential for a health concern was evaluated by comparing the calculated air concentrations to the health information. If the calculated air concentration for a compound or odor control product is lower than the corresponding inhalation health criterion, adverse public health effects would not be expected to occur under the assumed odor control application scenario. If an air concentration exceeds its criterion, this does not mean that adverse effects will occur among the general public because of the conservative assumptions included in both the derivation of the criterion and the

[3] Information sources searched included: The US Environmental Protection Agency's (USEPA) Risk-Based Screening Levels (RSLs), USEPA's Acute Exposure Guideline Levels (AEGLs), the American Industrial Hygiene Association's Emergency Response Planning Guidelines (ERPGs), Temporary Emergency Exposure Limits (TEELs) developed by the DOE Office of Emergency Management, California Environmental Protection Agency (CALEPA) Reference Exposure Levels (RELs), the US National Library of Medicine PubChem databases, European Union and European Food Safety Authority assessments on food additives, Safety Assessments prepared by Cosmetic Ingredient Review Expert Panels, and Japan Food Safety Commission reports on food additives.

[4] Consistent with screening-level methods for deriving reference air concentrations, the uncertainty factor of 100 incorporated one factor of 10 for animal to human extrapolation and another factor of 10 for human variability.

calculation of air concentrations. Rather it indicates that further investigation may be warranted, using more refined and realistic assumptions, to help determine whether or not levels in air may present a potential public health concern.

In this analysis, the potential worst-case air concentrations calculated in the immediate vicinity of the distribution pipe were from 20 to more than 16,000 times below the available health-protective criteria.

Discussion of Uncertainties

The results of health assessments inherently reflect some uncertainty because of the complexities involved in the analysis. In accordance with standard practice, key uncertainties affecting this assessment are discussed here. In general, uncertainties in health assessments, including this one, are addressed by using conservative (i.e., health protective) assumptions which collectively produce results much more likely to be overestimated than underestimated. This adds a margin of safety to the results. These conservative assumptions have been noted above, such as concentrating emissions from multiple holes in a distribution pipe into one emission source location, assigning small dimensions (i.e., 15 feet by 15 feet) to the simple box model and assessing the blend of citrus and pine oils using only the lowest available inhalation health criterion among those for dominant components of these oils. Some uncertainties were not explicitly addressed in this study, such as whether the form of emissions might vary in extremely cold temperatures (e.g., gas versus aerosols) or whether the composition of volatilized constituents might vary after long periods of operation. These uncertainties are not expected to change the conclusions of this assessment. This assessment addressed only the inhalation route of exposure. Consideration of inhalation, and not other exposure routes (e.g., dermal), is appropriate given that the general public would not be expected to come into contact with the odor control product in any manner other than through the air.

Conclusions

This screening-level assessment showed that operation of the Byers-defined application scenario would not pose public health concerns. Potential worst-case air concentrations calculated in the immediate vicinity of the distribution pipe were from 20 to more than 16,000 times below available health-protective criteria.

ABOUT CPF ASSOCIATES

CPF Associates, Inc. is an independent Maryland-based scientific and research consulting firm with in-depth experience and expertise in the health and environmental evaluation of waste management technologies, industrial facilities, waste sites and air emission sources. CPF applies state-of-the-art scientific tools - risk assessment, life-cycle analysis, epidemiology and environmental impact analysis - to address public health and environmental issues. In over 30 years of professional association, the CPF Principals have conducted hundreds of projects for energy-from-waste (EfW) facilities, landfills, hazardous waste incinerators, medical waste incinerators, biosolids management facilities, recycling plants, transfer stations and other types of treatment units. The principal investigator for this assessment was Ms. Sarah Foster, a Principal with CPF Associates. Internal review was provided by Dr. Paul Chrostowski, also a Principal with CPF.