Letter Health Consultation

ROYAL FUMIGATION SITE

520 FINNEY AVENUE

SUFFOLK, VIRGINIA

Prepared by
Virginia Department of Health

September 24, 2012

Virginia Department of Health
109 Governor Street
Richmond, VA 23219

Letter Health Consultation: A Note of Explanation

A letter health consultation is a verbal or written response from VDH to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the letter health consultation process for Royal Fumigation, unless additional information is obtained by VDH which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Dear Mr. Turner:

This letter is in response to your request for the Virginia Department of Health (VDH) to examine potential health risks associated with the fumigant, methyl bromide, at the Royal Fumigation facility in Suffolk, Virginia. Thank you for providing VDH with air sampling information related to this facility. Through a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR), we completed an evaluation of the air sampling information you provided to VDH on October 5, 2011. The purpose of this letter is to conduct a review of the air sampling information and evaluate the potential public health implications of methyl bromide used at this facility.

BACKGROUND

Royal Fumigation, located at 520 Finney Avenue in Suffolk, VA, uses methyl bromide to treat various import and export commodities (Figure 1) (1). Commodities are fumigated in one of two warehouses located at the western end of the property. Royal fumigation is surrounded by businesses directly to the north and west of the warehouses. Royal Fumigation's property east of the warehouses is surrounded by trees on three sides with residential properties to the south and the far east end of the property. A railroad track runs along the southern edge of Royal Fumigation (2).

The Virginia State Air Pollution Control Board became aware of Royal Fumigation after receiving a letter sent to the Board suggesting that fumigation facilities in Suffolk used control equipment that should be evaluated. The Air Pollution Control Board directed Virginia Department of Environmental Quality (DEQ) to perform an air quality study to determine if Virginia's Significant Ambient Air Concentration (SAAC) for one-hour average concentration of methyl bromide (950 micrograms/cubic meters ($\mu g/m^3$)) was being exceeded. The SAAC is the concentration of a toxic pollutant in the ambient air that, if exceeded, may have an adverse effect

to human health. VDH was asked to evaluate the air quality study and determine if methyl bromide use at this facility had any potential public health implications.

METHYL BROMIDE

Methyl bromide is a colorless, odorless nonflammable gas occurring naturally in the environment at low levels. Methyl bromide is manufactured to make other chemicals and is also used extensively as a fumigant. As a fumigant, methyl bromide is used to control a number of pests including rodents, insects, and fungi in warehouses, agricultural fields, and shipping containers. Methyl bromide exposure occurs primarily through inhalation. Workers who fumigate homes, fields, and commodities may be exposed to higher than background levels of methyl bromide (3).

Inhalation of methyl bromide can cause headaches, dizziness, fainting, apathy, weakness, confusion, speech impairment, visual effects and numbness. Inhalation of higher concentrations of methyl bromide can cause paralysis, lung injury, kidney damage, and injury to the heart. There are no reports of reproductive or developmental effects of methyl bromide exposure. The U.S. Environmental Protection (EPA) has determined that methyl bromide is not classifiable as to its human carcinogenicity (3,4). Long-term inhalation carcinogenicity studies conducted by the National Toxicology Program found no evidence of carcinogenesis in male or female mice (5).

SAMPLING METHODOLOGY AND RESULTS

Sampling data collected at the property perimeter indicates the presence of methyl bromide in samples collected outside the facility prior to fumigating (background) and while aerating (venting). Background samples were collected when methyl bromide was not being used and were collected from multiple sites located at the property line surrounding the fumigation facility (Figure 2). Twelve background samples were collected on Monday, February 22, 2010 and 12 samples on Friday, March 5, 2010. Of those 24 samples, 18 were grab samples with seven of them containing measurable quantities of methyl bromide (range: 0.4-2.8 $\mu g/m^3$, average: 0.8 $\mu g/m^3$). The remaining six of the 24 samples were 1-hour samples. Only one of those samples had a measurable amount of methyl bromide (2.4 $\mu g/m^3$) (Table 1).

A total of 35 air (30 grab and five 1-hour) samples were collected when methyl bromide was being aerated from the facility on three non-consecutive days: Thursday, January 28, Friday, March 19, and Friday, April 23, 2010. Methyl bromide was detected in multiple sampling locations around Royal Fumigation during aeration (Figure 2). Thirty grab samples collected from all sides of the facility ranged from not detected to 958.9 $\mu g/m^3$. Nineteen out of the 30 grab samples collected contained measurable amounts of methyl bromide, with a geometric mean equivalent to 7.0 $\mu g/m^3$ (Table 1).

A total of five 1-hour samples were collected during aeration. Methyl bromide was detected in all of the 1-hour samples collected. For the 1-hour samples, the geometric mean air concentration of methyl bromide was 95.5 $\mu g/m^3$ with the highest (846.3 $\mu g/m^3$) and lowest (22.1 $\mu g/m^3$) concentrations collected on March 19 and January 28, 2010, respectively (Table 1).

A review of the air sampling results indicates that methyl bromide is detected during aeration on all sides of the facility with the lowest concentration reported upwind (wind direction west to east). We compared the geometric mean of the 1-hour (95.5 µg/m^3) and grab samples (7.0 µg/m^3) to ATSDR's Minimal Risk Level (MRL) and EPA's Reference Concentration (RfC) for methyl bromide.

- A MRL is defined as, "an estimate of daily exposure of a human being to a chemical that is likely to be without an appreciable risk of deleterious effects (non-carcinogenic) over a specified period of time." MRLs are based upon human and animal studies and are reported for acute exposure (less than 14 days), intermediate exposure (15 to 364 days), and chronic exposure (greater than 365 days).

- The RfC is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily inhalation exposure of the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. It is not a direct estimator of risk but rather a reference point to gauge the potential effects.

Both the 1-hour and grab samples are representative of short-term exposure and their geometric means are below the acute MRL (200 µg/m^3) (3). MRLs are derived for substances by factoring the most relevant documented no-observed-adverse-effects level (NOAEL) or lowest-observed-adverse-effects level (LOAEL) and applying uncertainty factors. ATSDR's MRL for methyl bromide acute exposure was derived from an 8-hour rat inhalation exposure study. The most sensitive indicator (neurological effects) identified in the study was a significant decrease in the hypothalamic concentration of norepinephrine and a decrease in the activity of tyrosine hydroxylase in rats exposed to methyl bromide in air at 31 parts per million (ppm) and not at 16 ppm (6,7). A NOAEL was assigned to animals exposed to 16 ppm. The acute MRL, 0.05 ppm (200 µg/m^3), was derived by adjusting the NOAEL for less-than-continuous exposure (8 hours/24 hours), and dividing by an uncertainty factor of 100 (10 for extrapolating from animals to human, and 10 for human variability) (3). Therefore, acute health effects would not be expected in individuals exposed continuously to methyl bromide at mean (average) levels for short periods of time.

One of the 1-hour samples did contain methyl bromide above the acute MRL during aeration. This occurred in one of five 1-hour samples (20 %). The concentration in this sample was 846.3 µg/m^3 and was from the sampling location closest to the fumigation facility. Elevated concentrations of methyl bromide would be expected in close range of the warehouse during aeration.

The chronic MRL for methyl bromide is 20 µg/m^3 (0.005 ppm) (3). ATSDR's MRL for methyl bromide chronic exposure was derived from an eight year human study. The critical effect was an increased prevalence of muscle ache, fatigue, and ataxia. This critical effect was observed at a LOAEL equal to 8930 µg/m^3 in the study. This concentration was adjusted for intermittent exposure and applying an uncertainty factor of 100 (10 for using a LOAEL, and 10 for human variability) (3).

EPA's RfC for methyl bromide is 5 µg/m^3 (8). RfCs are doses derived from the NOAEL or LOAEL by application of uncertainty factors and an additional modifying factor, which is based on a professional judgment of the entire database of the chemical. In general, the RfC is an

estimate of a daily inhalation exposure (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. EPA's RfC for methyl bromide was derived from a 29-month rat inhalation study (8,9). The study's critical effect was degenerative and proliferative lesions of the olfactory epithelium of the nasal cavity. This critical effect was detected at a LOAEL of 11,700 µg/m^3. The LOAEL was converted to a Human Equivalent Concentration and an uncertainty factor of 100 (10 for intraspecies uncertainty, and 10 because a LOAEL was used for a mild effect and to account for interspecies dosimetric adjustments) was applied (10).

DISCUSSION

VDH determines exposure to environmental contamination by identifying exposure pathways. A completed exposure pathway consists of: a source of contamination, an environmental medium (e.g., air, water and soil), a point of exposure, a route of exposure, and a receptor population (e.g., workers, community members and individual household members). A complete pathway exists when people are actually exposed to a contaminant through inhalation, ingestion, or by skin contact. VDH has determined that two exposure pathway exists at Royal Fumigation.

- Completed exposure pathway - unprotected workers, visitors, and trespassers exposed to methyl bromide within the perimeter of Royal Fumigation during aeration.

- Potential exposure pathway - members of the community outside of the perimeter may be exposed to methyl bromide downwind during aeration.

Both the 1-hour and grab samples' geometric mean are below ATSDR's acute MRL. Although the 1-hour samples' geometric mean is above ATSDR's chronic MRL and EPA's RfC, the samples do not necessarily represent what an individual would be exposed to all day, every day. Two grab and one 1-hour samples measured higher than the acute MRL. It is possible that on-site visitors, workers, and trespassers exposed to these acute elevated levels could sustain lung, neurological, or renal damage. More samples are needed to characterize the frequency and duration of peak levels of methyl bromide during aeration.

Chronic inhalation MRLs and RfCs are derived for continuous, long-term 24-hour-a-day exposures. In most instances, inhalation exposures from a site will be for less than 24 hours per day. The 1-hour and grab samples collected represent short-term exposure and their geometric mean are below ATSDR's acute MRL (200 µg/m^3). Based on the sampling information received, VDH is not able to evaluate potential health risks posed to nearby businesses, schools, and homes without additional sampling information that extends beyond the Royal Fumigation facility's perimeter.

EVALUATING HEALTH EFFECTS

A hazard quotient (HQ) is the ratio of the exposure dose to the reference dose (Equation 1). If the ratio is greater than one, then the potential for adverse health effects needs to be assessed further.

Equation 1

$$HQ = \frac{Exposure\ Dose}{Reference\ Dose}$$

The reference dose is typically derived from either an RfC, or a MRL. Derivation of the reference dose is shown in Appendix A. RfCs and MRLs are based on a continuous exposure which is different than what workers, trespassers, or visitors may actually be exposed to on site. Because workers are known to be present at the warehouse during aeration of methyl bromide, VDH calculated the exposure dose based on: an 8-hour work day, aeration once a week, and a daily inhalation rate of 15.2 cubic meters per day (m^3/day) for adults aged 19-65 years old. Equations and exposure parameters are shown in Appendix A. An exposure dose for trespassers and visitors was not calculated because the duration and frequency of these receptors are not known.

The ratio of the exposure dose to reference dose (chronic MRL) was less than one (HQ = 0.23) for workers exposed to methyl bromide on site using VDH's exposure parameters. Because the HQ is less than one, the potential for adverse health effects does not need to be assessed further for this receptor. Any additional worker exposure concern should be referred to the Virginia Department of Labor and Industry. Because trespassers and visitors are expected to be exposed less frequently and for shorter durations than workers, any HQ calculated for these receptors would also be less than one.

CONCLUSIONS

During warehouse aeration, the geometric mean of methyl bromide (95.5 µg/m^3) in 1-hour perimeter samples was above ATSDR's MRL (20 µg/m^3) for chronic exposure and EPA's RfC (5 µg/m^3). Both the 1-hour and grab samples geometric mean were below ATSDR's MRL (200 µg/m^3) for acute exposure. The highest reported 1-hour sample concentration (846.3 µg/m^3) and grab sample concentration (958.9 µg/m^3) were above the acute MRL. Grab and 1-hour samples varied considerably based on sampling location. No background grab samples were above ATSDR's chronic MRL or EPA's RfC. Based on this information, VDH concludes:

- Chronic exposures to methyl bromide might have occurred in the past and are still occurring, but exposure to workers are not at levels likely to cause adverse health effects (HQ = 0.23).
- Unprotected workers, visitors, and trespassers may suffer from respiratory, neurological, and renal damage if exposed to the maximum grab samples' concentrations of methyl bromide detected during aeration. Additional sampling is needed to characterize the potential health risks that may occur during aeration.
- Assessing the risk to nearby residents, businesses, and schools, is not possible at this time without further sampling.

RECOMMENDATIONS

VDH recommends that DEQ collect 8-24 hour time weighted average ambient air samples during fumigation and aeration at adjacent businesses, schools, and residential homes to assess any public health impact to the community.

VDH recommends that the frequency of grab and 1-hour samples be increased during aeration on site to better assess the public health impact to visitors, workers, and trespassers during peak levels.

VDH recommends more background samples be collected on site during and after fumigation operations. This information will be used to better assess background levels of methyl bromide and its potential impact on public health.

Thank you for allowing us time to address your concerns. If you have additional questions, please contact the VDH Division of Environmental Epidemiology at (804)-864-8182 or at 109 Governor Street, Richmond, VA 23219.

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REFERENCES

1. Personal communication with Chuck Turner of DEQ, Summer 2011.

2. Virginia Department of Environmental Quality, Tidewater Regional Office. Ambient Air Monitoring Work Plan for Royal Fumigation, Suffolk County Monitoring Project.

3. Agency for Toxic Substances and Diseases Registry (ATSDR). Toxicological Profile for Methyl bromide. U.S. Public Health Services, U.S. Department of Health and Human Services, Atlanta, GA, 1992.

4. U.S. Environmental Protection Agency. Technology Transfer Network Air Toxics Web Site. April 1992, revised January 2000.

5. National Toxicology Program; accessed July 18, 2012. Available from: http://ntp.niehs.nih.gov/?objectid=BCB76C27-123F-7908-7B86ECADBD05ED28

6. T.Honma, M. Miyagawa and M.Sato.1986. Methyl bromide alters catecholamine and metabolite concentrations in rat brain. Neurotoxicology and Teratology. 9: 369 – 375.

7. T.Honma. 1987. Alteration of catecholamine metabolism in rat brain produced by inhalation exposure to methyl bromide. Jpn J Ind Health 29:218-219.

8. US Environmental Protection Agency, Integrated Risk Information System; accessed August 19, 2011. Last updated December 3, 2002. Available from: http://www.epa.gov/iris/index.html

9. Reuzel, P.G.J., H.C. Dreef-van der Meulen, V.M.H. Hollanders, C.F. Kuper, V.J. Feron and C.A. van der Heijden. 1991. Chronic inhalation toxicity and carcinogenicity study of methyl bromide in Wistar rats. Fd. Chem. Toxic. 29(1): 31-39.

10. Agency for Toxic Substances and Diseases Registry (ATSDR). Public Health Assessment Guidance Manual (2005 Update). http://www.atsdr.cdc.gov/hac/PHAManual/appf.html

Appendix

Figure 1. Location of Royal Fumigation Facility and surrounding area.

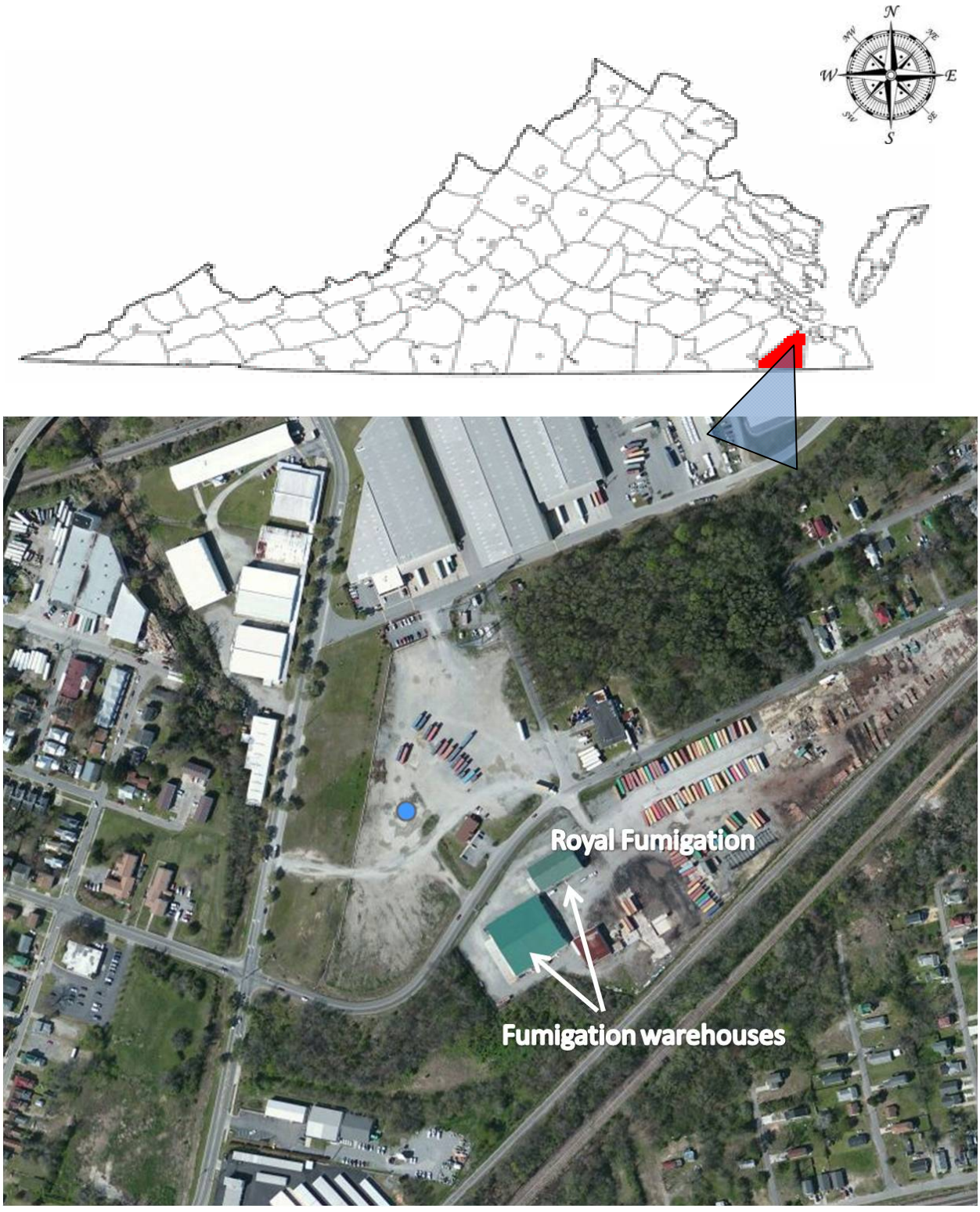

Figure 2. Methyl bromide air concentrations collected during aeration at Royal Fumigation on March 19, 2010.*

(*Sources:* DEQ & Bing maps) ***G**=grab sample. **1H**=1-hour sample. **ND**=methyl bromide not detected. Sample results are displayed on the map in the approximate location of where the sample was collected.

Table 1. Methyl bromide summary of January-April 2010 air sample results

Collection Date	Sample Type	µg/m^3		Detection Frequency	Comparison Value	
		High	Average*		Acute	Chronic
January 28, 2010 (Venting Building #2)	Grab	55.1	7.5	6/9	200 µg/m^3	20 µg/m^3
	1-Hour	22.1	22.1	1/1		
February 22, 2010 (Background)	Grab	2.8	0.7	4/9		
	1-Hour	0	0	0/3		
March 5, 2010 (No operation)	Grab	1.9	1.0	3/9		
	1-Hour	2.4	2.4	1/3		
March 19, 2010 (Venting Building #1)	Grab	958.9	3.4	4/10		
	1-Hour	846.3	846.3	1/1		
April 23, 2010 (Venting Building #1)	Grab	223.0	9.3	9/11		
	1-Hour	84.3	75.2	3/3		
January 28, March 19, and April 23 samples combined	Grab	958.9	7.0	19/30		
	1-Hour	846.3	95.5	5/5		
February 22 and March 5 samples combined	Grab	2.8	0.8	7/18		
	1-Hour	2.4	2.4	1/6		

(*Source:* DEQ) *Averages are geometric and only include samples with measurable quantities of methyl bromide.

Equations and exposure parameters used to determine Hazard Quotient

Equations

Chronic Average Daily Dose

$$ADD_{Chronic} = \frac{C * IR * EF * ET}{BW * CF_1 * CF_2}$$

Reference dose

$$RD = \frac{MRL * IR}{BW}$$

Hazard Quotient

$$HQ = \frac{ADD_{Chronic}}{RD}$$

Where:

Exposure Parameters

Abbreviations	Value	Comments and Definitions
$ADD_{Chronic}$	µg /kg/day	Chronic Average Daily Dose
BW	70 kg	Average weight of a human adult
C	95.5 µg/m^3	Geometric mean of five 1-hour methyl bromide samples collected on three different days
CF_1	24 h/day	Number of hours in a day
CF_2	7 days/week	Number of days in a week
EF	1 day/week	Number of days the warehouse is aerated in a week
ET	8 hours/day	Number of hours worked in a day
HQ	Unit less	Hazard Quotient
IR	15.2 m^3/day	Volume of air an adult breaths in a day
MRL	20 µg/m^3	ATSDR chronic minimal risk level concentration
RD	µg/kg/day	Reference Dose