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From: MARAMA Fumigation Workgroup
To: MARAMA Air Directors
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Purpose

The MARAMA member agencies have identified the need for consistency in addressing and controlling emissions of hazardous air pollutants (HAPS) in commodity fumigation operations. At their February 2018 meeting, the MARAMA board instructed MARAMA to provide coordination among member agencies to collect and review information from agency staff on practices, regulations and potential management, permitting and control strategies that address toxic emissions resulting from the use of fumigants to treat commercial commodities. Further, the Board directed MARAMA to prepare a summary paper of their findings for presentation at the summer Board Meeting and Air Toxics Workshop. In April 2018, MARAMA established a Fumigation Workgroup. Air directors from each member agency identified staff to serve on the workgroup, and a list is included in the appendix.

In addition, a few other agencies outside the MARAMA membership (Maine, Georgia, South Carolina) requested to join and were added to the project.

This paper is an overview of the findings of the workgroup, including the fumigation regulations and policies established by the MARAMA region (DE, MD, NJ, NC, PA, WV, VA, DC, Alleghany Co. and Philadelphia) along with input from Georgia, South Carolina, and Maine. This is an ongoing workgroup and materials are current as of publication (April 2019). It is best to contact the air agencies directly to obtain the latest information.

What is Fumigation?

The United States Department of Agriculture *Fumigation Handbook* (September 2006) lists the following definitions of "Fumigant", "Fumigant Formulation," and "Fumigation:"

> **Fumigant** - A chemical which, at the required temperature and pressure, exists in the gaseous state in sufficient concentrations to be lethal to a targeted pest.

Fumigant Formulation - The chemical or mixture of chemicals comprised of all active and inert (if any) ingredients which releases a fumigant. Fumigant formulations may exist in any of the three physical states: liquid, gas, or solid.

Fumigation - The action of introducing a toxic chemical in the gaseous state to control a targeted pest.

Why should we be concerned?

Fumigation activities have caused severe health damage, including death, to workers, residents and bystanders in different parts of the world. There are many reported incidences. However, exposure to fumigants may be causing unreported health impacts when fumigation activities occur. Links to some of the reported incidences caused by fumigation exposure are listed below. A toxicity description and comparison of chemicals typically used for fumigation activities are provided later in the document.

- "Terminix Fined For Poisoning Virgin Island Family" - https://www.wccbcharlotte.com/2016/03/30/terminix-fined-for-poisoning-virgin-island-family/
- "Orkin Held Responsible For 2 Fumigation Deaths" - https://www.washingtonpost.com/archive/local/1988/11/17/orkin-held-responsible-for-2-fumigation-deaths/34fd0939-f0c9-41fc-bb7e-b06dfae1af32/?noredirect=on&utm_term=.f408aebf252e
- "Boy, 10, faces long recovery after pesticide poisoning" - https://www.cnn.com/2016/05/09/health/pesticide-poisoning-investigation/index.html
- Fruit fly fumigation halted after Tasmanian biosecurity workers fall ill - https://www.abc.net.au/news/2018-02-18/fruit-fly-chemicals-blamed-for-sickness/9459634
- "Fumigants in shipping containers are hazardous to workers" - https://safety.blr.com/workplace-safety-news/hazardous-substances-and-materials/chemical-hazards/Fumigants-in-shipping-containers-are-hazardous-to-/

The workgroup focused on routine fumigation of commodities rather than the periodic or one time fumigation of structures. Products are routinely fumigated as they enter (import) or exit (export) the US. Examples include: Lumber/Logs, Fruit (such as grapes, peaches), cocoa beans, grains, tobacco, peanuts, and pasta. Exported vehicles may need fumigation depending on their destination.

The most commonly used fumigants for the treatment of commercial commodities are methyl bromide, sulfuryl fluoride, and phosphine. Of these, only sulfuryl fluoride is not federally regulated as a hazardous air pollutant or a VOC, and is not regulated by all States. Alternative fumigants are described in Attachment 1 to this document.

Methyl Bromide (MBr)

Methyl bromide, also known as bromomethane, is a highly toxic halogenated hydrocarbon (CH_3Br) used as a fumigant and pesticide. It was introduced as a pesticide in 1932 and registered with the US EPA in 1961 for use as a pesticide.[1] MBr is a colorless, non-flammable gas with a very low odor concentration (odor threshold 80 mg/m^3).[2] For this reason, an odor agent such as chloropicrin is often added as a sensory warning agent similar to the way mercaptan is used in natural gas. At high concentrations, MBr has a sweetish chloroform-like odor.

MBr is used to treat commodities such as grapes, asparagus, logs, and other imported goods to prevent introducing pests to the United States. MBr is also used as a fumigant for domestically sourced logs prior to export.

MBr is most dangerous at the fumigation site because it rapidly dissipates from the commodity/product to the atmosphere. However, the vapor is more than three times as dense as air and may collect in low spots or poorly ventilated places. MBr gas is able to penetrate many substances such as concrete, leather and rubber.[3] Human exposure to high concentrations (acute (short-term) and chronic (long-term)) of MBr can cause central nervous system and respiratory system failures and may harm the lungs, eyes, and skin. The main routes of exposure are dermal and inhalation.

Methyl bromide is a Hazardous Air Pollutant (HAP) and is listed under Section 112(b) of the Clean Air Act (CAA) (#74-83-9). Section 112(b) lists the 187 toxics air pollutants that are addressed by section 112. However, methyl bromide fumigation is not included in the list of major HAP source categories under 112(c) of the CAA. Section 112(c) is the list of categories of sources that emit HAPs and that the EPA is required to publish and regularly update. Therefore, EPA has not established a regulation to limit emissions of the substance during fumigation.

Under the Clean Air Act and the Montreal Protocol on Substances that Deplete the Ozone Layer, U.S. production and import of MBr is banned, except for uses that qualify for (1) a critical use exemption (CUE), (2) a quarantine and pre-shipment exemption (QPS), or (3) an emergency exemption. Commodity fumigation is considered a "quarantine and pre-shipment exemption." [4]

Sulfuryl fluoride (SF)

Sulfuryl fluoride is an inorganic compound with the chemical formula SO_2F_2. SF was originally developed by the Dow Chemical Company (Dow AgroSciences, LLC) under the trade names Vikane® gas fumigant and ProFume® gas fumigant. Additional trade

[1] https://www3.epa.gov/pesticides/chem_search/reg_actions/reregistration/red_PC-053201_9-Jul-08.pdf
[2] https://www.epa.gov/sites/production/files/2016-09/documents/methyl-bromide.pdf
[3] https://www.worksafe.qld.gov.au/__data/assets/pdf_file/0011/96680/health-monitoring-methyl-bromide-guidelines.pdf
[4] https://www.epa.gov/ods-phaseout/methyl-bromide

names are Zythor® and MasterFume®. SF's use has increased as a replacement for MBr due to the phase out of MBr as a substance that depletes the ozone layer under the Montreal Protocol. SF is not an ozone depleter; however, evidence suggests that it can act as a potent greenhouse gas, similar to chlorofluorocarbons (CFCs).[5] It is also an alternative to the use of phosphine, which is more acutely toxic. SF is a colorless, odorless gas. It is marketed as a liquid gas in pressurized steel containers.

Sulfuryl flouride is an insecticide and rodenticide fumigant initially registered with the EPA in 1959 for control of termites in wood structures.[6] It is used to fumigate commodities and to control infestations of pests in residential structures, processed-food and pet food facilities, warehouses, and shipping containers. In 2004, EPA registered SF for control of insect pests in harvested and processed foods such as cereal grains, dried fruits, tree nuts, cocoa beans, and coffee beans.

One of the negative impacts of SF is that it breaks down to fluoride, which can leave fluoride residues on the commodity being treated. As a result, EPA established maximum allowable residue limits, known as tolerances, in 2004 for fluoride on the food commodities approved for treatment with SF. The EPA proposed to withdraw these SF and fluoride tolerances in 2012 under an implementation schedule that would provide time for sulfuryl fluoride users to transition to new pest control alternatives.[7] However, The House of Representatives passed a bill under the 2014 House Appropriations Bill that prohibited EPA from including "nonpesticideal sources of fluoride from any aggregate exposure assessment required under section 408 of the Federal Food, Drug, and Cosmetic Act (21 U.S.C. 346a) when assessing tolerances associated with residues from the pesticide".[8] This resulted in EPA continuing to allow SF tolerances and usage since other causes of fluoride exposure (drinking water, dental products, and food) did not have to be evaluated when assessing the impact of fluoride from SF fumigation. Most of the human exposure to fluoride results from these nonpesticideal sources of fluoride.

In humans, acute inhalation exposure to high concentrations of SF results in respiratory irritation, pulmonary edema, nausea, abdominal pain, central nervous system depression, numbness in the extremities, muscle twitching, seizures, and even death. Direct contact with concentrated SF liquid causes tissue damage to eyes, mucous membranes, or skin. At lethal concentrations, SF disrupts carbohydrate and lipid metabolism of humans. [9]

California EPA determined the following SF reference concentrations for residents/bystanders:

[5] https://www.cdpr.ca.gov/docs/emon/pubs/tac/tacpdfs/sulfluor/final_rcd_vol3.pdf
[6] https://www3.epa.gov/pesticides/chem_search/reg_actions/reregistration/fs_PC-078003_1-Sep-93.pdf
[7] https://www.regulations.gov/document?D=EPA-HQ-OPP-2005-0174-0249
[8] http://uscode.house.gov/view.xhtml?req=granuleid:USC-prelim-title21-section346a&num=0&edition=prelim
[9] http://www.fluoridealert.org/wp-content/uploads/sf.epa-hra.2004.pdf

- Acute – 1,700 µg/m^3, averaging time of 24 hours; and
- Long-Term or Chronic – 60 µg/m^3.[10]

It should be noted that the 24-hour SF reference concentration is currently being reevaluated. As a result of this reevaluation, California is currently considering a value up to 4,150 µg/m^3 as the 24-hour acute exposure reference concentration. However, this may be modified as additional information and data is generated and considered.[11]

In Maryland, there is a facility that fumigates vehicles exported to New Zealand and Australia with SF to control the spread of Brown Marmorated Stinkbugs as a result of a September 2015 requirement from those countries.

Phosphine (Phos)

Phosphine (PH_3) is a colorless, flammable, and toxic gas initially registered with the EPA in 1999.[12] It is commonly known as Phos. Pure Phos is odorless, but technical grade samples have a highly unpleasant odor like garlic or rotting fish, due to the presence of substituted Phos and diphosphane (P_2H_4). This odor cannot be relied upon as a warning of Phos gas exposure.[13]

Phos is used as an insecticide for the fumigation of grains, animal feed, and leaf-stored tobacco, and as a rodenticide. The public may be exposed via the inhalation of contaminated ambient air or via the consumption of food contaminated with Phos residues. Acute (short-term) inhalation exposure to Phos may cause headaches, dizziness, fatigue, drowsiness, burning substernal pain, nausea, vomiting, cough, labored breathing, chest tightness, pulmonary irritation, pulmonary edema, and tremors in humans. Chronic (long-term) occupational exposure of workers to Phos may cause inflammation of the nasal cavity and throat, weakness, dizziness, nausea, gastrointestinal, cardiorespiratory, central nervous system symptomology, jaundice, liver effects, and increased bone density. [14] [15]

ECO_2FUME™, is a commercial product containing Phos. It is packaged as a liquefied gas under pressure, and is a Restricted Use Pesticide (RUP) because of its acute inhalation toxicity. The Phos is withdrawn from the cylinder as a liquid, but dispensed as a gas. ECO_2FUME™ is applied at a concentration of 200-500 ppm, which is maintained for a period of 2-14 days depending upon the temperature of the immediate surroundings of the target pest.

[10] https://www.cdpr.ca.gov/docs/emon/pubs/tac/tacpdfs/sulfluor/final_rcd_vol2.pdf
[11] https://www.cdpr.ca.gov/docs/risk/rcd/establishing_sulfuryl_fluoride.pdf
[12] https://www3.epa.gov/pesticides/chem_search/reg_actions/registration/fs_PC-066500_01-Dec-99.pdf
[13] https://www.cdpr.ca.gov/docs/risk/rcd/phosphine.pdf
[14] https://www.epa.gov/sites/production/files/2016-09/documents/phosphine.pdf
[15] https://www3.epa.gov/pesticides/chem_search/ppls/068387-00007-20100318.pdf

Phos is the only widely used cost-effective, rapidly acting fumigant that does not leave significant residues on the stored product. While several studies have found residues of Phos remaining on foods fumigated with Phos gas or Phos-generating products, the residues are below a level of concern of 0.01 mg/m^3 (0.01 ppm). Studies have also shown that some pests have a high level of resistance to Phos in other regions (e.g., Asia, Australia, and Brazil).

Table 1a provides a general comparison and Table 1b provides a toxicity comparison of the three above described fumigants.

Table 1a Comparison of Fumigants – General

	MBr	**SF**	**Phos**
Classification	VOC, HAP	Maryland Toxic Air Pollutant (TAP)	HAP
Initial US Registration	1961 (used in 1930's)	1959	1999 (but around since the 1780's)
Characteristics	Colorless, Odorless	Colorless, Odorless	Colorless, Garlic/Fish Odor
Impact on Environment	Ozone Depleting Substance (ODS)	Potent greenhouse gas, could contribute to Climate Change	unknown
Banned*	January 1, 2005	Ban proposed in 2012; but not implemented.	No

* Banned but with some exemptions, especially with quantities below a certain threshold

Table 1b Comparison of Fumigants – Toxicity

	Methyl Bromide (ppm) [16]					Sulfuryl Fluoride (ppm) [17]					Phosphine (ppm) [18]				
	10 min	30 min	60 min	4 hr	8 hr	10 min	30 min	60 min	4 hr	8 hr	10 min	30 min	60 min	4 hr	8 hr
AEGL 1	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
AEGL 2	940	380	210	67	67	27	27	21	13	6.7	4	4	2	0.5	0.25
AEGL 3	3300	1300	740	230	130	81	81	64	40	20	7.2	7.2	3.6	0.9	0.45

[16] AEGLs Methyl Bromide (Final values): https://www.epa.gov/aegl/methyl-bromide-results-aegl-program
[17] Sulfuryl fluoride (Interim values): https://www.epa.gov/aegl/sulfuryl-fluoride-results-aegl-program
[18] Phosphine (Final values): https://www.epa.gov/aegl/phosphine-results-aeglprogram

AEGL = Acute Exposure Guideline Levels
By the National Advisory Committee for Acute Exposure Guideline Levels for Hazardous Substances

The available human and animal data indicate that there is very little margin between exposures having no effects and lethal exposures, therefore AEGL 1 values were not derived.

AEGL-1 is the airborne concentration (expressed as parts per million or milligrams per cubic meter [ppm or mg/m^3]) of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic, non-sensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.

AEGL-2 is the airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.

AEGL-3 is the airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death.

Overview of the Fumigation Process

There are many locations and methods used to implement fumigation. Fumigation can occur in warehouse buildings, shipping containers, or under tarps. In general there are three steps:

1) Isolate product
    a. Under tarps
    b. Enclosed room or building

2) Introduce fumigant for specific amount of time (commodity and fumigant dependent)
    a. USDA rules specify fumigant hold time and concentration

3) Aerate the enclosed space to release the fumigant at a specific flowrate.
    The aeration method depends on the location and type of commodity. Aeration could be active (using fans or another source to force air through) or passive (during which venting takes places through stacks, open doors or windows, and stacks/vents after a certain period of time has elapsed to disperse the pollutant safely). The highest concentration is emitted during the first hour of aeration; therefore, this is the time period of greatest concern. However, 24 – 48 hours or longer may be required before aeration is complete. If a control device is required, it must be designed to address the heavy load during the initial aeration, but it also should stay in service during the entire aeration as even small emissions can have health impacts.

    At the current time, very few fumigation source operations vent their air toxic emissions to an air pollution control device.

Fumigation companies operating in the MARAMA region may include:

Western Fumigation,
Terminix,
Alleghany Wood,
Vanguard Pest Control,
Ehrlich,
Horizon Stevedoring,
TIMA Capital,
MAFCO,
Malec Brothers, and
Ecolab (formerly Royal Pest Solutions (RPS)).

Fumigation Control Technologies

Several companies provide control technology to reduce emissions from fumigation pollutants. The workgroup identified Nordiko Quarantine Systems PTY LTD, Value Recovery Inc. and Spectros Instruments.

Value Recovery, a New Jersey company, developed and patented technology for the conversion of MBr into non-hazardous byproducts. This occurs through a chemical reaction in an aqueous solution of potassium thiosulfate. Two commercial facilities have been operating the control technology for 5+ years; Guadalupe Cooling in CA and Flagler / ACL at the Port of Miami, FL. (http://www.valuerecovery.net/Home.html)

Nordiko Quarantine Systems Pty Ltd (Nordiko) is an Australian company that has patented technology in fumigation recapture and gas scrubbing systems. Nordiko operates in more than 30 countries around the world. Its gas capture and scrubbing products treat MBr, Phos, ethanedinitrile and other fumigants. (http://nordiko.com.au/wp/)

Spectros Instruments markets a technology, for the quantitative destruction of methyl bromide (EIM's GDU (Gas Destruction Unit)). Based on information obtained in 2018, there are 2 commercialized units in use, one each in Australia and New Zealand; however, other information was that it had only undergone pilot testing and was not placed into commercial use.

Other companies could be identified and if so, should undergo additional research.

Cost Effectiveness of Controls

Facilities claim that it is not cost effective to control emissions from fumigation operations. However, APC manufacturers have demonstrated that control costs are not as high as fumigators claim. In fact, commercial facilities with controls are in place in California, Florida and elsewhere in the world. At least one vendor has expressed in interest in providing a free pilot demonstration to verify effectiveness and cost control.

NACAA Request for 112(c) Source Category Status of Methyl Bromide (status as of July 2018)

The National Association of Clean Air Agencies (NACAA) collected information from its member agencies about sources located throughout the country that emit major

amounts of HAPs for which there are no applicable source categories under 112(c). The first and most critical that NACAA identified is the category of fumigation facilities that use methyl bromide. On March 21, 2016, NACAA wrote to the EPA Acting Assistant Administrator for the Office of Air and Radiation to request that EPA formally evaluate the completeness of the source category list under Section 112(c) and, further, that the agency develop a MACT standard for the methyl bromide fumigation source category as expeditiously as possible.

Based on conversations with EPA, the only correspondence found in reference to the 2016 NACAA letter is an acknowledgement letter dated June 23, 2016, stating that EPA's next step would be to "follow up with the states on the listed categories and evaluate the information you have provided." The current status of methyl bromide fumigation is that the Office of Air Quality Planning and Standards (OAQPS) continues to coordinate activities with the Office of Pesticide Programs (OPP) on monitoring equipment and potential labeling changes. However, there are no 112 rule activities currently underway.

International Fumigation Regulations/Policies

Regulations have been imposed by countries receiving US exports that require MBr to be used as a fumigant. For example, China requires US wood to be fumigated with MBr; no other fumigant is currently acceptable.

State Fumigation Regulations/Policies

A review of regulations and state policies revealed that there is not a consistent method for establishing fumigation permits for the MARAMA agencies. The following summarizes the MARAMA agency fumigation regulations and the types and thresholds for air pollution control permitting.

Rather than specific fumigation regulations or policies, many MARAMA agencies cite the provisions of Title V of the Clean Air Act to issue Operating Permits or Synthetic Minor Permits for a fumigation source. Two agencies have fumigation references in their regulations:

Pennsylvania has Chapter 128 Pesticides code[19], but the text does not discuss air permitting specifically.

Virginia has Code 10.1-1308.01, which is specifically part of Chapter 13, Air Pollution Control Board regulations.[20]

New Jersey requires that fumigation processes obtain APC Permits pursuant to NJAC 7:27-8 if more than 50 pounds per hour of total raw materials (commodity and fumigant) is processed. New Jersey intends to draft regulations that specifically

[19] https://www.pacode.com/secure/data/007/chapter128/chap128toc.html
[20] https://law.lis.virginia.gov/vacode/title10.1/chapter13/section10.1-1308.01/

address fumigation source operations. The proposal will likely have much lower reporting thresholds.

Maryland regulation COMAR 26.11.02.09 and COMAR 26.11.02.10 regulate which sources of air pollution require a pre-construction air quality permit. Generally speaking, if the fumigation source emits one ton per year or more (as a VOC, federal HAP, or state-regulated toxic air pollutant (TAP)), an air quality permit to construct would be required in Maryland.

Outside of MARAMA, South Carolina (DHEC) has a Memorandum on Fumigation Permitting guidance, dated May 6, 2013.[21]

Specific parameters used by agencies to regulate fumigation activities are listed in Table 2. Many have similar pollutant thresholds as a result of the common applicability of Title V of the CAA. However, there is little consistency between the boundary or buffer requirements, which may range from none to up to a mile. New Jersey has a spreadsheet for a screening process in place based on risk. A snapshot of the spreadsheet is shown in the appendix (Attachment 4). Maryland has a state air toxics regulation that applies to emissions of the three described fumigants. Under the Maryland rule, fumigators must install T-BACT and meet the ambient impact requirement demonstrating that the pollutant concentration does not exceed established threshold and risk based screening levels.

Some states do require a minimum stack discharge point, which could be based on the results of a health risk assessment.

Example State Permits / Case Histories

Many MARAMA agencies either have permitted fumigation facilities or are currently going through the permit application process. The following is an overview of several example permits or permit applications:

Maryland

Maryland issued a Permit to Construct and State Permit to Operate for a SF fumigation operation at the Port of Baltimore to fumigate transportation vehicles prior to export to Australia and New Zealand. While SF is not a VOC or HAP, it is considered a Maryland TAP. This facility was able to demonstrate compliance with Maryland TAP regulations using complex AERMOD dispersion modeling techniques. However, log fumigation operations using methyl bromide at the Port of Baltimore could not meet applicable VOC and Maryland TAP requirements and subsequently shut down with the intention to relocate to another area.

[21] https://www.scdhec.gov/sites/default/files/docs/Environment/docs/FumigationGuidance.pdf

New Jersey

In 2017, New Jersey focused on understanding the fumigators operating in the state and created a process as follows:

1) An Enforcement Compliance Advisory was issued in April 2017 via List Serve (Email) and website, rather than newspaper notices. This advisory requested facilities to submit information on their fumigation practices.

2) Meetings were held with three of the four fumigation companies active in the state: Western Fumigation, Royal Pest Services and Vanguard Pest Control.

3) In 2017 information requests were sent to the following four fumigation companies: Western Fumigation, Royal Pest Services, Vanguard Pest Control, and Ehrlich Pest Control. Additional letters to additional companies have been sent since 2017.

4) The fumigation company responses included information on fumigation events for MBr, SF and Phos. Based on a review of the responses, Notices of Violation (NOVs) were issued to the fumigation companies and the property owners/responsible entities for 33 sites that met air permit and regulatory applicability. The NOVs did not require immediate cessation of fumigation, but provided notice and compliance deadlines to submit air permit applications.

5) NJDEP Air Permitting and Compliance & Enforcement conducted joint site visits at several fumigation facilities to facilitate the air permit application process.

6) About twenty Air Pollution Control (APC) permit applications have been submitted by New Jersey facilities.

This outreach to fumigators was intended to ensure that air toxics emissions do not pose a threat to human health and the environment. As stated above, about 20 APC permit applications for fumigation source operations are under review. Each application is subject to a health risk assessment. New Jersey guidance on health risk assessment can be found at: https://www.state.nj.us/dep/aqpp/risk.html.

The two fumigation facilities that have undergone health risk assessments are Gloucester Terminals located in Gloucester City, and MAFCO Corporation Worldwide (MAFCO) located in Camden. Gloucester Terminals submitted an APC permit application to fumigate imported grapes with MBr. MAFCO proposed in an APC permit application for a one-time fumigation, with SF, of imported licorice root in seven sections of its warehouse.

The general procedure to perform a health risk assessment is as follows and is consistent with how NJ would evaluate any other air toxic release. The air permit reviewer compiles the following information: maximum hourly and annual air toxic emissions, a facility plot plan, stack parameters, and hours of operation. The Air Quality

Evaluation staff inputs this information into AERMOD, or an equivalent air quality model, to determine the maximum off-site ambient air toxic concentrations. The concentrations are then compared to the applicable unit risk factors to determine the carcinogenic impacts, and the reference concentrations to determine other health impacts. The facility has the option of conducting the air quality modeling and submitting the results for review and approval.

If modeling shows a potential for a significant health risk, the facility must take the necessary actions to lower the risk. This could include, but may not be limited to, installing controls, increasing stack height, increasing discharge velocity, increasing control efficiency, decreasing operating hours, and decreasing processing rates. Gloucester Terminals has proposed to minimize health impacts by venting the MBr at high discharge points. MAFCO's proposal is to vent each section of its warehouse one at a time to limit the amount of SF emitted over any 24-hour period. This is effective since SF has a reference concentration based on a 24-hour exposure period.

In addition to a health risk assessment, applications must undergo a technology assessment to determine the feasibility of the installation of a control device, pursuant to NJAC 7:27-16.16, NJAC 7:27-16.17 and State of the Art (SOTA) requirements.

USDA requirements are evaluated to confirm the pound per hour emissions listed in the application are appropriate and correct.

Once the air permit reviewer confirms that the fumigation scenario passes the health risk assessment, a compliance plan is drafted which specifies how the facility must operate to meet the required limits. The condition of the compliance plan places restrictions on the amount of fumigant applied and confirms that the discharge parameters are consistent with those used in the health risk assessment. The compliance plan requires that the facility monitor its fumigant according to standard USDA practice. In the case of SF, this means weighing the canisters before and after the fumigant is released and recording those values. Limits are also specified in the permit and are consistent with the calculated or proposed hourly and annual worst-case emission rates. Compliance plan requirements are also developed to address site-specific parameters like the sealing of the structure, the duration of aeration, the exhaust flowrate, the use of air pollution control equipment, and any other requirements that were proposed by the facility to lower the health impacts of fumigation.

Table 2. Summary Table of State Fumigation Information

State	Fumigation Regulation	Threshold	Boundary / Buffer	Screening Process?	Permit	Fumigant Pollutant	Product(s)
DE	None; Title V	VOC major >25 ton/yr. HAP > 10 ton/yr.	No Minimum, but known source is located ~ 1 mi from residences	AERMOD / limited onsite monitoring	None yet. Complete construction application rec'd 2017		
MD	AQ permit required for > 1 tpy or VOC, HAP or MD TAP	Prohibits VOC > 20 lbs/day unless controlled 85% Must install T-BACT and meet TAP ambient impact requirements	Concentration of the pollutant at the Property Line and beyond must be less than any applicable threshold and risk based screening levels established for each TAP		SO_2F_2 for vehicles exported to Au & NZ Existing, non-permitted MBr source for logs exported to China at the Port of Baltimore has shut down due to inability to comply with VOC/TAP requirements	SF	Vehicles
NJ	Proposing fumigation regulation to clarify permit requirements. Currently, NJAC 7:27-8.2 does not have a direct reference to fumigation activities.	Proposing a 0.01 lb/hr threshold emission rate for fumigants applied. Currently: >50 lb/hr based on processing rate of raw material	Case by Case basis determination	Level 1 Health Risk Screening Worksheet, then, if necessary, Level 2 Refined Modeling	Nineteen (19) Pending Permit applications	MBr, SF, Phos	Lumber, Cocoa Beans, Fruits, Logs, licorice roots, clothing
NC	None specific; – NC is in the rule making process for methyl bromide and log fumigation;	SM less than or = 10 tpy Title V > 10 tpy	None.	None.	Five Synthetic Minor Permits	MBr (HAP); Phos (HAP and TAP); SF (not HAP)	Exports: hardwood Oak and S. Yellow Pine Imports: Fruits and Vegetables
PA	PA Code Chapter 128	1.370 lb/hr	200 feet		Macaroni Co. permit	MBr	pasta

State	Fumigation Regulation	Threshold	Boundary / Buffer	Screening Process?	Permit	Fumigant Pollutant	Product(s)
PA – PHL	None, AMR VI for ambient MBr	Limits < MBr 2.7 tpy (1.254 lb/hr); Phos 0.0462 lb/hr and 0.0609 tpy		Working on Risk Analysis Policy; Modeling for larger projects.	Plan Approval & Monitoring Plan to Horizon to limit MBr to 9.9 tpy.	MBr	Port of Philadelphia goods
VA	Yes, since 2011 Statute Code of VA: 10.1-1308.01	HAP major (10 tpy); exempt if not HAP major	300 feet buffer or monitor @ property line		4 Syn minor permits issued (logs)	MBr, Phos	logs
WV	None; General Permitting for MBr	HAPs > 2 lb/hr or 5 tpy; max potential					
GA	None, 112(g), Title I	>2 tpy of HAP	None	Toxic Guidelines if permitted; Annual AAC = 5 ug/m3; 15-min AAC = 8000 ug/m3	1 Active – PortFresh (Synthetic Minor) 1 Closed – Ultimate Pest (Syn Minor) 1 Proposed but withdrawn – Royal Pest (112(g))	MBr	PortFresh – produce; Ultimate & Royal - logs
ME	None, Minor/Major	Minor <10 tpy of HAP; Major >10 tpy			None		
SC	None, 112(g) & Title V; May 6, 2013 Memorandum on Fumigation Permitting guidance.	>1000 lb/month	None	N/A	None	MBr; Phos; 1,3-dichloropropene	Produce, grain, logs, etc.

Abbreviations: MBr = Methyl bromide ; Phos = Phosphine; Sulfuryl fluoride = SF

North Carolina

The North Carolina Division of Air Quality (NCDAQ or DAQ) currently permits five synthetic minor fumigation facilities. An additional three facilities have submitted synthetic minor permit applications to begin fumigation operations.

In late 2017, NC DAQ received two major source permit applications for separate fumigation facilities. Tima Capital applied for an ownership change at a Royal Pest Solutions facility near the Wilmington, North Carolina port. Royal Pest Solutions operated under a synthetic minor permit. Tima Capital's application estimated a methyl bromide emission rate of 60 tons per year. The major source application contended that CAA 112g did not apply since this was a modification and not a new or reconstructed source. Additionally, since the Royal Pest Solutions facility had been operating for several years, the applicant contended that the request to increase HAP emissions above major source levels was not circumvention of 112g. There was significant public interest and media coverage of the permit application. Ultimately, Tima Capital withdrew their major source permit application. Subsequently, the property owner requested Royal Pest Solutions to cease operations as well. Royal Pest Solutions requested permit rescission.

Malec Brothers Transport submitted a greenfield major source permit application at a location approximately 15 miles inland from the Wilmington NC port. Malec's application estimated a methyl bromide emission rate of 140 tons per year. Since the facility was new and a major source of HAPs, a CAA 112g submission was required. The draft 112g condition contained primarily notification, signage, record keeping / reporting, and a monitoring provision.

The draft permit was taken to public notice including two public hearings for the proposed Title V draft permit. There were approximately 300 attendees at each public hearing and the Department received more than 1000 comments.

After considering all public comments, it was the recommendation of the Hearing Officer that:

- The case-by-case MACT evaluation included in the permit application appeared to contain some inaccurate information such as available control technology. DAQ should re-evaluate the MACT determination provided and evaluate appropriate air emissions control.
- The DAQ should re-evaluate the aeration process, emission capture methodologies, ducting and stack parameters in concert with the re-evaluation of emissions control.
- After determining any controls/final scenarios, DAQ should conduct modeling to ensure protection of community health.
- Monitoring for container leak checks, frequency of monitoring at the boundary, as well as multiple locations at the property boundary should be re-evaluated.
- Inhalation risk of methyl bromide be prioritized by the NC Department of Environmental Quality (DEQ) and Department of Health and Human Services

(DHHS) Secretaries' Scientific Advisory Board to evaluate the necessity of developing an Acceptable Ambient Level, in 15A NCAC Section 02D .1100.

As a result, and in response to the hearing officer's report for the draft Title V permit, on July 26, 2018, the Division of Air Quality executed following actions:

1) Sent 60 days reopen for cause letter to all existing facilities indicating that the Division intended to reopen their permits for modification to address those areas noted by the hearing officer.
2) Requested additional information from all applicants for new fumigation operations to obtain detailed monitoring plans, appropriate control technologies, and operational limitations to be incorporated into their permit applications.
3) Requested that the Scientific Advisory Board list methyl bromide as a state air toxic as well as establish an Acceptable Ambient Level (AAL) of methyl bromide.
4) Initiated rulemaking for proposed temporary and permanent rules affecting log fumigation operations.

In January of 2019, Malec Brothers Transport withdrew their major source air permit application. According to James Harris, Malec CEO, they "managed to find alternative methods" to using fumigants. Their CEO also said "…those methods are effective" when referring to the process of debarking instead of fumigating.

NC DAQ's activities since July 2018: The DAQ has requested that the Department of Environmental Quality's and the Department of Health and Human Services' Secretaries' Scientific Advisory Board (SAB) perform a risk analysis and recommend an AAL for methyl bromide.[22] That process has resulted in a 30 day comment period on a draft report which ended on March 27, 2019.

The AAL recommendation is based on the EPA's IRIS reference value. Once the SAB approves a final report, the DAQ will request the North Carolina Environmental Management Commission (EMC) to approve and send to public hearing the adoption of 15A NCAC 02D .0546 "Control of Emissions from Log Fumigation Operations" and revisions to 15A NCAC 02D .1104 "Toxic Air Pollutant Guidelines".[23]

The requested revision to 2D .1104 will establish methyl bromide as a North Carolina toxic air pollutant (TAP) with an AAL suggested below:

15A NCAC 02D .1104 "Toxic Air Pollutant Guidelines":

- Adds methyl bromide to the list of toxic air pollutants with a proposed 24-hour acceptable ambient level (AAL) of 5 ug/m^3 (0.005 mg/m^3).

The requested addition of 2D .0546 would include the provision for a log fumigation facility to comply with the methyl bromide AAL.

[22] https://deq.nc.gov/news/press-releases/2019/02/25/state-requests-public-comment-methyl-bromide-report
[23] https://files.nc.gov/ncdeq/Air%20Quality/Calendar/Planning/november2018aqc/Agenda_4_Rules.pdf

15A NCAC 02D .0546 “Control of Emissions from Log Fumigation Operations”:

- Requires the Permittee to comply with the proposed methyl bromide AAL of 5 ug/m^3at the property boundary.
- Requires the Permittee to comply with 15A NCAC 02D .1106 “Determination of Ambient Air Concentrations” through appropriate modeling.
- Requires the Permittee to comply with 15A NCAC 02Q .0709 “Demonstration” through dispersion modeling demonstrating that the TAP emitted will not exceed the AAL.
- Requires the permit to go to public notice and public hearing pursuant to 15A NCAC 02Q .0710.
- Requires notification of the public through visible signage at the property boundaries adjacent to public right of ways.
- Requires monitoring, recordkeeping and reporting to demonstrate compliance with the Air Quality Permit.
- Requires an initial notification of commencement of operations to the appropriate DAQ Regional Office within 15-day of initial fumigation start-up.
- Requires compliance within 60 days after the Rule is effective for all new and modified facilities or in accordance with an alternate compliance schedule approved by the Air Quality Director for existing facilities.

Philadelphia, PA

Philadelphia issued a temporary MBr permit for Western Fumigation at Packer Avenue Marine Terminal from March - October 2017. The requirements were less than 8.0 tons per rolling 12-month period of any single HAP (minor source limit for HAP). Also, HAP emissions from fumigation activities were not to exceed 400 lb/hr or 50.5 gram/second. A SCREEN3 modeling exercise was submitted with the application and the permit stipulation that the discharge stack must be designed to meet what was modeled with their application. Additional restrictions were that there be no one within 200 feet of an exhaust outlet during the first 10 min. of fumigation and there be a minimum 2 hour fan aeration period, followed by passive aeration. Only one (1) fumigation event per day is permitted, occurring between 6 PM – 6 AM. An additional requirement was to provide a stack test within 30 days of start-up. The installation permit allowed the facility to get an Air Management Services-approved alternative monitoring plan instead of the stack test. The facility went with that option as there were safety concerns with testing.

Philadelphia has also issued a permit to Horizon Stevedoring for MBr fumigation. They are limited to 250 lbs. of MBr per hour and per batch, and 9.9 tons of MBr per rolling 12-month period. They submitted screen model showing that ambient MBr concentrations will be below the guidelines in AMR VI. The various parameters used in the screen model are permit limits (ex. batch size, stack and exhaust details). They have to follow a monitoring plan and complete a fumigation log for each event.

Another facility, Tioga Marine Terminal at the Port, back in 2010, indicated a 24 tpy source with PTE of more than 600 tons/year, but fumigators indicated that it is no longer there. According to current USDA records, it is not shown reporting.

Virginia

Virginia has had a fumigation code since 2011. As a representative example, Virginia issued a NSR Synthetic Minor permit to Royal Pest Solutions, Inc. for their Suffolk, Virginia fumigation facility (1,152 lb/day MBr) with a requirement of no more than 9.9 tons/year of VOC. A permit requirement established a minimum 300-foot boundary from the fumigation treatment area to either fence or property line.

Georgia

Georgia reviewed a Title V permit application (130+ pages) submittal for Royal Fumigation in Port Wentworth, Georgia under 112(g). Royal withdrew the application when the draft 112(g) determination suggested add-on pollution control was case-by-case MACT. Ultimate Pest Control received an Synthetic Minor permit in 2013 to fumigate logs, but permanently shut down in 2015. Portfresh Logistics received an Synthetic Minor permit in 2016 to fumigate produce.

Next Steps / Conclusion

The workgroup suggested the following possible next steps:

- **Continue the MARAMA Workgroup –** The fumigation workgroup should continue so that fumigation practices can be shared with interested states. MARAMA should investigate possible alternative fumigants to present to the responsible agencies for approval. By conducting this workgroup, MARAMA has started this process of coordination between our states.

- **Fumigation-related Incident Reports** – Keep a record of incident reports that relate to fumigation accidents.

- **Consistent Regulations / Policies across agencies** – Work towards consistent regional regulations and policies. There should be good fumigation practices applied, including using the least toxic pollutant as possible for the shortest time period. Additionally, states should take a proactive approach when issuing air permits by providing Stakeholder Outreach events.

- **Comprehensive Permits -** Based on review of agency permits, the following components are recommended by the workgroup to be included in a fumigation permit:

    - Facility Name / Location
    - Object / Product being fumigated (including size and quantity)
    - Type of fumigant (MBr, Phos, SF)
    - Method of application (including containment system)
    - Fumigation (application) Rate and Quantity
    - Frequency and duration of fumigation (Hour/Day/Yr)
    - Volume to be fumigated

- Duration and rate (acfm) of aeration
- Maximum Emissions on an hourly and on an annual basis (lb/hr & tpy)
- Air Pollution Control, if applicable
- Discharge parameters, including, as applicable stack height, flowrate, and exit velocity
- Risk assessment
- Monitoring, recordkeeping and reporting requirements (before, during and after any aeration events.)
- Signage requirements before/during/after fumigation event.
- If appropriate; measuring instrumentation may be installed to measure and record the total instantaneous fumigant (lb/hr) emitted from all stacks combined and Fumigant detectors may be installed at the fence-line to measure and record the ongoing impact (ppm) at the property line.

- **Urge EPA to establish fumigation facilities as a 112 (c) MACT source category –** To prevent fumigators from crossing state lines to take advantage of less stringent requirements, MARAMA should continue to encourage EPA to implement a national solution. As required by the Clean Air Act Section 112(c), EPA must list categories of major HAP sources. EPA has been notified on multiple occasions of this major source category without a promulgated MACT standard. Promulgating a MACT standard is the surest way to obtain a consistent approach throughout the USA.

    - Publish fumigation categories and subcategories for major and area sources
    - Set emission standards for HAPs (i.e. MBr)
    - Promulgate regulations to establish emission standards for fumigation

- **Require Good Fumigation Practices**

    - Use the least toxic fumigant possible, with a long aeration time
    - Elevate the emission point
    - Conduct monitoring for verification and testing of permitted sources

- **Consider Alternative Fumigants**

    - Ask USDA to approve ethyl formate for use as is approved in other countries (Australia, Indonesia, Israel, Korea, New Zealand, Philippines, Tunisia, South Africa (pending), and Malaysia (pending)).
    - A detailed presentation on Vapormate can be viewed at: http://tablegrape.geometryit.com/wp-content/uploads/2016/02/1200-Swaminathan-Thalavaisundaram-Vapormate-applications.pdf

- **Review and Implement Consistent Technical Approaches**
    - Control Technologies & Industry Cooperation
    - During a recent discussion (with NJ), a technology vendor offered test equipment “free of charge” for on-site technology evaluation.
    - Dispersion Modeling and Risk Mitigation

- **Conference Information**
    - The next Methyl Bromide Alternatives Outreach Conference is scheduled for November 11 - 13, 2019 in San Diego California. Conference details and objectives can be found at: https://mbao.org/conference.
    - Previous conference materials may be found here: https://mbao.org/prev_year.

This paper provided an overview of the findings of the fumigation workgroup, including the regulations and policies established by the MARAMA region (DE, MD, NJ, NC, PA, WV, VA, DC, Alleghany Co. and Philadelphia) along with input from Georgia, South Carolina, and Maine. The main topics were: consistency, EPA/Federal Agency involvement and technical approach. There is still work that needs to be done to make fumigation consistent among our Agencies and more information needs to be shared, including additional presentations by fumigation control technologies, cost and research on alternative fumigants. At the Summer Workshop in August 2018, the MARAMA Board approved MARAMA to continue the workgroup and conduct webinars on a quarterly basis.

Attachment 1 - Other Fumigants to Consider

Ethanedinitrile

The Linde Group, which is a German company, is the patent holder of EDN® FUMIGAS, which has the active ingredient ethanedinitrile, or cyanogen. EDN®s FUMIGAS was developed by the Commonwealth Scientific and Industrial Research Organization (CSIRO) in Australia as a replacement for the ozone depleting MBr. EDN® FUMIGAS limits the impact of pests and disease on timber and in agriculture. It can be used to sterilize soil and control insects, diseases, nematodes, weeds and other parasites before planting fruit and vegetables. It can also be used to fumigate harvested timber and logs.[24]

Ethanedinitrile or Cyanogen is a colorless gas with a strong almond odor at very high levels, and a cyanide derivative.[25] Exposure to cyanogen can lead to cyanide poisoning with headache, weakness, confusion, nausea, dizziness, coma, and even death.[26] OSHA lists cyanogen in the category of "Highly Hazardous Chemicals, Toxics and Reactives. "[27]

Ethyl Formate

VAPORMATE, another product developed by The Linde Group, is a post-harvest fumigant used to control insects in stored grains, fresh produce and food processing equipment.[28] VAPORMATE® contains 16.7% by weight or 11% by volume ethyl formate (active ingredient) in liquid CO_2.[29] When dispensed, the liquid carbon dioxide reduces flammability and acts as a vehicle to deliver the gaseous ethyl formate to the target pests.

Ethyl formate is marketed as a substitute for typical fumigants, given that it is a non-ozone depleting fumigant with a favorable toxicological profile for use on general horticulture as well as commodities impacted by stored product pests. In 1995, The California Department of Food and Agriculture identified ethyl formate as an alternative to MBr.[30] Ethyl formate is a VOC, but not a HAP. Linde Electronics and Specialty Gases of NJ applied for a pesticide registration of ethyl formate in 2013. There is no update by EPA on the status of this registration.[31] Ethyl formate is used outside of the US, but it currently is not a registered fumigant with EPA.

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[24] http://cropscience.linde-gas.com/en/products_services/edn_fumigas/edn.html

[25] he Linde Group Manual for Fumigation; EDN FUMIGAS Fumigant. http://cropscience.linde-gas.com/en/images/EDN_FUMIGAS_application_guide_tcm903-122389.pdf

[26] https://nj.gov/health/eoh/rtkweb/documents/fs/0554.pdf

[27] https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9761

[28] The Linde Group Manual for Fumigation; VAPORMATE. http://www.fumigaciya.ru/sites/default/files/public/page/2011-09/15/vapormate1-13.pdf

[29] http://cropscience.linde-gas.com/en/products_services/vapormate/vapormate

[30] Alternatives to Methyl Bromide: Research Needs for California, California Department of Food and Agriculture, 1995. http://www.cdpr.ca.gov/docs/emon/methbrom/mb4chg.htm

[31] https://iaspub.epa.gov/apex/pesticides/f?p=CHEMICALSEARCH:3:::NO:21,3,31,7,12,25:P3_XCHEMICAL_ID:2314

Ethyl formate occurs naturally in soil, water, vegetation and a range of raw foods like raspberries, cabbage and butter. It has the characteristic smell of rum, and it is a flavoring agent in food. The United States Food and Drug Administration identifies ethyl formate as a "Generally Recognize As Safe" (GRAS) food additive under the FD&C Act.[32]

Ethyl formate advantages include: natural occurrence in food; rapid kill of insects (2-4 hours); fast breakdown of residues to natural products; and low human toxicity. It breaks down on the commodity after fumigation forming naturally occurring products: ethanol and formic acid; however studies have shown residues to be compared to background levels. Due to the lack of residues there is no need for a withholding period before the sale of commodities post-fumigation.

A detailed presentation on Vapormate can be viewed at: http://tablegrape.geometryit.com/wp-content/uploads/2016/02/1200-Swaminathan-Thalavaisundaram-Vapormate-applications.pdf.

Also see EPA document on MBr Alternatives depending on the commodity. [33]

[32] Food Additive Status List, Food and Drug Administration. https://www.fda.gov/food/ingredientspackaginglabeling/foodadditivesingredients/ucm091048.htm#ftnE

[33] https://www.epa.gov/sites/production/files/2015-07/documents/alternatives_for_specific_commodities_0.pdf

Attachment 2 - Fumigation Workgroup

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Attachment 3 – References and Resources stored on the MARAMA Sharefile Site

References:

https://www.epa.gov/sites/production/files/2016-09/documents/methyl-bromide.pdf

https://www.epa.gov/ods-phaseout/methyl-bromide

https://www3.epa.gov/pesticides/chem_search/reg_actions/reregistration/fs_PC-078003_1-Sep-93.pdf

https://en.wikipedia.org/wiki/Bromomethane

https://en.wikipedia.org/wiki/Sulfuryl_fluoride

https://en.wikipedia.org/wiki/Phosphine

Sulfuryl Fluoride General Fact Sheet by NPIC Jan. 2017 http://npic.orst.edu/factsheets/sfgen.pdf

http://www.valuerecovery.net/Home.html

http://cropscience.linde-gas.com/en/images/MPG_BA_Fumigants%20EDN%20datasheet_Timber_A4%20leaflet_VIEW_tcm903-115753.pdf

http://nordiko.com.au/wp/

State information given via email, webinars and phone calls provided throughout this document and in an excel spreadsheet.

2018 national treatment facility list – provided by Mary Sullivan Douglas from Tom Gentile, NY

Resources – many are stored on the MARAMA Sharefile Site

Spreadsheet of State Information (as of July 2018)

State Policies as Written (when available) – SC, MD

112(c) Source Category Letters

2018 National Treatment Facility List

Example Permits / Applications: DE, NJ, PA-PHL, VA, GA

a. GA: http://permitsearch.gaepd.org/ search for “portfresh” or “ultimate pest”

NJ Sample Risk Worksheet

b. https://www.state.nj.us/dep/aqpp/risk.html

NJDEP DIVISION OF AIR QUALITY RISK SCREENING WORKSHEET

For Long-Term Carcinogenic and Noncarcinogenic Effects and Short-Term Effects

October 2017

For source operations emitting air toxics. One worksheet should be completed for each emission point, which should include all air toxics above reporting threshold or for which there is a federally enforceable limit included in an approved permit. Based on the assumptions made when generating the model, the following sources may not use this worksheet: (1) Sources without stacks, such as certain dry cleaners, degreasers, storage tanks, and gasoline stations, (2) sources with stacks with a horizontal or downward discharge direction, or (3) sources with stack heights less than 10 feet. See Technical Manual 1003 Guidance on Preparing a Risk Assessment for Air Contaminant Emissions for a complete list of assumptions. For information on how to evaluate risk from other kinds of sources, contact Air Quality Evaluation at 609-292-6722.

To see a listing of air toxics by CAS number, click on the "CAS Index" tab at the bottom of this worksheet page.

This is a protected file. Changes are allowed only to certain cells (those in yellow). It is also a "read only" file. To save the data you input, select "File" on the menu above, then "Save as" in your own files, under the name of your choice. Input data only to yellow fields. Incremental cancer risk (IR) and hazard quotient (HQ) will calculate automatically when you type in the stack parameters (stack height and distance to property line) and an emission rate.

For references for toxicity data (URFs and RfCs), see the lists at www.nj.gov/dep/aqpp/risk.html.

Date	
Facility ID No.	
Activity ID No.	
Facility name	EXAMPLE!
Facility location	
File name (.xls)	

Emission Unit/Batch Process ID No.		Stack height[1]	10.0	ft
Emission Point ID No.		Distance to property line	20	ft
Equipment ID No(s).		**Annual air impact value, C'**	162.77	**(ug/m³)/(ton/yr)**
Operating Scenario(s)		**24-hour air impact value, C'_{st}**	4469.5	**(ug/m³)/(lb/hr)**

KEY:

Long-Term Effects

- **Q** = Annual emission rate (in tons per year)
- **C** = C' x Q = Annual average ambient air concentration
- **URF** = Unit risk factor (for carcinogenic risk)
- **IR** = C x URF = Incremental risk (for carcinogen)
- **RfC** = Reference concentration (for noncarcinogenic effects)
- **HQ** = C/RfC = Hazard quotient (for noncarcinogenic risk)
- **Rslt** = The result of comparing the IR or HQ to the negligible threshold (FER if > threshold, Negl. if <= threshold)
- **FER** = Further Evaluation Required (See Notes for thresholds)
- **Negl.** = Negligible (See Notes for thresholds)

Short-Term Effects

- **Q_h** = Hourly emission rate (in pounds per hour)
- **C_{st}** = C'_{st} x Q_h = Short-term average ambient air concentration
- **RfC_{st}** = Short-term reference concentration (for noncarcinogenic effects)
- **HQ_{st}** = C_{st}/RfC_{st} = Hazard quotient for short-term noncarcinogenic effects
- **Rslt** = The result of comparing the HQ_{st} to the negligible threshold (FER if > threshold, Negl. if <= threshold)
- **FER** = Further Evaluation Required (See Notes for thresholds)
- **Negl.** = Negligible (See Notes for thresholds)

[1] When evaluating risk for diesel engines, use the equivalent stack height consistent with the memo dated June 10, 2009. Click here to view the "Stack Height Equivalents for Use in First Level Screening Analyses for Diesel Engines" memo.

EXAMPLE!				LONG-TERM EFFECTS								SHORT-TERM EFFECTS				
	HAP	CAS No.	Air Toxic	Q (ton/yr)	C (ug/m³)	URF [(ug/m³)⁻¹]	IR	Rslt	RfC (ug/m³)	HQ	Rslt	Q_h (lb/hr)	C_{st} (ug/m³)	RfC_{st} (ug/m³)	HQ_{st}	Rslt
1	*	75070	Acetaldehyde			2.2E-06			9					470		
2	*	60355	Acetamide			2.0E-05										
3		67641	Acetone						31000					62000		
4		75865	Acetone cyanohydrin						2							
. . . . .																
150	*		Lead			1.2E-05								0.1		
151	*	108316	Maleic anhydride						0.7							
152	*		Manganese						0.05					0.17		
153	*		Mercury (elemental)						0.3							
154	*	7439976	Mercury (inorganic)						0.03					0.6		
155		126987	Methacrylonitrile						0.7							
156	*	67561	Methanol						4000					28000		
157	*	74839	Methyl bromide	1.0E+00	1.6E+02				5	**3.3E+01**	**FER**	3.0E+00	33521.3	3900	**8.6E+00**	**FER**
158	*	74873	Methyl chloride			1.8E-06			90							
159	*	71556	Methyl chloroform						1000					9000		
160		78933	Methyl ethyl ketone						5000					13000		
161	*	108101	Methyl isobutyl ketone											3000		
162	*	624839	Methyl isocyanate						1							