VALUE RECOVERY

Proposed Rule 1495 – Commodity Fumigation

Rule Making Suggestions to the South Coast Air Pollution Management District submitted by Peter J. Joyce. January 5, 2026

1. **No 'fracturing' of Methyl Bromide (MB) related imports via use of multiple locations.**

   Importers are thwarting the intent of the 10 ton rule where emissions controls are required for those facilities using more than 10 tons/yr. They are doing this by 'fracturing' their imports to several locations, with all of them being under 10 tons. A rule is needed to require imports from any individual ship that requires more than 10 tons/yr of MB (or a lower threshold if that is in the interest of SCAQMD) fall under the requirement for emissions controls.

2. **Elimination of the 'fumiscope' as a method for measuring the concentration of methyl bromide in a fumigation chamber or exhaust stream.**

   The fumiscope is based on using the principal of thermal conductivity detection to create an electrical signal where a stream containing methyl bromide is compared via a Wheatstone bridge to a stream not containing methyl bromide.

   Documented (I have an internal document from the USDA) problems with the fumiscope are as follows:

   a. Calibrations of the fumiscope happens BEFORE they are being used and are based on air streams that have different levels of humidity as compared to the stream actually being measured. The fumigated commodities are expelling moisture into the sweep air (that also has moisture) thus throwing off the calibration. Humidity has a strong influence on thermal conductivity and is not accounted for by using a thermal conductivity detector.
   b. It was recommended that fumiscopes be warmed up at least an hour in advance (and one USDA researcher recommended 24 hours in advance) to come to equilibrium. This is not happening in the field where they are turned on, not calibrated for use, and then applied resulting in bogus results.
   c. The flowmeter used in both calibration and use is not accurate nor is it standardized, thus the air flowrate over the electrical elements during use and calibration can be significantly different, resulting in either greater or less heat loss from the Wheatstone bridge elements, resulting in erroneous results.

VALUE RECOVERY

d. Methyl bromide when heated by the electrical elements in the Wheatstone bridge can produce small amounts of HBr, a very strong mineral acid. Over long service times the electrical elements suffer oxidation, thus changing their resistance and providing false readings.
e. The noise to signal ratio is very high and these units are inaccurate below 2 oz/ft3 (=2 g/m3). Thus, at the end of fumigations the fumigators claim that methyl bromide is no longer present when in fact they are just not reading it.

It is recommended to use a Non-Dispersive Infra-red detector with a path length of at least 10 cm or its equivalent be used. One company that made these was Spectros (1) and we found these to be accurate to within 1 – 2%.

3. Methyl bromide injection practices.

Fumigators currently use a propane heated water tank to heat a small coil that heats methyl bromide as it is injected. Methyl bromide, upon evaporation, withdraws enthalpy (from the water) and 'spits' out droplets of pure MB from the injection tube if it is not fully evaporated. This is why the fumigators place plastic covers over the produce inside the fumigation chamber to keep the methyl bromide droplets from landing on produce and degrading it. This is also the reason they use internal recirculation fans to uniformly distribute the unevaporated methyl bromide throughout the chamber. This practice is absurd in that it ignores the fundamental thermodynamics of transfer of methyl bromide from the liquid state to a gas dissolved in air. It also leads to the false conclusion that the methyl bromide is 'heavier than air' and thus concentrates at the bottom of the chamber. This is a fallacy because the higher concentration is observed due to evaporating droplets that have fallen to the floor of the chamber, and evaporates slowly, and not molecules of methyl bromide in air sinking due to their higher molecular weight. It is absurd to consider that a molecule, once mixed in air, would 'de-mix' in this time frame without the aid of aggressive centrifugation. This also shows the complete lacking of either application or understanding of the thermodynamics of methyl bromide practiced for decades by the fumigation industry.

It is recommended that:

a. The rate of introduction of methyl bromide into a fumigation volume be controlled via a flowmeter or a loss in weight scale so as to not overcome the rate of heat transfer from the heated coil. If the rate is too fast (and currently it is not controlled) then droplets of methyl bromide are sent into the chamber resulting in mal distribution of the concentration of methyl bromide.

The coil must be immersed in a heat transfer fluid greater than 200F. Water will work in this instance but must be continuously replenished if it is allowed to vent.

b. The outlet distribution piping of the vaporizer MUST be heated and insulated to keep the methyl bromide gas stream in a vapor state all the way to the point of delivery inside the fumigation chamber.
c. The injection system needs to be 'balanced' so that the same rate of delivery is maintained across each injection point.

4. Sealing methyl bromide fumigation volumes.

Current practice of sealing overhead tarps to a porous cement floor with 'sand snakes' is archaic and dangerous. We have specific recommendation on this topic that will be supplied in a subsequent letter.

5. Fumigation and Emissions Automation and Data Collection

Modern process control computers can easily be used to control the temperatures needed in these systems, the flow of methyl bromide into the fumigation chamber, the flow of air during desorption as well as control all the necessary automatic valves. These flows, temperatures and valve positions can easily be recorded every minute of a fumigation, thus giving management the ability to 'tune' the system to obtain the maximum control of methyl bromide while simultaneously minimizing cycle times.

It is not prudent to determine exactly what instruments are needed for any individual fumigation operation because each is custom designed and sized. However, the overall expectation that everything that can be measured, should be measured and recorded. Thus, if a failure should ever occur it can be pinpointed and corrected immediately or, if necessary, more dramatic interventions made to ensure total compliance.

6. Methyl Bromide Inventory management

The cylinders on site for use in methyl bromide fumigation should be barcoded and available upon inspection. They must match invoices received. A database set up for easy inspection should be kept that shows cylinders received, cylinders in use and cylinders returned. Return date should absolutely match the records of the methyl bromide vendors.

7. **Methyl bromide handling – 'Pigs'**

Methyl bromide should be allowed to be distributed through 1.5 ton (3,000 lb) 'Pigs' specifically engineered to allow for dispensing under computer-controlled conditions. (In the precious metal industry, liquid chlorine is dispensed through these cylinders. They are located in a sealed, cement block building with special overhead handling cranes that provides straightforward and direct connection to distribution piping. Regulatory oversight is done through the TCPA – Toxic Chemical Protection Act – that could be adopted for methyl bromide). The benefit of this system is that it enables large users to handle one cylinder at a time and up to 3 cylinders can be manifolded together, under controlled conditions. Thus, one ship's cargo can be fumigated with just 3 of these large cylinders. The alternative, used now is that fumigators can only use many 200 lb cylinders that are moved to the fumigation chambers on wheeled carts. These relatively small volumes that must be connected individually. Inherent in the use of pigs is dedicated and fixed methyl bromide distribution piping, heated and insulated, made of 1/2" stainless steel. (Pure methyl bromide is NOT corrosive). Weigh scales, evaporation coils and baths and all valves are engaged under computer control. Rates of release are controlled by orifices that limit the flowrate to that prescribed for the fumigation and the evaporator is sized to ensure that all the methyl bromide is gaseous as it enters the fumigation chamber.

8. **Fumigation practices – fumigating during daylight hours.**

With fumigation done in sealed environments and with proper emissions controls, fumigation during daylight hours frees up resources to allow for movement of product 24/7 and not restricted to between 10 PM or midnight and 6 AM as is current practice. This significantly decreases the size of the emissions control equipment, allowing it to service more than one fumigation chamber and balances the rates of product movement through ports or distribution facilities.

9. **Other fallacies and falsehoods –**

   a. **Carbon capture for methyl bromide is typically 10 wt %.**
      i. This data was reported in a paper by Leech et al (2) who set up an experiment where pure methyl bromide was fed to a fixed weight of carbon and when breakthrough occurred, he measured that the carbon had taken up 10% of its weight in methyl bromide. This was done using small tubes

VALUE RECOVERY

at temperatures ranging from 10 to 50C. While his data is probably accurate, the extension of this application to fumigations in practice is not. An accurate statement from this data would be that the equilibrium concentration of 100% methyl bromide on carbon is 10 wt%

ii. However, these parameters are not achieved in practice. The methyl bromide coming from a fumigation chamber is at a maximum of 1.5 volume % in air, not 100% and the fumigation chamber is continually swept with fresh air resulting in the concentration of methyl bromide being fed to the carbon bed decreasing exponentially with time. The same phenomena occurs in a chromatographic column where chemicals are swept along the column to a detector with a carrier gas. In this case the carrier gas is the sweep air that flushes out the fumigation chamber. Commercial fumigations show that the carbon holds about 2.4 wt% methyl bromide prior to breakthrough due to the large volumes of air that 'chases' the methyl bromide through the carbon bed until just before breakthrough.

b. Emissions controls will not scale up

i. <u>Those making this claim are the same ones that prevent it from happening.</u> The commercial system installed at Guadalupe Cooling was scaled without incident and this is the basis of the 5 Source Tests done on Value Recovery technology. The scrubber scale-up went from 1 sq ft to a tank 15 ft in diameter or a factor of 254x. The carbon bed was scaled from a one inch pipe to a container 8 ft wide and 12 ft long – a factor of 17,657x. the latter is also supported by a fundamental math model based on the Navier-Stokes equations published by Peter Joyce at the Chengdu Fumigation conference in 2008 (3), attached.

c. The maximum efficiency of emissions controls is 99% for the carbon bed and 92% for the scrubber.

i. The carbon bed efficiency actually increases with continued use because the desorption step is in the opposite direction of the adsorption step. Thus, the top of the carbon bed is continually swept with hot (200+F) air on each successive desorption cycle thus continually enhancing its adsorption capability due to this on-going conditioning and can easily be over 99.9%.

ii. The scrubber efficiency is currently shown as 92% based on the Source Tests at Guadalup Cooling. However, our system operated at the Port of Miami was based on continuous internal recirculation of the desorption air

iii. back to the scrubber. The net result is that the methyl bromide once captured on the carbon beds after exiting the scrubber never leaves the system. This results in scrubber efficiencies greater than 99%. However, this has not been demonstrated yet with a source test but will be the design used in the future.

d. **The carbon beds will catch on fire.**

We did have a carbon bed fire at Guadalup Cooling. However, the reason the bed caught fire was that we dried the carbon bed out, mistakenly, for over 72 hours until parts of it oxidized and reached temperatures that supported combustion. The reason this happened was two-fold. First, a temperature probe meant to read the temperature of the center of the bed was way off center (contractor error) and gave us a bad reading. The second error, compounded by the poor positioning of the temperature probes, was still drying the bed out over 72 hours when it was, unknown to us, bone dry and heating up. The flames immediately ceased when the desorption blower was turned off. Future designs have multiple temperature probes plus limits on conditioning times. This event never occurred in the subsequent hundreds of fumigations done over 10 years after start up.

e. **The carbon will have to be replaced often**

This is a fallacy supported by those who feel the carbon bed needs to be replaced after each fumigation. The carbon itself is part of the capital cost. The same carbon bed was used for over 10 years at Guadalupe Cooling and showed no signs of needing to be replaced.

10. Suppliers and Receivers of fumigated products should be required to be responsible for, and underwrite the fumigators handling their products.

The current set up allows for suppliers and commerce customers to have a hands-off relationship with the fumigator who is treated as an independent actor. This provides for the incentive to minimize capital investment and cut costs whenever possible. The produce imported (or exported) into commercial retail facilities should be grandfathered back to the supplier, legally, and any errors, emissions or regulator avoidance should fall equally on the supplier and the final customer.

VALUE RECOVERY

Peter J. Joyce
President Value Recovery, Inc.
January 5, 2026

References

1. Spectros Non-Dispersive Infra-Red Analyzer https://www.pestfogsales.com/wp-content/uploads/2019/02/Spectros-Instruments-MB400-Data-Sheet.pdf

2. J. Snyder, J. Leesch, "Methyl Bromide Recovery on Activated Carbon with Repeated Adsorption and Electrothermal Regeneration", Ind. Eng. Chem. Res. 2001, Vol. 40, pgs 2925-2933.

3. Peter J. Joyce and Roman Bielski, “Two Stage System for the Destruction of Methyl Bromide from Fumigation Ventilation Streams”. Paper given at the 2008 Conference on Fumigation Practices, Chengdu, China. (attached)