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1. PAPER DOCUMENTS:	No. of pages	Date sent to Ozone Secretariat
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USA CUN11 <u>Post Harvest National Pest Management Association</u>		
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METHYL BROMIDE CRITICAL USE RENOMINATION FOR PREPLANT SOIL USE (OPEN FIELD OR PROTECTED ENVIRONMENT)

NATIONAL PEST MANAGEMENT ASSOCIATION

1. SUMMARY OF NEED FOR METHYL BROMIDE AS A CRITICAL USE

This sector includes cheese and food processing plants treated by National Pest Management Association (NPMA) members and are not included in the Commodity or in the Food Facilities Chapters of the US nomination. Food Processing Facilities included in this application are: processed foods (such as chips, crackers, cookies and pasta), spices and herbs, and cheese processing plants. Methyl bromide is typically utilized in processed food and feed facilities as a space fumigant for treating the facility 1 to 3 times per year. As the need arises, methyl bromide is also used for trailer fumigations of product or packaging material. These facilities are under intense pressure from many insect pests as well as rodents.

CHEESE: Methyl bromide fumigation for cheese occurs to ensure pest-free food and meet the strict requirements of the Food Sanitation Regulations. Cheese manufacturers may target their products during fumigations with methyl bromide when a mite infestation is identified by USDA inspection and a fumigation is ordered. Cheese does not have a technically and economically feasible alternative available. Whereas sulfuryl fluoride and phosphine are the primary alternatives in most commodities, they are unsuitable for cheese facilities. Phosphine fumigations take much longer than methyl bromide fumigations and are not a feasible alternative when rapid fumigations are needed; is corrosive to certain metals; is limited by temperature. Sulfuryl fluoride has been determined not to be efficacious on mites. Therefore, sulfuryl fluoride will not be able to replace methyl bromide in this sector. Also, adoption of not in kind alternatives, such as controlled atmospheres, cold, and carbon dioxide under pressure, would require major investments for appropriate treatment units and /or retrofitting of existing cheese manufacturing facilities.

FACILITIES: Primarily this sector is treating only the portions of the facilities that contain electronic components and have machinery with copper and copper alloy parts. These facilities are under intense pressure from many insect pests. The majority of these food processors do not target any of their commodities to be fumigated with methyl bromide, although some may be present in the equipment during fumigation.

Food processing facilities in the United States have reduced the number of methyl bromide fumigations by incorporating many different techniques to control pests. The most critical strategy implemented is IPM, especially sanitation, in all areas of a facility. Facilities are now being monitored for pest populations, using visual inspections, pheromone traps, light traps and electrocution traps. When insect pests are found, facilities will attempt to contain the infestation with treatments of low volatility pesticides applied to both surfaces and cracks and crevices; spot treatments with heat or phosphine will be used in areas that are suitable. Incoming ingredients are inspected for insect pests and may be treated with phosphine. These techniques do not disinfest a facility but are critical in monitoring and managing pests, and hopefully preventing

outbreaks. However, when all these methods fail to control a pest problem, facilities must rely on fumigation, to kill insects within the equipment and even the walls of the structure. There are two primary fumigants available to this industry that may accomplish these tasks: methyl bromide and sulfuryl fluoride.

HERBS AND SPICES: Methyl bromide is requested for a few small mills where herbs and spices are blended into packages (such as for pizza mixes) that are then added to pre-packaged goods. These facilities are similar to food processing facilities in that there are silos, mixing areas, packaging areas, etc. These facilities utilize methyl bromide to target pests present in inaccessible areas of the structure, such as the equipment and buildings. The ingredients or finished products that may be stored on-site are not targeted for fumigation. However, the problem in some of these small mills is that they are all under one roof without any way to completely segregate the different areas.

Fumigants of choice for treating herb and spice commodities are ETO, PPO, irradiation and phosphine. These alternatives are not feasible to disinfect the facility itself.

See previous discussion on sulfuryl fluoride in food processing facilities.

The USG has applied an aggressive transition rate which is reflected in the nomination amount and detailed in Table 2.

TABLE 2. NOMINATION AMOUNT

**2011 Methyl Bromide Usage Newer Numerical Index (BUNNI)
Transition Use Reduction Description Spreadsheet**

SECTOR		NPMA			
		Processed Foods	Spices and Herbs	Cheese Processing Plants	Sector Total / Average
Quantity Requested for 2010:	Amount (kgs)	33,527	2,439	1,812	37,778
Quantity Recommended by MBTOC/TEAP for 2010 :	Amount (kgs)	33,527	2,439	1,812	37,778
Quantity Approved by Parties for 2010:	Amount (kgs)	33,527	2,439	1,812	37,778
	Volume (1000 m ³)	1,676	122	91	1,889
	Rate	20	20	20	20
Transition from 2010 Baseline Adjusted Value	Percentage (%)	-84%	-84%	0%	-82%
Quantity Required for 2011 Nomination:	Amount (kgs)	14,498	1,055	1,812	17,365
	Volume (1000 m ³)	725	53	91	869
	Rate	20	20	20	20

2. SUMMARIZE WHY KEY ALTERNATIVES ARE NOT FEASIBLE

This nomination is for facilities, or portions of facilities, that are unsuitable for the alternatives, and where the alternatives are not economically feasible. Sulfuryl fluoride is highly dependent upon temperature, so should a facility need fumigation during cold temperatures, this chemical may not be a cost-effective solution. In addition sulfuryl fluoride requires higher dosages for egg kill, a paramount concern in certain facilities. Phosphine can be explosive and is corrosive to many metals that are present in facilities, especially in the computers and other electronic process control instrumentation. Heat is dependent on several parameters: the structural composition, as different components expand and contract at different rates; the building design/layout factors, which affect the ability to evenly distribute heated air; and the availability of convenient and economical sources of heat. Also heat may not be a viable option for treatment of food products or commodities.

There are also some regulatory issues with sulfuryl fluoride related to the commodities that may be directly fumigated. For example, according to the Profume® label pasta is not listed as a material approved for direct treatment. Therefore, the interpretation is that all pasta products would need to be removed from treatment areas or sufficiently protected to prevent the formation of sulfuryl fluoride residues within the pasta products. This may sufficiently increase the costs and timing considerations for sulfuryl fluoride use on a host of processed foods and ingredients.

The objection by the Fluoride Action Network, Beyond Pesticides, and Environmental Working Group against the tolerances of sulfuryl fluoride is still pending.

3. SUMMARY OF RECENT RESEARCH

Cheese

There has been no research specific to cheese, as these facilities are only fumigated when mites are found during a USDA inspection. However, researchers investigating dry cured pork products are including cheese in their studies as the arthropod pests are the same. For the convenience of MBTOC, the research information from the US nomination for dry cured pork products appears below.

In the spring of 2007 a proposal was submitted to USDA CSREES Integrated Research, Education, and Extension Competitive Grants Program- Methyl Bromide Transitions by several meat scientists and an entomologist. This proposal was recently funded for the next three years.

There are several objectives to this multiple year research program: First is to determine the effectiveness of chemical controls (sulfuryl fluoride, phosphine, and methyl bromide) against all life stages of both mold mites (*Tyrophagus putrescentiae*) and red legged ham beetles (*Necrobia rufipes*). Second objective is to determine the effectiveness of carbon dioxide and ozone against all life stages of both mold mites and red legged ham beetles. The third objective is to test the effects of sulfuryl fluoride, phosphine and methyl bromide on the quality and safety of the dry cured hams. The fourth objective is to conduct an economic analysis of the alternatives demonstrated to be technically viable alternatives for methyl bromide in this industry.

The results of sulfuryl fluoride efficacy investigations on *Tyrophagous putrescentiae*, ham mite, and *Necrobia rufipes*, red-legged ham beetle, were presented at the 2008 MBAO Conference, in Orlando, FL. The studies included eggs and a mixture of adults and nymphs of mites and eggs, large larvae, pupae and adults of beetles. The experiments were conducted for 48 hours at 23° C at various concentrations of sulfuryl fluoride. The investigators achieved 100% mortality of red-legged ham beetle adults and pupae at about 4.0 g/m³, 100% mortality of larvae at 5.7 g/m³. Eggs of red-legged ham beetles died at 24.0 g/m³ of sulfuryl fluoride, well below the maximum label rate. (Phillips, et al. 2008) Mortality of ham mites required higher concentrations of sulfuryl fluoride. A concentration of about 100.3 g/m³ was necessary to obtain 100% mortality of adults and nymphs under the test conditions. However this concentration obtained only a 95% mortality of mite eggs. This is about three times the legal label rate. (Phillips, et al. 2008)

Facilities

Jim Campbell (2008) evaluated efficacy of structural fumigations. He investigated trap catches of *Tribolium castaneum*, red flour beetle (RFB), in two flour mills. Mill 1 had 8 methyl bromide fumigations and 2 sulfuryl fluoride fumigations. Mill 2 had 11 methyl bromide fumigations. The average trap capture was higher in Mill 1 than in Mill 2, with a reduction of 93% and 67%, respectively, after fumigation. In addition, the average proportion of traps with RFB was reduced after fumigation (62% and 66%, respectively). Campbell (2008) also examined the seasonal impact of fumigation efficacy. In Mill 1 he reports that the mean trap captures in summer are higher than in either spring or fall, although there is no significant difference between spring and summer. There is a major reduction of in mean trap captures after fumigation, regardless of time of year. Mill 2 has higher mean trap captures in the fall, but again reduction after fumigation. Spring fumigations at Mill 1 results summarized in Table 3 below:

Table 3. Summary of Trap Capture Reductions by Campell (2008).

Fumigant	Reduction	
	% Average Trap Capture	% Proportion of Traps with Captures
Sulfuryl Fluoride, low rate	98	71
Sulfuryl Fluoride, high rate	96	93
Methyl Bromide, normal rate, single	84	28
Methyl Bromide, normal rate, overall average	92	55

Campbell (2008) also presented data regarding rebound after fumigation. He found that season and pest density did have an impact on rebound. Rebound was slower during the fall. The use of aerosols and enhanced IPM also slowed rebound. This multiyear study has taken place in only two flour mills, and needs to be demonstrated in other locations.

In a comparison of sulfuryl fluoride and methyl bromide in mill fumigations (Tsai, et al., 2008), it was found that methyl bromide killed RFB and Indianmeal moth (IMM) eggs better than sulfuryl fluoride. But that sulfuryl fluoride killed RFB and IMM pupae better than did methyl

bromide. There was no difference in the fumigants on the mortality of larvae and adults. These were commercial fumigations, but rates and exposure times were not reported. In addition, rebound was also investigated in these mills. It was found that rebound varied by both season and mill. One mill which responded only when critical conditions existed averaged a rebound rate of 8 months, whereas other mills had a spring rebound average of 3 months. Summer populations of flour beetle averaged a 4.8 months rebound period. Fall fumigations took advantage of the lower ambient temperature by increasing rebound periods to an average of 7 months. (Tsai, et al., 2008)

Reichmuth and Klementz (2008) have investigated how to better use sulfuryl fluoride to manage pest populations. They report that in Germany and UK that many mills have considerable numbers of surviving pests despite strict dosage schedules. The authors propose an increased dosage of sulfuryl fluoride or perhaps to use the fumigant in combination with heat or another chemical. They cite the methyl bromide CT for RFB as 5 g/m³ in the laboratory but the field (structural) requires 20g/m³. For sulfuryl fluoride, the CT for RFB post-embryonic is 113 gh/m³ but eggs require 1,669 gh/m³. In addition to heat, the authors examine sulfuryl fluoride with phosphine, with carbon dioxide, with hydrogen cyanide. They provided data on the combination with hydrogen cyanide, but since cyanide is not registered for use in the U.S., it will not be considered further. The authors also looked at Pulsed Fumigation. As the authors noted this method has a longer down time and potentially an MRL problem. The conclusion was that although these combinations may be clumsy or time consuming, there is still a potential that further research may be able to overcome these weaknesses. (Reichmuth and Klementz, 2008)

Indianmeal moth is a ubiquitous stored product pest and information on aerosol efficacy on eggs and larvae is limited (Arthur, et al. 2008). This investigation examined methoprene alone and in combination with esfenvalerate. Percent mortality of IMM eggs exposed to esfenvalerate was about 65% and about 65% when exposed to methoprene. Percent mortality of IMM larvae exposed to esfenvalerate was 10% but 99.6% when exposed to methoprene. The combination of esfenvalerate aerosol with an IGR like methoprene does control eggs and larvae of IMM. In addition to efficacy, an economic analysis was also conducted, which demonstrated that this combination was cost effective. (Arthur, et al. 2008)

4. ECONOMIC INFEASIBILITY OF ALTERNATIVES

TABLE 4. ECONOMIC SUMMARY FOR EACH ALTERNATIVE

METHYL BROMIDE ALTERNATIVE	ECONOMIC SUMMARY
HEAT TREATMENT	Heat treatments are technically and economically feasible in some cases. Most insects do not survive more than 12 hours when exposed to 45°C or more than 5 minutes when exposed to 50°C (Fields, 1992). In very cold regions, heat is costly and production time is lost for heat up. In old facilities, high heat could inflict structural damage. Also, this approach is not feasible for treating commercial-scale commodity volumes, as heat is a poor penetrator of packaging, boxes, and commodities. Also, structures with many concrete partitions are not good candidates for heat treatment because heat may not be

METHYL BROMIDE ALTERNATIVE	ECONOMIC SUMMARY
	<p>evenly distributed; hence, efficacy is reduced.</p> <p>Under laboratory conditions, brief exposure of commodities to high temperatures may eliminate insects without adversely affecting product quality. However, high heat can have an adverse affect on food quality (e.g., cheese).</p> <p>For food processing facilities which are able to convert to heat treatment, there may be economic losses are from additional production downtimes in cold facilities due to longer fumigation time. There are other food processing facilities in areas of United States where heat treatment is not feasible. Economic losses due to downtime with heat treatment are persistent. However, some facilities experience better control with heat than fumigation due to leaky structures that allow gas to escape.</p>
<p>PHOSPHINE (ALONE OR IN COMBINATION)</p>	<p>Although phosphine does kill insects, it is corrosive to metals, especially copper and its alloys (bronze and brass); these metals are important components of the electronics that run the manufacturing equipment. In addition, some equipment (e.g., motors, mixers, etc.) has metal parts that contain copper. This alternative is already being used in the areas without electronics and where temperatures are not a factor.</p> <p>Phosphine also requires a longer application time compared to methyl bromide. Phosphine fumigation takes 3-10 days, depending on temperature, compared to 1 day for MB (Hartsell et al., 1991, Zettler, 2002, Soderstrom et al., 1984, phosphine labels). An additional 2 days are needed for outgassing phosphine. Phosphine fumigation is least feasible during the colder winter months when, according to label directions, the minimum exposure periods increases to 8-10 days (plus two days for aeration) when commodity temperature decreases to 5°C - 12°C. Phosphine is not used when commodity temperature drops below 5°C (Phosphine and Eco2fume® labels). Phosphine is not a suitable alternative to methyl bromide when rapid fumigations are needed to meet customer timelines.</p> <p>Resistance to this fumigant has also been reported for several stored product pests. Furthermore, cheese makers claim that phosphine causes damage to the cheese, “melting of the cheese” and may cause acid residue, acrid off-odors and affect flavor.</p>
<p>IRRADIATION</p>	<p>Although rapid and effective, irradiation alone may result in living insects left in the treated product. Treated insects are sterilized and stop feeding but are not immediately killed. The high dosages necessary to cause immediate mortality in target insects may reduce product quality. Irradiation also requires major capital expenditures and irradiated food are not widely accepted by consumers.</p>
<p>CARBON DIOXIDE (HIGH PRESSURE)</p>	<p>Facilities in the United States are not airtight enough for modified atmospheres or carbon dioxide to be effective primarily due to age of the facility; specifically, most facilities are more than 25 years old.</p>
<p>SULFURYL FLUORIDE</p>	<p>A portion of the food processing facilities can economically convert to sulfuryl fluoride. Other facilities cannot due to economic losses that would result from higher treatment costs which arise at lower temperatures. For a small</p>

METHYL BROMIDE ALTERNATIVE	ECONOMIC SUMMARY
	percentage, SF is not technically feasible due to cold temperatures. Adding heat to increase the efficacy of SF is also not an economically feasible option.

Sulfuryl Fluoride

Results of the assessment of using sulfuryl fluoride as an alternative to methyl bromide are provided in Table 4. For purposes of this analysis, current prices of sulfuryl fluoride and methyl bromide were assumed equal and plant temperatures are assumed to be 29.44 degrees centigrade (85 degrees Fahrenheit). This analysis only covers cases where sulfuryl fluoride is a technically feasible alternative to methyl bromide and its use is not restricted by label instructions or state regulations. For example, sulfuryl fluoride is technically feasible only in facilities that do not prepare mixed products (e.g., cake mixes). Fumigation with sulfuryl fluoride at lower temperatures controlling all pest life stages is infeasible due to prohibitively high application rates and minimal efficacy.

Heat Treatment

Potential economic losses were estimated for the food-processing facilities that have not been converted to heat treatment. This analysis only covers cases where heat treatment is technically feasible; it does not cover situations where heat would degrade the commodity being processed (those with fats and edible oils).

Production downtime is estimated at one additional day for cold facilities due to longer heat-up period. Costs of heat treatment include all labor, transportation, and fuel. Fuel used is generally propane and could increase significantly with fuel costs. See Table 5 below.

TABLE 5. ANNUAL ECONOMIC IMPACTS OF METHYL BROMIDE ALTERNATIVES FOR NPMA STRUCTURES

NPMA Structures (Spices & Food Processors) ¹	Units	MeBr ²	SF ²	Heat: 7°C	Heat: 29 °C	SF + 7°C Heat
Total Operating Costs	\$/year	na	na	na	na	na
Total Fumigation/Heat Costs	\$/year	\$ 24,000.00	\$ 30,000.00	\$ 70,000.00	\$ 150,000.00	\$ 100,000.00
Quantity of Fumigant (One treatment per year)	kgs/facility	522	1,134	na	na	na
Fumigant cost (i.e., gas)	\$/year	\$ 9,000.00	\$ 15,000.00	na	na	\$ 15,000.00
Other fumigation costs (i.e., labor, equip., etc.)	\$/year	\$ 15,000.00	\$ 15,000.00	\$ 70,000.00	\$ 150,000.00	\$ 85,000.00
Other Operating Costs	\$/year	na	na	na	na	na
Time Lost	days	0	0	0	1	0
Total Loss (MeBr to alt)	\$/year	\$ -	\$ 6,000.00	\$ 46,000.00	\$ 126,000.00	\$ 76,000.00
Average Facility Loss per Kg MeBr Requested	\$/kg MB requested	na	\$ 11.50	\$ 88.18	\$ 241.55	\$ 145.70

¹ Analysis for a 28,317 cubic meter (1,000,000 cubic foot) facility

² Temperature at 29 degrees C

CITATIONS

Arthur, F. H., E. A. Jenson, and J. R. Nechols. 2008. Esfenvalerate plus methoprene aerosol to control the Indianmeal moth. Presented at MBAO, Orlando, Fl. November 2008. Available at: <http://mbao.org>

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