



## Recommended Preventative and Control Measures to Reduce the Risk of Obstructive Lung Disease Among Workers in the Microwave Popcorn Packaging Industry

### PULMONARY FUNCTION TESTING

Spirometry, or pulmonary function testing (PFT), involves measuring the breathing capacity of the lungs. It is particularly useful in determining the presence or absence of obstructive lung disease among exposed workers.

Decreased lung function has occurred in flavoring exposed workers before the onset of symptoms of bronchiolitis obliterans. For that reason, diminished breathing capacity, particularly among younger workers in the plant population, should serve as a signal to further investigate potential problems associated with exposure to volatile butter flavorings in the work environment.



*Spirometer*

Since decreased PFT serves as an important identifying factor of the presence of the disease, it is recommended that all newly hired employees be asked to complete a health questionnaire. It should focus on respiratory symptoms or airway obstruction and serve as baseline information for subsequent annual evaluation. You may choose to develop one locally or use the model questionnaire found at the end of this document. This questionnaire was the one employed by NIOSH in its Missouri study.

Baseline PFT should be provided for all new workers before starting work. New workers who have pre-existing lung diseases or abnormal spirometry on pre-placement testing should be evaluated by a physician to determine the risk of exacerbating their lung disease from volatile flavorings or their ingredients.

It is recommended that PFT be repeated on an annual basis, at least, for all exposed workers. Tests should include the ratio of the 1-second forced expiratory volume (FEV1) to the forced vital capacity (FVC). Workers should be encouraged to report respiratory symptoms or symptoms of eye, nose, throat, or skin irritation.

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### **EYE AND SKIN PROTECTION**

NIOSH is aware of eye injuries occurring in at least three microwave popcorn packaging plants, which are believed to be due to employee exposure to flavoring vapors. These volatile organic compounds may affect the eyes and skin due to their irritant properties. They also report several instances of workers experiencing severe skin rashes, in some cases including sloughing of the skin, which may be associated with flavoring vapors or handling of liquid flavorings.

It is recommended that employers provide chemical goggles for exposed employees to protect against potential splash and/or vapor exposure. Goggles are available that fit over corrective lenses if necessary.

It is also recommended that employees making process additions, or otherwise handling liquid, paste, or powdered flavoring ingredients where direct skin contact is possible, be provided with appropriate chemical resistant gloves. Since butter flavorings vary among manufacturers, communication with both your flavoring manufacturer and glove vendor will be necessary to ensure that appropriate glove materials are selected.

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### RESPIRATORY PROTECTION

Respiratory protection in the Mixing Room should be mandatory regardless of the amount of time employees spend in the room. At a minimum, it is recommended that employees working in the Mixing Room be provided with and required to wear half mask air-purifying respirators. Respirators should be equipped with NIOSH-approved P-100 filters and cartridges for protection against organic vapors.



*Half mask air-purifying respirator*



*Powered air-purifying respirator*

You may consider additional worker protection for the eyes with the use of a full face-piece respirator. Other options for respirators that workers may find easier to wear in hot mixing rooms include powered air-purifying respirators (PAPR) or supplied air respirators.

Respirators should only be used as part of a formal written respiratory protection program detailed in the OSHA respirator standard at 29 CFR 1910.134. This includes a medical evaluation to determine an employee's physiological and psychological ability to use a respirator, fit testing of the respirator, required training of employees wearing respirators, and appropriate administration of the program.

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### ENGINEERING AND ADMINISTRATIVE CONTROLS

The basic principles for controlling the occupational environment consist of substitution of less hazardous materials; isolation of the hazard; and the use of local and general exhaust ventilation to remove contaminants from the workroom. Experience has shown that occupational hazards can be controlled by the use of one or more of these principles. Consult with your plant engineer or refer to *Industrial Ventilation – Manual of Recommended Practice* (see "References" section of this document) for ventilation design examples and options.

While their applicability will depend upon variables in the manufacturing processes among various employers, some preventative engineering and work practice measures which have been shown to help reduce employee exposure levels to flavoring ingredients include:

- Reducing the operating temperature of the holding and mixing tanks to that necessary to prevent solidification of the flavoring mixture for your process (generally less than 120°F). This will aid in reducing the volatilization of components of the butter flavoring and their release into the workroom air.
- Equipping the head space of the mixing and holding tanks where flavorings are added to oil or held in pure form with local exhaust ventilation directed out of the plant. Local environmental regulations should be considered if this is done without a scrubber.
- Isolating the mixing room from the rest of the plant through the use of walls, doors or other barriers.
- Providing the mixing room with a separate ventilation system; or ensuring that a negative pressure (relative to atmospheric pressure) is maintained in the mixing room to avoid the outward migration of contaminated air to adjacent areas of the plant.



*Ventilation on finished oil tanks in mixing room*

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### ENGINEERING AND ADMINISTRATIVE CONTROLS

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- Automation of the mixing process.
- Covering the flavoring and finished oil tanks and ventilating the headspace to reduce emissions into the room.
- Eliminating spillage from overfilling tanks, leaks in seals and fittings, and manual transfer of materials, all of which have been identified as sources of emissions.
- Reducing dust exposure during bag dumping by installing commercially available bag dumping stations equipped with local exhaust ventilation (three-sided canopy hood) and bag disposal.
- Putting lids on transfer buckets to avoid residual vapor release and/or placing buckets in a ventilated area following transfer; or pumping flavoring from smaller to larger tanks to avoid manual transfer altogether.
- Adding flavorings at room temperature.
- If a flavoring must be heated prior to adding it to the flavoring tank or mixing tank, transfer the flavoring to the tank via a pumping system rather than manual transfer.
- The application of axial flow dilution ventilation wall fans (require an adequate supply of tempered make-up air in cold months).



*Covered/ventilated flavor tank*



*Flavor tank ventilation*

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### ENVIRONMENTAL MONITORING

Diacetyl, a ketone with butter flavor characteristics, has been shown to be the predominant volatile organic compound (VOC) present in these work environments. It is suggested that it may be the cause, or a marker for a cause, of respiratory disease in this workforce.

For that reason, it is recommended that full-shift industrial hygiene sampling be employed to measure its presence in the work environment. This should include both personal and area samples. Such sampling is useful in determining initial concentrations and locations of diacetyl and other VOCs in the work area. It also serves to determine the success of the application of engineering and administrative controls in reducing the levels of diacetyl, as well as total VOCs, in the workplace.



*Sampling pump and sampling tube*

While it is recommended that all areas of the plant be sampled initially to determine exposure levels, it is of particular importance to assure that the following plant areas are sampled:

- The mixing room
- Plant areas where flavoring tanks are located
- The production lines
- The quality assurance laboratory.

Since the composition of butter flavorings varies among manufacturers, it is recommended that you consult with your flavoring manufacturer when conducting environmental monitoring.

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### ENVIRONMENTAL MONITORING

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The following OSHA sampling and analytical method (or subsequent revision) is recommended:

#### GENERAL DESCRIPTION

- **Name:**  
Diacetyl
- **Synonyms:**  
Biacetyl; 2,3-Butandione; 2,3-Diketobutane; Dimethyldiketone
- **Chemical Abstracts Service #:**  
431-03-8
- **Description:**  
Colorless liquid
  - Molecular weight: 86
  - Vapor pressure: 178 mm
  - Molecular formula: C<sub>4</sub>H<sub>6</sub>O<sub>2</sub>
  - Boiling point: 88°C
  - Melting point: -2°C
- **Incompatibilities:**  
Strong oxidizers; bases; reducing agents; metals

#### MONITORING

Primary Sampling/Analytical Method (SLC1)

- **Media:**  
Anasorb CMS tubes
- **Analytical solvent:**  
99:1 acetone:methanol
- **Maximum volume:**  
10 Liters
- **Maximum Flow:**  
0.2 L/min
- **Anl 1** (current OSHA analytical method):  
Gas chromatography with flame ionization detector; GC/FID
- **Reference:**  
1 (NIOSH 2557)
- **Class:**  
Validated
- **Conditions:**  
30-m Stabilwax DA (0.32 mm ID; 1µ film thickness)

**NOTE:** *Samples must be refrigerated immediately after sampling and shipped to the laboratory as soon as possible.*

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### RESOURCES

Assistance in performing environmental monitoring and with control measures may be obtained from your plant engineer, insurance carrier, private consultants, or the following:

#### • OSHA-funded state consultation programs (no cost to you)

Iowa Workforce Development Department  
Division of Labor Services  
1000 East Grand Avenue  
Des Moines, IA 50319  
(515) 281-6308

Kansas Department of Human Resources  
Division of Workers Compensation  
Industrial Safety and Health Section  
512 West Sixth Street  
Topeka, KS 66602-3150  
(785) 296-7476

Missouri Division of Labor Standards  
P.O. Box 449  
Jefferson City, MO 65102  
(573) 751-3403

Nebraska Department of Labor  
Division of Safety Consultation  
301 Centennial Mall South, Lower Level  
P.O. Box 95024  
Lincoln, NE 68509-50248  
(402) 471-4717

#### • State Health Departments

Iowa Department of Public Health  
Division of Health Protection & Environmental Health  
Lucas State Office Building  
321 East Twelfth Street  
Des Moines, IA 50319-0075  
(515) 281-8707

Kansas Department of Health and Environment  
Bureau of Epidemiology and Disease Prevention  
1000 SW Jackson Street  
Topeka, KS 66612  
(785) 296-1127

Missouri Department of Health & Senior Services  
P.O. Box 570  
Jefferson City, MO 65102  
(573) 751-9071

Nebraska Department of Health & Human Services  
Regulation and Licensure  
301 Centennial Mall South  
Lincoln, NE 68509  
(402) 471-0550

#### • OSHA

United States Department of Labor  
Occupational Safety and Health Administration  
1100 Main Street, Suite 800  
Kansas City, MO 64105  
(816) 426-5861  
<http://www.osha.gov>

#### • NIOSH

Centers for Disease Control and Prevention (CDC)  
National Institute for Occupational Safety & Health  
Appalachian Laboratory for Occupational Safety & Health  
Respiratory Disease Hazard Evaluation & Technical Assistance Program  
Field Studies Branch  
Division of Respiratory Disease Studies  
1095 Willowdale Road  
Morgantown, WV 26505-2888  
(304) 285-5749  
<http://www.cdc.gov/niosh>

### REFERENCES:

- ACGIH. *Industrial Ventilation – A Manual of Recommended Practice*, 24<sup>th</sup> ed. Cincinnati, Ohio, American Conference of Governmental Industrial Hygienists. 2001.

ACGIH  
1330 Kemper Meadow Drive  
Cincinnati, OH 45240  
(513) 742-2020

- NIOSH. *NIOSH Investigation of Gilster Mary Lee, HETA #2000-0401, Technical Assistance to Missouri Department of Health, Interim Report, August 22, 2001*. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention (CDC), National Institute for Occupational Safety and Health, 2001.
- CDC. *Fixed Obstructive Lung Disease in Workers at a Microwave Popcorn Factory – Missouri, 2000 – 2002*. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention (CDC), Morbidity and Mortality Weekly Report (MMWR). 2002; 51(16):345-7.
- Kreiss, Kathleen, M.D., et al., *Clinical Bronchiolitis Obliterans in Workers at a Microwave Popcorn Plant*. New England Journal of Medicine. 2002; 347:330-338.





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### Health Questionnaire\* (Used by NIOSH in its Missouri study)

<u>Health Condition</u>	<u>Question</u>
Chronic cough	Do you usually cough on most days for 3 consecutive months or more during the year?
Wheeze	Have you ever had wheezing or whistling when you did not have a cold?
Wheezing Attacks	Have you ever had 2 or more attacks of wheezing that have made you feel short of breath?
Chest tightness	During the last 12 months, have you woken up with a feeling of chest tightness?
Shortness of breath	Are you troubled by shortness of breath walking with people of your own age on level ground?
Trouble breathing	- I have regular trouble with my breathing but it always gets completely better. - My breathing is never quite right.
Fever	While working at the plant have you had weekly or daily fever?
Chills	While working at the plant have you had weekly or daily chills?
Night-sweats	While working at the plant have you had weekly or daily night-sweats?

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### Health Questionnaire\* (Used by NIOSH in its Missouri study)

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<u>Health Condition</u>	<u>Question</u>
Flu-like achiness	While working at the plant have you had weekly or daily flu-like achiness?
Fatigue	While working at the plant have you had weekly or daily unusual tiredness or fatigue?
Mucous membrane	Is there any exposure in your work environment that you find irritating to your eyes, nose, or throat?
Asthma	Have you ever had asthma confirmed by a doctor?
Chronic bronchitis	Have you ever had chronic bronchitis confirmed by a doctor?
Emphysema	Have you ever had emphysema confirmed by a doctor?
Atopy (allergic)	Have you ever had hay fever or eczema confirmed by a doctor?
Attacks of bronchitis	Since you began working at the plant have you ever had attacks of bronchitis confirmed by a doctor?
Pneumonia	Since you began working at the plant have you ever had pneumonia confirmed by a doctor?
Skin problems	Since you began working at the plant have you developed any new skin rash or skin problem?

\* *This questionnaire should be administered and interpreted only under the direction of a licensed physician with specific knowledge of the workplace.*

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