



DEPARTMENT OF HEALTH & HUMAN SERVICES

Phone: (304) 285-5751
Fax: (304) 285-5820

Public Health Service

Centers for Disease Control
and Prevention (CDC)
National Institute for Occupational
Safety and Health (NIOSH)
1095 Willowdale Road
Morgantown, WV 26505-2888

July 2, 2003
HETA 2002-0089

Frank Morrison
Nebraska Popcorn
RR 1, Box 50A
Clearwater, Nebraska 68726

Dear Mr. Morrison:

I am writing to provide you with updated information from NIOSH's ongoing investigation of flavoring-related lung disease in the microwave popcorn industry. Please refer to my October 2002 letter to you for background information on this problem and a description of the findings from our February 2002 health hazard evaluation (HHE) at your plant (a copy is enclosed for your convenience). This letter contains revised recommendations for minimizing risk to you workforce and serves to closeout this HHE.

NIOSH Investigation of Flavoring-Related Lung Disease Risk in Microwave Popcorn Plants

In addition to your facility, NIOSH has investigated the risk for lung disease from exposure to butter flavorings in five other microwave popcorn plants. At all five of these plants we found evidence that workers had been affected. The workers at highest risk are workers who combine flavorings with heated soybean oil (i.e., mixers), workers near non-isolated tanks that contain heated oil and flavorings, and quality control workers who microwave many dozens of bags of product per work shift. The average air concentrations of diacetyl and other butter flavoring chemicals measured by NIOSH at several of these plants were similar to the concentrations we measured at your plant. Our findings strongly suggest that workers are at risk from brief, intense exposures to butter flavoring chemicals even when ventilation maintains low average air concentrations. Such exposures occur when workers handle or measure flavorings in open containers, manually pour these flavorings into open tanks of heated soybean oil, look into tanks containing heated oil and flavorings, or repeatedly microwave product without adequate local exhaust ventilation. In some plants, workers were affected even though they had used respirators.

Another exposure consideration in microwave popcorn production involves the use of powdered butter flavorings. Some powdered flavorings are formulated such that the flavoring chemicals are not released until heating in a microwave oven occurs. Our air sampling measurements at two plants documented lower air concentrations of diacetyl when powdered flavorings were in use compared to when liquid or paste flavorings were in use. However, we currently do not know the extent of the risk posed by inhalation of dust generated from the handling of powdered flavorings.

Updated Recommendations for Nebraska Popcorn

While our lung function tests of workers at your plant did not reveal obstruction, the abnormality most associated with butter flavoring exposure, this should not be interpreted to mean that there is little or no risk from flavoring exposure in your plant. As I discussed in my previous letter, while most of your microwave production workers had lung function that was in the normal range, it is possible that some had higher levels of function in the past. The respiratory symptoms reported by some of them may mean that their lung function could become abnormal in the future. In addition, since not all workers are equally susceptible to the effects of a chemical exposure, it is possible that the small number of workers we tested at your plant did not include workers that were sensitive to the air concentrations of flavoring chemicals that were present during our evaluation. Future new employees could be at risk, and changes in your production process, level of production, or the flavorings that you use could increase risk for current workers if exposures to flavorings chemicals increase as a result.

Listed below are updated recommendations for protecting the workforce at your plant from the potential health effects of exposure to flavoring chemicals. Some of these were listed in my October 2002 letter and may have already been addressed by you.


1. Eliminate the splashing and burning of oil on the packaging machine heated crimpers since over-heated oils can produce lung health hazards.
2. Consult with a ventilation engineer regarding additional ventilation for the microwave popcorn packaging area and mixing room. Provide general dilution ventilation to the packaging area to decrease exposure to airborne flavoring-related chemicals that are likely responsible for many of the symptoms reported by the workers. Install lids on any tanks used for heated oil and flavorings in the mixing room and implement local exhaust ventilation of these tanks. Continue the use of an exhaust fan in the mixing room to control fugitive vapors from the tanks. Extend all exhaust ducts to the outside of the building. Regularly check and maintain all ventilation systems to minimize the possibility of a malfunction. Perform periodic air sampling for diacetyl to verify that the ventilation systems are functioning optimally.
3. Maintain the temperature of the oil and flavorings mixture as low as the production process will allow. Also make sure to continue to keep the mixing room doors closed to minimize the escape of vapors from the heated oil and flavorings mixture into the microwave popcorn packaging area.
4. When preparing the oil and flavorings mixture, weigh or measure all flavorings in the mixing room, or in an area away from other workers. Keep all containers of flavorings tightly sealed when not in use. Empty flavoring containers that still have residual flavorings in them also need to be tightly sealed.

5. Discuss with your flavoring suppliers the possibility of using powdered flavorings (for example, encapsulated powders) that release lower amounts of flavoring chemicals into the air during the production process. A powdered flavoring that generates little dust when handled, and has low emissions of flavoring chemicals before and after it is added to heated soybean oil, may be safer than a dustier powder that may be inhaled by workers.
6. If possible, identify process changes that would allow the handling of flavorings in closed or sealed systems for addition to heated soybean oil.
7. Decrease the amount of airborne salt dust generated when adding salt to the oil mixture because airborne salt dust can be irritating to the eyes, nose, and airways.
8. Institute mandatory respirator use and skin and eye protection for anyone working in the mixing room, anyone measuring out quantities of flavoring in or outside of the mixing room, and anyone washing buckets or tanks that contain residual flavorings. Set up a written respiratory protection program that meets the requirements of the OSHA respiratory protection standard (29 CFR 1910.134). Workers need to have a medical evaluation for respirator use, fit testing for tight fitting respirators, and training on proper respirator use and maintenance and on the nature of the health hazard. The minimum protective respirator we recommend is a NIOSH-certified half-face mask, negative pressure respirator with organic vapor cartridges and particulate filters. A full facepiece respirator will provide respiratory and eye protection. Otherwise use tight fitting goggles for eye protection.
9. Institute medical monitoring with spirometry twice a year (more often than we recommended in October 2002) for all workers in oil mixing, in microwave packaging, and in the adjacent non-microwave packaging area, to see if workers' lung function is remaining stable over time. Also do this for any workers that microwave many bags of product per shift for quality control purposes. Workers should have a baseline test before starting work in any of these areas. It is important to choose a health care provider that can assure high quality spirometry testing in order to compare test results over time. The provider should provide documentation that their spirometry technician has attended a NIOSH certified spirometry course, and that routine calibrations of their spirometer are performed as recommended by the American Thoracic Society. If you are unable to locate a provider near your company that can provide such documentation, NIOSH can provide guidance to a provider that you select.

The federal regulations governing the health hazard evaluation program require that you post this letter (and the October 2002 letter) for 30 days in a suitable location where it can

be reviewed by workers. Please feel free to contact me (304-285-5932) with any questions that you have or if you would like additional assistance.

Sincerely,

A handwritten signature in black ink, appearing to read "Richard Kanwal". The signature is fluid and cursive, with the first name "Richard" and last name "Kanwal" clearly distinguishable.

Richard Kanwal, MD, MPH
Respiratory Disease Hazard Evaluation and
Technical Assistance Program
Field Studies Branch
Division of Respiratory Disease Studies

Enclosure

cc:
OSHA, Region 7
Rick Hartle (HETAB)
Closeout file (HETA 2002-0089)



October 28, 2002
HETA 2002-0089
Interim 1

Centers for Disease Control
and Prevention (CDC)
National Institute for Occupational
Safety and Health - ALOSH
1095 Willowdale Road
Morgantown, WV 26505-2888

Frank Morrison
Nebraska Popcorn
RR 1, Box 50A
Clearwater, Nebraska 68726

Dear Mr. Morrison:

On January 2, 2002, the National Institute for Occupational Safety and Health (NIOSH) received a request from you to perform a health hazard evaluation (HHE) at your company. The request was to evaluate whether the ventilation for the microwave popcorn production process was adequate to prevent worker health effects. You reported that two of your workers who mix flavorings with heated oil had reported respiratory symptoms and had normal lung function when evaluated by physicians. A NIOSH team visited your plant from February 12 through February 15, 2002 to learn about the microwave popcorn production process, tour the plant, conduct voluntary breathing tests (spirometry) and interviews of workers, and perform industrial hygiene air sampling. This report summarizes the findings of these medical and environmental surveys. Based on these findings and information on the known risks to worker health from microwave popcorn production, we make several recommendations for steps you should take to prevent work-related health problems at your company.

Background on Bronchiolitis Obliterans in Workers Exposed to Concentrated Flavorings

NIOSH has investigated the occurrence of a rare lung disease, bronchiolitis obliterans, in workers exposed to butter flavorings at other microwave popcorn plants and in workers of a flavoring manufacturing plant. Those investigations, and animal studies conducted at NIOSH, have shown that inhalation of flavoring vapors may lead to lung disease under some working conditions. Studies at NIOSH are in progress to determine which ingredient(s) is responsible, and at what level of exposure effects occur.

In bronchiolitis obliterans, inflammation and scarring occurs in the small airways of the lung and can lead to severe, permanent shortness of breath. The main respiratory symptoms include cough (usually without phlegm) and shortness of breath on exertion. These typically do not improve much when the worker goes home at the end of the workday or on weekends or vacations. Some affected workers have fever, night sweats, or weight loss. Usually symptoms are gradual in onset and progressive, but severe symptoms can occur suddenly. Some cases may not respond to medical treatment. The onset of symptoms in affected workers has occurred from months to years after the first exposure to flavoring vapors. Spirometry (a type of breathing test) generally shows fixed airways obstruction (i.e., difficulty blowing air out fast and no response to asthma medications). Whether or not restriction (i.e., decreased ability to fully expand the lungs) on spirometry tests is related to excessive flavoring-exposure is unknown. Some workers show evidence of fixed airways obstruction on spirometry tests before they develop symptoms of lung

disease. Because medical treatment does not reverse the condition, some workers with severe disease have been placed on lung transplant waiting lists.

In addition to lung disease, workers exposed to butter flavoring vapors may develop problems with their eyes and skin. Eye irritation is common, and occasionally workers report chemical burns of the eyes requiring medical treatment. Similarly, exposed workers may report skin irritation, and one worker in another plant developed a disabling skin allergy to butter flavorings.

Microwave Popcorn Production at Nebraska Popcorn

NIOSH learned about the microwave popcorn production operations at Nebraska Popcorn by visiting the plant and through a series of telephone conversations and reviews of documents provided by the company. Packaging of microwave popcorn occurs in a small area (approximately 35 by 35 feet) of a building that also houses offices, non-microwave popcorn packaging, and a warehouse. The microwave packaging area is partially walled off from an adjacent non-microwave popcorn packaging area and the warehouse. The offices are located at one end of the building and are completely walled off from the production areas. Bulk packaging of corn and other products (e.g. beans) occurs in different buildings at the plant.

The company produces several varieties of microwave popcorn by combining different butter and cheese flavorings with other ingredients such as yeast, monosodium glutamate (MSG), disodium 5'-ribonucleotide (ribotide), sugar, caramel, capsicum, jalapeno, bay oil (an extract of the leaves of *Pimenta racemosa*), salt, and annatto coloring in heated soybean oil. This company does not produce an extra butter, or "theater-style", variety of microwave popcorn. The mixing of these ingredients occurs in a small (approximately 8 by 15 feet) mixing room within the microwave packaging area. This room has two doors that are usually kept closed. Soybean oil is poured into mixing tanks from storage tanks above this room. Salt is poured from 50-lb bags directly into the mixing tanks. Amounts of flavorings that can be measured with a measuring cup are measured in the mixing room and poured into the mixing tanks. Larger amounts of flavorings are weighed in the warehouse and then brought to the mixing room and poured into the mixing tanks. One worker (oil mixer/supervisor) spends approximately 1.25 hours per day performing these tasks. Another worker performs mixing operations when needed. During the past year, the mixer has worn a half-face mask respirator with organic vapor cartridges and dust pre-filters during oil mixing activities. The mixing tanks are not covered with lids. The entire mixing room is heated to maintain the oil mixture at a desired temperature of 110-115 degrees Fahrenheit. The room temperature was 108 degrees Fahrenheit during NIOSH's visit. A small exhaust fan (installed in the month prior to NIOSH's visit) in the mixing room was exhausted to another area of the building via a flexible duct. An opening had not yet been made in the side of the building to facilitate venting of the duct outdoors.

The heated mixture of oil and flavorings is pumped via pipes to a machine in the packaging area where it is combined with popcorn in microwave bags. As many as six workers, including the oil

mixer, work in the microwave packaging area at any given time. Some of these workers also work in non-microwave popcorn packaging and in bulk packaging as needed. During the NIOSH visit, both heating and cooling units were being utilized to circulate, condition, and filter (with a furnace-type fiberglass mesh filter) the air in the microwave packaging area. There was no general dilution ventilation with outside make-up air. Oil that splashed onto the heated bag crimpers on the packaging machine caused smoke.

Medical Evaluation Findings

Twelve workers participated in voluntary interviews and lung function testing with spirometry. Eight (including one former worker) worked mostly or often in microwave production. The duration of employment for these eight workers ranged from 1.5 to 10 years (median 3.75 years). Three were current full time office workers and one was a current full time worker in bulk packaging. Spirometry results were mailed to workers in March 2002.

Spirometry results: Eleven workers had normal results. One worker in microwave popcorn production had moderate restriction and was referred to their personal physician for further evaluation.

Reported symptoms and health events: Among current workers in microwave popcorn production, almost all reported nasal irritation during work and several also reported eye irritation. Three current microwave production workers reported the onset of a regular cough and/or mild shortness of breath with exertion since they started work in this area. Many workers reported being bothered by the smell of the bay oil used in the “seasoned cheese” recipe. Two microwave production workers reported headaches, and two others reported abdominal pain and other gastrointestinal upset when the seasoned cheese recipe was being used in production. None of these symptoms were reported by office workers. Eleven of the twelve workers interviewed reported never having smoked and one reported being a former smoker. Two workers were concerned because they were aware of the occurrence of miscarriages in three different workers in microwave production (two of whom no longer work at the plant) in recent years.

Industrial Hygiene Survey

NIOSH conducted air sampling on February 13 and 14, 2002. Almost all samples were collected for the duration of the work shift. Area samples were obtained at least once at every workstation, and on both days at least one worker of each job title wore a personal sampler. Area sampling baskets contained sampling media for the following chemicals that are known to be present in many butter flavorings: diacetyl, acetoin, acetic acid, butyric acid, and acetaldehyde.

Additionally, volatile organic compounds (VOCs) and dust concentrations were measured. Personal samples were analyzed for diacetyl and acetoin. The results of these measurements are listed in Tables 1 and 2.

Table 1. Area air sampling measurements

Work Area [number of samples]	Diacetyl (ppm)	Acetoin (ppm)	Total other VOCs* (mg/m ³)	Acetic and Butyric Acids (ppm)	Acetaldehyde (ppm)	Respirable Dust (mg/m ³)	Total Dust (mg/m ³)
Microwave packaging machine [2]	~0.01 - 0.05	ND - ~0.02	~0.28 - ~0.88	ND	ND	0.18 - 0.39	0.38 - 0.63
Oil mixing room [2]	~0.02 - 0.85	ND - 0.02	ND - 1.36	ND	ND - ~0.02	1.35 - 1.83	4.16 - 4.84
Microwave packing area [2]	~0.01 - 0.04	ND	~0.37 - ~0.88	ND	ND	0.08 - 0.19	0.17 - 0.32
Office [2]	ND - 0.01	ND	~0.25 - ~0.30	ND	ND	ND - 0.01	ND - 0.02
Bulk packing [1]	ND	ND	1.68	ND	ND	0.11	0.58
Non-microwave popcorn packaging [1]**	0.02	ND	ND	ND	ND	0.08	0.15
Refrigerated Warehouse [1]	ND	ND	~0.3	ND	~0.02	0.02	0.06
Outside [1]	ND	ND	ND	ND	ND	ND	ND

Table 2. Personal air sampling measurements

Worker type [number of samples]	Diacetyl (ppm)	Acetoin (ppm)
Microwave popcorn packager [6]	~0.01 - 0.04	ND - 0.07
Maintenance/machine operator [1]	~0.02	ND
Supervisor/mixer (mixing only) [1]	0.18	ND***
Supervisor/mixer [2]	~0.01 - 0.04	ND
Office worker [4]	ND - 0.01	ND
Bulk bagger [4]	ND	ND
Outside worker [1]	ND	ND

ppm - parts per million parts air

mg/m³ - milligrams per cubic meter of air

ND- not detectable; measurements were below the following limits of detection: 0.01 ppm (diacetyl and acetoin), 0.22 mg/m³ (total VOCs), 0.06 ppm (acetic acid), 0.16 ppm (butyric acid), 0.02 ppm (acetaldehyde), 0.01 mg/m³ (respirable and total dust).

*Analysis excluded the contribution of diacetyl and acetoin

**Not in operation during sampling (adjacent to microwave packaging)

***The limit of detection for this 43-minute sample was 0.08 ppm

~ - approximate concentration; chemical was detected but below minimum quantifiable concentration

Acetic and butyric acids were not detected in any of the samples. The levels of acetaldehyde detected were far below the the Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) of 200 ppm as a time weighted average and the American Conference of Governmental Industrial Hygienists (ACGIH) ceiling threshold limit value of 25 ppm. Exposure limits for diacetyl and acetoin have not been established by NIOSH, OSHA, or ACGIH. Compared to diacetyl and acetoin levels measured by NIOSH in a microwave popcorn plant where many workers developed lung disease, the levels of these chemicals at Nebraska Popcorn were substantially lower. The levels of diacetyl at the other plant ranged from 2.3 to 98 ppm for mixers and 0.3 to 6.8 ppm for machine operators and packaging workers. Acetoin levels at the other plant ranged from 0.08 to 12.2 ppm for mixers and up to 1.5 ppm for machine operators and packaging workers. Dust levels at Nebraska Popcorn were below the OSHA PEL for particulate not otherwise regulated of 15 mg/m³ for total dust and 5 mg/m³ for respirable dust.

Smoke tubes were used to study air currents at the doors of the mixing room. When the tube was placed at the bottom of the door, air was seen flowing under the door into the mixing room, but when placed along the top of the door, the air was flowing from the mixing room into the packaging room. This indicates that the small exhaust fan in the mixing room was not maintaining the room under negative pressure with respect to the packaging room and not preventing release of vapors into it.

During the NIOSH visit, two workers were observed mixing flavoring ingredients. Wearing of respirators during this task was not consistent. Either no respirator, a disposable dust respirator, or a half-face respirator with organic vapor cartridges and dust pre-filters was worn. On one day, the pre-filters were not on the cartridges. Only one half-face respirator was available, so both workers shared it. The respirator was found to be very dirty inside and out, and the rubber inhalation and exhalation valves were deteriorating (one exhalation valve was stuck in an open position.) The workers had not been fit tested and did not perform user seal tests when they donned the respirator. They were not aware when the organic vapor cartridges were last replaced.

Discussion and Conclusions

Spirometry testing of Nebraska Popcorn workers performed by NIOSH in February 2002 did not reveal evidence of fixed airways obstruction, the abnormality that has been associated with airborne exposure to butter flavorings in other microwave popcorn plants. Air concentrations of butter flavoring chemicals at Nebraska Popcorn were lower than they were at a plant where many workers were found to have flavoring-related lung disease. While these are encouraging findings, they should not be interpreted as confirming that there is little or no flavoring-related risk to workers at your plant. While our spirometry tests show lung function to be in the normal range in 11 of 12 workers, we do not know if the lung function in some of these workers has decreased significantly from higher levels of lung function they may have had in the past. Some workers have been affected after many years of work in this industry. The fact that some workers

are currently experiencing respiratory symptoms may mean that their lung function could become abnormal in the future. In addition, individual personal susceptibility is a factor in determining whether someone will be affected as a result of a particular exposure. The workforce involved in microwave popcorn production at Nebraska Popcorn is small and may not currently include individuals who are predisposed to develop flavoring-related lung problems. Future new employees could be at risk.

NIOSH measured the air levels of diacetyl and acetoin, two common ingredients in butter flavoring, as indicators of exposure to butter flavoring vapors. Ongoing animal experiments at NIOSH indicate that diacetyl is one of the chemicals in butter flavoring that can lead to airway injury. Compared to the levels of diacetyl and acetoin seen in a plant where many workers had abnormal breathing tests, the levels at Nebraska Popcorn were lower. One of the possible factors responsible for this difference is the composition of the flavorings in use at the two plants. If Nebraska Popcorn uses different butter flavorings in the future, the risk to workers for lung disease could increase if these flavorings release more compounds into the air upon heating than the ones used during the NIOSH visit.

There are other factors that probably contribute to the lower levels of flavoring-related chemicals in the air at Nebraska Popcorn. The number of tanks containing heated oil and flavorings was far greater at the other plant, and the mixer at the other plant spent much more time in the mixing room preparing heated oil and flavoring mixtures than the mixer at Nebraska Popcorn currently does. Exposures at Nebraska Popcorn could increase significantly if production is increased and larger amounts of heated oil and flavorings are required. The doors of the mixing room at Nebraska Popcorn are kept closed to minimize heat loss from that room and prevent the oil mixture from cooling off, compared to the mixing room at the other plant where the doors were often kept open (the tanks, not the room, are heated) allowing air containing flavoring-related chemicals to escape into the adjacent packaging area. Finally, the temperature of the oil and flavoring mixture is 10-15 degrees lower at Nebraska popcorn than at the other plant. It is likely that this lower temperature leads to less evaporation of flavoring chemicals into the air.

Many workers in the microwave popcorn production area at Nebraska Popcorn reported work-related symptoms that indicate physical irritation and discomfort due to some of their exposures. It is probable that the eye and nasal symptoms are accounted for by flavoring vapors and salt dust in the air. Headaches reported in association with the seasoned cheese recipe could be due to MSG, or may just be a consequence of the smell of the bay oil used in the recipe. Similarly, the gastrointestinal upset reported in association with this recipe is likely due to the smell of the bay oil. With regard to miscarriages in microwave popcorn production workers, it is nearly impossible in a small workforce to establish if a workplace exposure is leading to pregnancy loss. In general, 10-20 % of known pregnancies end in miscarriage. We could not find consistent evidence in the scientific literature for reproductive hazards among the following chemicals: MSG, disodium 5'-ribonucleotide (ribotide), eugenol and myrcene (two of the predominant chemicals in bay oil).

The half-face mask respirator that was used by mixers during the NIOSH visit was poorly maintained and probably is not providing adequate protection from butter flavoring exposures. Recommendations addressing proper respirator use and other mechanisms to decrease exposure in microwave popcorn production are presented below.


Recommendations for the Protection of Workers in Microwave Popcorn Production

1. Eliminate the splashing and burning of oil on the packaging machine heated crimpers since over-heated oils can produce lung health hazards.
2. Consult with a ventilation engineer regarding additional ventilation for the microwave popcorn packaging area and mixing room. Provide general dilution ventilation to the packaging area to decrease exposure to airborne flavoring-related chemicals that are likely responsible for many of the symptoms reported by the workers. Install lids on any tanks used for heated oil and flavorings in the mixing room and implement local exhaust ventilation of these tanks. Continue the use of an exhaust fan in the mixing room to control fugitive vapors from the tanks. Extend all exhaust ducts to the outside of the building. If you decide to replace the existing tanks and install heated ones, maintain the temperature of the oil and flavorings mixture as low as the production process will allow. Also make sure to continue to keep the mixing room doors closed to minimize the escape of vapors from the heated oil and flavorings mixture into the microwave popcorn packaging area.
3. Keep all containers of flavorings tightly sealed when not in use. When preparing the oil mixture, weigh or measure all flavorings in the mixing room, or in an area away from other workers.
4. Decrease the amount of airborne salt dust generated when adding salt to the oil mixture because airborne salt dust can be irritating to the eyes, nose, and airways.
5. Institute mandatory respirator use and skin and eye protection for anyone working in the mixing room, and anyone measuring out quantities of flavoring in or outside of the mixing room. Set up a written respiratory protection program that meets the requirements of the OSHA respiratory protection standard (29 CFR 1910.134). Workers need to have a medical evaluation for respirator use, fit testing for tight fitting respirators, and training on proper respirator use and maintenance and on the nature of the health hazard. The minimum protective respirator we recommend is a NIOSH-certified half-face mask, negative pressure respirator with organic vapor cartridges and particulate filters. A full facepiece respirator will provide respiratory and eye protection. Otherwise use tight fitting goggles for eye protection.

6. Institute medical monitoring with yearly spirometry for all workers in oil mixing, in microwave packaging, and in the adjacent non-microwave packaging area, to see if workers' lung function is remaining stable over time. New workers should have a baseline test before starting work. It is important to choose a health care provider that can assure high quality spirometry testing in order to compare test results over time. The provider should provide documentation that their spirometry technician has attended a NIOSH certified spirometry course, and that routine calibrations of their spirometer are performed as recommended by the American Thoracic Society. If you are unable to locate a provider near your company that can provide such documentation, NIOSH can provide guidance to a provider that you select.

Please feel free to call (304-285-5932) with any questions that you have.

Sincerely,

A handwritten signature in black ink, appearing to read "Richard A. Kanwal". The signature is fluid and cursive, with a large, sweeping flourish at the end.

Richard Kanwal, MD, MPH
Respiratory Disease Hazard Evaluation and
Technical Assistance Program
Field Studies Branch
Division of Respiratory Disease Studies

cc:

Rick Hartle (HETAB)