Evaluation of respiratory and indoor environmental quality concerns at a snack foods facility - Pennsylvania

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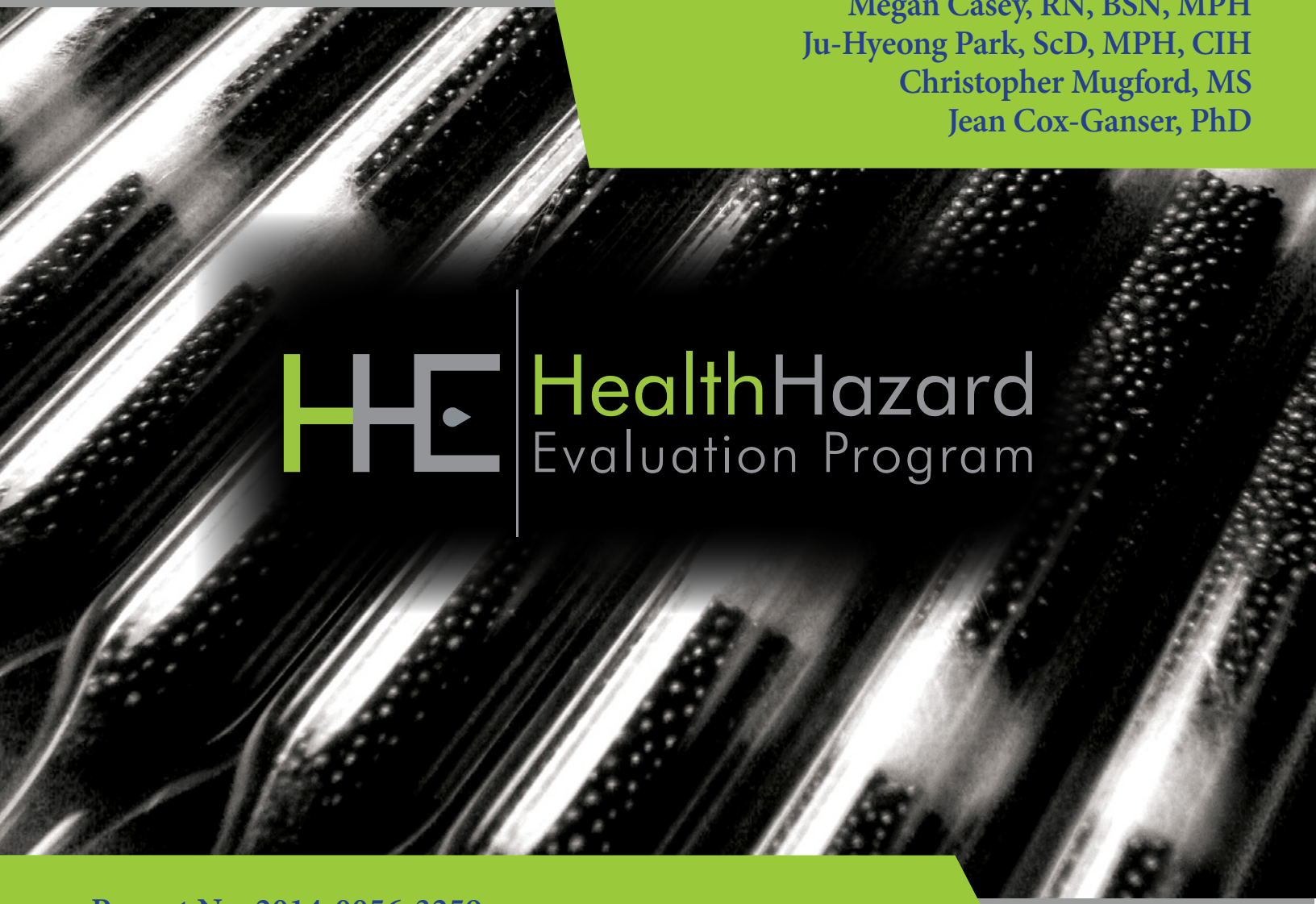

HHE Health Hazard Evaluation Program

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Contents

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The cover photo is a close-up image of sorbent tubes, which are used by the HHE Program to measure airborne exposures. This photo is an artistic representation that may not be related to this Health Hazard Evaluation.

Highlights of this Evaluation

In December 2013, the National Institute for Occupational Safety and Health received a confide tial health hazard evaluation request from employees at a snack foods manufacturing facility in Pennsylvania. The request listed concerns about respiratory illnesses, headaches, nosebleeds, and cancer related to indoor dampness and potential exposure to mold and mildew, seasonings, and asbestos.

What NIOSH Did

- We conducted a walk-through survey at the snack food facility in September 2014.
- We conducted in-person, private interviews with 85 employees.
- We reviewed medical records from five current or former employees who released their records to the National Institute for Occupational Safety and Health.
- We performed observational assessments for dampness and mold, checked for signs of water damage in administrative offices nd production areas, and investigated potential roof leaks.
- We performed real-time air sampling for dust as we walked throughout the plant.
- We collected bulk samples of seasonings and slurry flavorings to assess diacetyl and 2,3-pentanedione content.
- We collected six area and one instantaneous evacuated canister air samples to assess air levels of diacetyl and 2,3-pentanedione.

We evaluated employee health concerns and potential exposures to mold and mildew, seasonings, flavoring chemicals and asbestos among employees at a snack food manufacturing facility. We performed an indoor environmental quality assessment and assessed air levels of seasonings, flavoring chemicals, and dust. We noted water damage from roof and window leaks that promoted dampness and the potential for mold growth in the facility. Our air samples highlighted several areas of the facility with high risk of exposure to irritant seasonings, dust, and flavoring chemicals. We recommend roof and building structure repairs to mitigate further water damage. We also provide several means to reduce potential employee exposure to irritant seasonings, dust, and flavoring chemicals.

What NIOSH Found

- Many employees reported respiratory symptoms that may be attributable to indoor dampness and mold, such as sinus infections, asthma exacerbation, and nasal congestion.
- One case of physician-diagnosed, work-related asthma in an individual who had close and frequent contact with the spices and seasonings.
- Many employees in the chips packaging and seasoning areas reported symptoms of irritation when working with spicy seasonings, particularly those seasonings which

contained higher levels of capsaicin. Symptoms included watery eyes, sneezing, coughing, congestion, running nose, and difficulty breathing.

- No employees mentioned cancer specifi ally as a work-related health concern during confide tial interviews.
- Some employees shared concerns about possible past exposures to asbestos during previous building renovations.
- A window leak in one office oom and signs of indoor water intrusion in many areas of the building from roof leaks.
- Roofing materials of the maintenance department, chip processing, and administrative office buildings were disintegrating and in need of prompt repair.
- High levels of dust in the chip production area when employees added seasonings to the tumbler funnel and near the corn extruder.
- Diacetyl (2,3-butanedione) and/or 2,3-pentanedione flavoring chemicals in bulk samples of the popcorn butter and puffed cheese snack product slurries and the sour cream/cheese, natural vinegar, and sour cream/onion seasonings.
- Area air concentrations of diacetyl and 2,3-pentanedione in the popcorn butter and cheese snack product slurries mixing areas that approached or exceeded the proposed National Institute for Occupational Safety and Health recommended exposure limit for diacetyl and 2,3-pentanedione.
- Levels of capsaicin were greater than 100 parts per million in bulk samples of jalapeño and other spicy seasonings.

What the Employer Can Do

- Repair or replace damaged roofi g materials where water is entering the building.
- Schedule regular checks of roof drain covers to ensure that drains are not clogged with leaves and other debris.
- Remove and replace water-damaged building materials after making necessary repairs to prevent water entry into the building. If mold is identifi d on materials during the repair, follow guidelines to minimize exposures for remediators and building occupants.
- Establish an anonymous environmental reporting system for staff o report building-related issues.
- Implement local exhaust ventilation at the mixing tanks that mix slurries containing diacetyl and/or 2,3-pentanedione, spice addition stations on the mezzanine level, and above the corn snack product extruders.
- Relocate the corn extruder to an enclosed area rather than a common area.
- Conduct personal air monitoring over multiple shifts or diacetyl and 2,3-pentanedione on employees in the popcorn butter and cheese snack product mixing areas in the popcorn room, the cheese snack product mixing area in the corn processing room,

and on employees performing tasks at or near the slurry vat by the corn snack product extruder area in the corn processing room. Personal air sampling should be performed using Occupational Safety and Health Administration methods 1012 for diacetyl and 1016 for 2,3-pentanedione.

- If personal air monitoring detects elevated levels of diacetyl and 2,3-pentanedione, use engineering controls, such as local exhaust ventilation, in these areas to lower air levels.
- If engineering controls in these areas do not reduce personal air monitoring levels of diacetyl and 2,3-pentanedione below the proposed National Institute for Occupational Safety and Health recommended exposure limits, require employees working in these areas to wear respirators fitted with organic vapor cartridges and particulate filters.
- Train employees on and encourage the voluntary use of N95 disposable filtering-facepiece respirators during seasoning additions, pouring or transferring seasoning powders, and while performing tasks near the rotating seasoning drums and corn snack product extruders in the corn processing room.
- Schedule regular cleaning of fl ors to prevent slips and trips due to wet conditions.
- Ensure fryers in frying room are adequately maintained and fl or drains are kept clean to prevent material build up on fl or creating a slip or trip hazard.
- Use wet cleaning methods instead of dry sweeping when cleaning in the corn snack product, seasoning, and packaging areas.
- If there is demolition work, repair, or renovations planned in the future, management should review and ensure they are in compliance with Pennsylvania Department of Environmental Protection and Pennsylvania Department of Labor and Industry asbestos regulations [Pennsylvania Department of Environmental Protection 2014].

What Employees Can Do

- Participate in personal air sampling surveys for flavoring chemicals.
- Use any local exhaust ventilation when it is installed and wear a respirator if required when working in the popcorn butter and cheese snack product mixing area in the popcorn room and when in the corn processing room.
- Wear an N95 disposable filtering-facepiece respirator during seasoning additions, pouring or transferring seasoning powders, and while performing tasks near the rotating seasoning drums on the mezzanine level.
- Use wet cleaning methods instead of dry sweeping when cleaning in the corn snack product, seasoning, and packaging areas.
- Report signs of water damage to the anonymous environmental reporting system.
- Report new, persistent, or worsening symptoms to your personal healthcare providers and, as instructed by your employer, to a designated individual at your workplace.

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Abbreviations

µm	Micrometers
ACGIH®	American Conference of Governmental Industrial Hygienists
APF	Assigned protection factor
cc	Cubic centimeters
CFR	Code of Federal Regulations
dB	Decibel
F	Fahrenheit
IR	Infrared
LOD	Limit of detection
LOQ	Limit of quantifi ation
mg/m3	Milligrams per cubic meter
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
PAPR	Powered air-purifying respirator
PEL	Permissible exposure limit
PPE	Personal protective equipment
ppm	Parts per million
ppb	Parts per billion
REL	Recommended exposure limit
SDS	Safety data sheet
STEL	Short-term exposure limit
UFCW	United Food and Commercial Employees
VOC	Volatile organic compound

Summary

The National Institute for Occupational Safety and Health (NIOSH) received a confide tial employee request for a health hazard evaluation at a snack foods manufacturing facility in Pennsylvania. The request listed concerns about respiratory illnesses, headaches, nosebleeds, and cancer related to indoor dampness and potential exposure to mold and mildew, seasonings, and asbestos.

During an on-site assessment of the facility in September 2014, we performed an observational assessment for signs of water intrusion and damage, visible mold, and mold odor in the facility and for signs of damage to the facility's roofi g materials. We collected area air samples for dust and flavoring chemicals and confide tially interviewed 85 employees. Employees shared many health concerns during confide tial interviews, to include (1) respiratory irritation from specific easonings; (2) skin irritation from dust; (3) exposure to corn dust; (4) exposure to mold and damp indoor environments; (5) exposure to cleaning chemicals; (6) dust generated from seasoning tumblers and while pouring seasonings into hoppers and storage containers; (7) lack of ventilation in the buildings; (8) excessive heat in the facility; and (9) potential exposure to asbestos during building renovations. Some employees mentioned that co-workers had been diagnosed with various types of cancer. Medical record review for five employees found one case of lung cancer in an employee with a history of smoking. Th s information did not indicate a specific ancer risk at the facility. We also collected 17 bulk ingredients samples of seasoning powders and flavored slurry mixtures for flavoring chemical content analysis.

During our observational assessment, we identifi d many areas with evidence of past and/or on-going water damage and indoor dampness issues. During confide tial interviews, many employees reported a history of water damage, dampness, and musty odors throughout the facility. Employees who reported musty or moldy odors in their work area also reported health symptoms such as increased sinus infections, bronchitis, pneumonia, sneezing, asthma exacerbation, and nasal congestion. Multiple employees with pre-existing lung disease (e.g., asthma or chronic obstructive pulmonary disease) indicated their chest symptoms worsened while at work. Further, some employees described taking over-the-counter decongestant or allergy medication before or after work to help manage upper respiratory symptoms. We recommend that damaged roofi g materials and all water-damaged materials be replaced. Additionally, we advocate routine scheduled inspections of the roof to proactively identify and repair any failing roofi g materials and clogged drainage covers.

We observed work areas with risk for exposure to the flavoring chemicals diacetyl (2,3-butanedione) and 2,3-pentanedione. Exposure to these flavoring chemicals may cause lung disease. We found areas with levels of these flavoring chemicals that approached or exceeded NIOSH's proposed recommended exposure limits. We recommend that management conduct personal air monitoring over multiple shifts or diacetyl and 2,3-pentanedione on employees in the popcorn butter flavor mixing area, cheese snack

product mixing area, and cheese snack product and popcorn room. If personal air monitoring detects elevated levels of diacetyl and 2,3-pentanedione in these areas, we recommend that management use engineering controls, such as local exhaust ventilation, in these areas to lower air levels. If engineering controls in these areas do not reduce personal sampling air levels of diacetyl and 2,3-pentanedione below the proposed NIOSH recommended exposure limits, management should require employees in these areas to wear respirators fitted with organic vapor cartridges and particulate filters. Further, we recommend that management develop and implement a written respiratory protection plan for employees that meets all regulatory requirements specifi d under the Occupational Safety and Health Administration (OSHA) Respiratory Protection Standard (29 CFR 1910.134).

We measured peak levels of dust greater than 15 milligrams per cubic meter (mg/m^3) in the corn snack product extruder area and during seasoning additions at the spice addition stations. We also measured capsaicin content in samples of snack product seasonings. Capsaicin is a naturally occurring irritant found in peppers. Seasonings with high capsaicin content were cited by employees as particularly bothersome. Employees expressed specific concerns with hot seasonings like jalapeño, chili, and salsa as well as vinegar and barbeque. Reported symptoms were consistent with mucus membrane and respiratory symptoms reported in previous studies. Reported symptoms included eye watering, sneezing, cough, congestion, runny nose, burning sensation in the nose and throat, bloody nose, difficulty breathing, and shortness of breath. These symptoms were most often reported by employees with packing and process operating job duties. Nearly all employees with exposure to seasonings reported mucus membrane irritation. We recommend that additional local exhaust ventilation be provided in specific reas and during specific ob tasks that were observed to have high dust levels measured during our survey. Greater detail is provided in the recommendations section of this report.

Introduction

The Health Hazard Evaluation Program received a confide tial request from employees at a snack foods manufacturing facility in Pennsylvania. The request listed concerns about respiratory illnesses, headaches, nosebleeds, and cancer related to indoor dampness, potential exposure to mold and mildew, seasonings, and asbestos. The facility was constructed in 1921 and is approximately 500,000 square feet. As of September 2014, 761 workers were employed at the facility. The facility produced 17 varieties of snack foods, including potato chips, popcorn, and other corn and onion snack products.

NIOSH visited the facility for three days in September 2014. On the fi st day of our visit, we held an opening meeting with management and the United Food and Commercial Employees (UFCW) union employee representative to discuss the nature of the health hazard evaluation request and tour the facility. We conducted on-site confide tial interviews with employees and performed limited air sampling. Th s report describes our fi dings and provides recommendations for protecting the health of the employees.

Process Description

Below, we describe the processes as of September 2014. No respiratory protection program or uniform policy was present at the time of our survey. Employees were required to wear hair nets, safety glasses, and nitrile gloves in all production and packaging areas. Hearing protection was required in selected areas of the facility. Hand washing stations were located at each entrance to both the chip and corn production areas.

Potato Chip Production

Receiving, Washing and Peeling

Each day, 12-15 trucks delivered approximately 15,000 pounds of potatoes to the facility. Each truck load was emptied into a hopper that distributed the potatoes to stainless steel water basins. The water basins served to remove excess dirt from potatoes before being moved to a line employee called a 'spotter' who performed quality assurance checks of the potatoes and removed detritus and/or damaged potatoes by hand. Potatoes were transported via fl tation in a water-filled conveyor system to an automated tumbler that peeled the potatoes.

Slicing, Frying, and Salting

Once peeled, the potatoes were transported on a conveyor system to one of three automatic slicers that were attached directly to fryers in the frying area. Sliced potatoes were automatically dropped into the fryer. Immediately after frying, the chips were automatically salted as they passed through a salt distributor on a conveyor belt. A computer system detected chips with undesirable brown spots and removed them from the conveyor line using compressed air. An employee in the frying room periodically went to the top of the fryer to manually add more salt to the salt distributor. An elevator system transported the chips to the packing room.

Seasoning and Packing

A conveyor system transported the salted chips to rotating seasoning tumblers on the mezzanine level of the packing room. The tumblers were located above employees in the packing room. Employees called 'seasoning attendants' periodically walked up to the mezzanine to manually add seasonings to tumblers by pouring seasonings into funnels at the top of the seasoning drum. Seasonings included pre-made formulations for different barbeque, onion, vinegar, sour cream, tomato, pepper, and jalapeno flavorings. After the funnel was filled, the tumbler began to rotate, releasing the seasoning, and coating the chips. A vibrating conveyor belt transferred the chips to the packing machine that dropped the chips into bags. A packing machine operator and packers were stationed at each line. Twenty-four packing machines were located on the main fl or of the packing room. Employees placed bags of chips in boxes. Chip boxes were then stacked onto pallets and wrapped using automated wrappers. Boxes were transported to a warehouse by forklift u til shipment or delivery. Approximately every 90 minutes, a quality control employee checked one bag from each packing line for salt and oil content, consistency, free fatty acids, and appearance.

Corn Chip Production

Masa (Corn Dough) Production

Rail cars delivered dry corn to the facility. The corn was milled and water was added to make masa (corn dough). Automated mixers kneaded the masa and extruded it into sheets. Employees operated machines that pressed extruded sheets into the desired shape for baking and/or frying. Remnant corn mix and water produced during pressing was sent to a corn solids separator, which drew out the remaining corn. The corn solids separator waste water was sent to the local municipal water treatment center.

Baked and Fried Corn Products

An extruder was used to press the masa into desired shapes. Depending on the product specifi ation, the shaped corn products were then baked or fried. A slurry mix containing oil, salt, and flavorings was added to the shaped corn products after they were baked or fried. The slurry mix was produced by mixing dry seasonings with liquid flavors and/or oil in a tank heated to 110°F. An employee manually weighed the appropriate amount of seasoning and/or liquid flavoring and poured it into the tank. After mixing, the slurry mix went into an automated mister that coated the corn product. The product was then sent to the packing area on a vibrating conveyor belt.

Other Products

Popcorn

Corn kernels were stored in super-sacks (large industrial bags) before being lifted and fed into a hopper. The hopper fed the kernels into a rotating oven that popped the corn. The popcorn was then dropped onto a conveyor belt that delivered the popcorn to an enclosed tumbler where a slurry mix was automatically added to the popcorn. The slurry was produced by mixing dry seasonings with liquid flavorings and/or oil in a tank heated at 110°F. An employee manually weighed the appropriate amount of seasoning and/or liquid flavoring and poured it into the tank. Cheese and butter flavorings were the most common slurry mixes added to popcorn. The flavored popcorn was then sent to the packing area by conveyor belt.

Onion Snack Product
Cornstarch and tapioca were combined and extruded to form pellets. The pellets were baked in an oven and then sent to a seasoning drum by a conveyor belt. An employee manually added dry onion seasoning into a funnel connected to the seasoning tumbler. The seasoning tumbler rotated and added onion seasoning to the onion snack product as the onion snack product passed underneath the tumbler, on a vibrating conveyor belt. The onion snack products were then sent on a vibrating conveyor belt to the packing area.

Packaging
The corn products packing room was located in the same space as the potato packing room. Finished corn and tortilla chips were sent on a conveyor belt to the mezzanine level of the packing room, and some products had additional seasonings added by a tumbler before packing. The corn products tumblers operated in a similar fashion to the potato products tumblers. Seasoning additions included barbeque, cheese, and salsa. The corn products were then sent to the packing machine on a vibrating conveyor belt and dropped into bags. A packing machine operator and packers were stationed at each line. Employees placed packaged chips into boxes. The boxes were then transported by a conveyor system to the warehouse. In the warehouse, employees stacked and wrapped boxes onto pallets using automated wrappers.

Cleaning of Process Equipment
Employees at the potato processing lines cleaned the equipment in their work area on a weekly basis. At the end of the week, a designated cleaning crew cleaned the corn processing equipment. Fryers were cleaned using a bleach agent that contained 12%–15% sodium hypochlorite. Employees added 25 gallons of the cleaning agent to each fryer and heated it to boiling for a cleaning cycle. Employees used the same cleaning mixture to spray down the exterior of fryers. Safety data sheets (SDSs) indicate that employees were required to wear face shields and impermeable gloves when performing cleaning tasks.

Wastewater Treatment
The facility had a 610,000 gallon wastewater system. Wastewater from potato processing was sent to settling basins located in a separate building. Ferric chloride was added to lower the wastewater pH to 3. Lime (calcium hydroxide) was then added to bring the pH to 12. Th s process removed solids from the wastewater. In addition, a starch recovery process removed residual starches in wastewater from the potato peeling process.

Methods

Review of Medical Records and Informal Employee Interviews
The company provided us a list of current employees; we stratifi d the list by shift nd job type and used JMP, version 11 (Cary, North Carolina) to randomly select 137 employees for an informal interview. Seven additional employees were selected for interview based on prior discussions with requesters, giving a total of 144 employees selected for interviews. In September 2014, three NIOSH staff embers confide tially interviewed a total of 85

employees in a private setting with largely open-ended questions. Average length of tenure was calculated among non-seasonal staff. Medical records were obtained and reviewed for five current or past employees.

Review of Company's OSHA Form 300 Log of Work-Related Injuries and Illnesses
We requested the company's OSHA's Form 300 Log of Work-Related Injuries and Illnesses from 2009 to 2014. We reviewed the OSHA Form 300 Logs of Work-Related Injuries and Illnesses, and summarized OSHA recordable injuries by type and year.

Indoor Environmental Quality Assessment
On September 17, 2014, we assessed the building's exterior and roofi g materials to identify areas of potential water intrusion. We assessed roofi g materials, caulking, roof flashing, and cracks in the joints between roof and walls. On September 18, 2014, we assessed interior spaces to identify signs of water damage or water stains due to roof or pipe leaks, presence of wet/damp materials, visible mold, or musty odors. A ladder was used to investigate the plenum area above ceiling tiles. We documented and photographed signs of water intrusion indoors using an infrared (IR) camera (Fluke Thermal Imager, Model TiR4, Everett, WA).

Bulk Samples
We used sterile 50 milliliter polypropylene centrifuge tube containers to collect bulk material samples of 14 types of dry seasonings and three slurry mixtures on site. The slurry flavoring samples were oil based mixtures of salt and specific avorings and were collected from the heated mixing vat on site. We performed headspace analysis for diacetyl (2,3-butanedione), 2,3-pentanedione, and 2,3-hexanedione from both dry seasonings and slurry mixtures bulk samples. We also analyzed bulk samples for capsaicin and dihydrocapsaicin content using high performance liquid chromatography with fluorescence.

Evacuated Canisters Monitoring
During the walkthrough, we placed seven 450 cubic centimeters evacuated canisters near seasoning and flavorings addition stations and storage areas for the collection of volatile organic compounds (VOCs), including diacetyl, 2,3-pentanedione, and 2,3-hexanedione. Canisters were placed approximately 1.5 meters above the fl or to approximate the height of an employees' breathing zone. Canisters were equipped with attachments for either instantaneous sampling (<30 seconds) or restricted fl w sampling that allowed for calculation of time-weighted average concentrations with 6 hour durations. Six evacuated canisters served as full-shift rea samples and one evacuated canister served as an instantaneous sample. Canisters were analyzed for VOCs using a pre-concentrator gas chromatography-mass spectrometry system pursuant to a published method validation study [LeBouf et al. 2012] with the following modifi ations: the pre-concentrator was a Model 7150 (Entech Instruments, Inc.); three additional analyte compounds, diacetyl (2,3-butanedione), 2,3-pentanedione, and 2,3-hexanedione were included.

Real-time Monitoring
DustTrak DRX Aerosols Desktop Monitors 8533 (TSI, Inc. Shoreview, MN) were used to obtain real-time air levels of respirable and total airborne dust. We conducted point source

and baseline screening during various operations at the facility. The DustTrak is optimized for detection of particles in the size range of 0.1 micrometer to 10 micrometers and was programmed to log data at 15 second averaging intervals. We held the DustTrak probe close to two employees' breathing zones as they performed a seasonings addition to screen for potential peak dust exposures in the seasoning areas. Other locations included the seasoning addition areas on the mezzanine of the packing room, frying room and fryers, corn processing room, onion snack product room, and corn packing room. Data analysis was performed using 2010 TrakPro software (TSI, Inc. Shoreview, MN).

Results

Review of Company's OSHA Form 300 Log of Work-Related Injuries and Illnesses
We reviewed the company's OSHA's Form 300 Log of Work-Related Injuries and Illness from 2009 to 2014. Reported injuries declined from 71 in 2011 to 46 in 2013. Work-related standard threshold shifts in earing (greater than 10 decibels) were reported in over half of the OSHA Log recordable events in 2011 (n = 46, 65%). In 2013, the number of recordable work-related standard threshold shifts w s much lower (n = 5, 11%).

Musculoskeletal injuries (strains, sprains, fracture, and contusions), lacerations, and two reports of chemical burns made up the majority of the remaining OSHA Log recordable events for 2009 to 2014. There were no reports of work-related asthma or respiratory complaints.

Informal Employee Interviews and Health Concerns
Of the 144 employees selected for informal interviews, three (2.1%) no longer worked at the facility, six (4.2%) were on leave or vacation, 10 (7.9%) declined to participate in the interview, and 22 (16.7%) did not arrive for the scheduled interview at the time of our visit. Further, due to time constraints, 18 (12.5%) employees were not interviewed. We conducted private, confide tial health interviews with a total of 85 employees. Our interview sample represented roughly 11% (85/761) of the workforce. The average job tenure of interviewed employees was 15 years and ranged from one month to 46 years.

Employees shared many health concerns, including (1) respiratory irritation from specific seasonings; (2) skin irritation from dust; (3) exposure to corn dust; (4) exposure to mold and damp indoor environments; (5) exposure to cleaning chemicals; (6) dust generated from seasoning tumblers and while pouring seasonings into hoppers and storage containers; (7) lack of ventilation in the buildings; (8) excessive heat in the facility; and (9) potential exposure to asbestos during building renovations. The health hazard evaluation request specifi d concerns regarding cancer risk in the facility. Some employees noted that co-workers had been diagnosed with various types of cancer. However, none of the interviewed employees reported a cancer diagnosis. Medical record review for five employees found one case of lung cancer in an employee with a history of smoking.

Nearly all employees with reported exposure to seasonings also reported irritant symptoms. Irritant symptoms were more common among employees in packing and process operating areas. The symptoms included eye watering, sneezing, cough, congestion, running nose, burning sensation in the nose and throat, bloody nose, difficulty breathing, and shortness of breath. Employees reported that jalapeño, chili, salsa, vinegar, and barbeque seasonings were particularly irritating. Several employees reported respiratory symptoms that occurred when using cleaning chemicals to clean fryers, to include difficulty breathing, cough, sore throat, and chest pain with inhalation.

A history of water intrusion, dampness, and musty odors throughout the facility including the warehouse, packing and production areas, and administrative offices s also reported by employees. Employees who reported musty or moldy odors in their workplace reported increased occurrence of sinus infections, bronchitis, pneumonia, sneezing, asthma exacerbation, and nasal congestion. Multiple employees with pre-existing lung disease (e.g., asthma or chronic obstructive pulmonary disease) indicated that their chest symptoms worsened while at work. Other employees described taking over-the-counter decongestant or allergy medications before or after work to help manage upper respiratory symptoms.

Additionally, employees reported heat stress concerns during the summer months, most notably in the frying room. During our visit in September, the weather was mild, and we did not observe elevated workplace temperatures.

Medical Record Review

We reviewed medical records from five current or former employees who released their records to NIOSH. We found that one employee developed physician-diagnosed work-related asthma during employment. Work-related asthma includes aggravation of preexisting asthma while at work and new-onset asthma induced by occupational exposure. Typical symptoms include cough, difficulty breathing, a tight feeling in the chest, shortness of breath, and wheezing. These symptoms may occur shortly after contact with a substance or may take several hours to develop. Because work-related asthma is triggered or aggravated by a workplace exposure, individuals often see that symptoms get better or disappear when they are away from work, for example on weekends or vacations. The treating pulmonologist evaluated this employee's pattern of respiratory complaints and frequent bronchodilator use and determined that the pattern of symptoms reported were characteristic of work-related asthma.

Indoor Environmental Quality Assessment

There was a considerable amount of water and sludge-like material around the base of the fryers in the frying room that made the fl or slick. Each fryer was fully enclosed with an exhaust hood that led up to the roof. In the corn products area, there were large amounts of visible settled corn meal dust on the machines and fl or. We observed musty odors, standing water, and corn meal sludge on the ground near the corn solids separator. We found multiple areas with water damage to ceiling tiles and walls, and peeling paint in the administrative offices

Roof Assessment

The roof had many different levels (Figure 1). We observed standing water in many areas on the facility's flat roofs (e.g., warehouse, maintenance department, chip packing, and frying room) and at the edge of the gable roof adjacent to chip packing and fryer room. Standing water near the edge of the gable roof of the chip processing, packing, and storage building can be seen in Figure 2 below.

Figure 1. Facility top with multiple levels, September 2014.

Figure 2. Pooled water near the edge of the gable roof of the chip processing and storage building, September 2014.

Figure 3. Hole in damaged roofing materials, September 2014. Hole was located near the water pool seen in Figure 2.

Many of the roof drain covers in those areas on the roofs were clogged with leaves or debris that prevented proper drainage of rain water and resulted in pooled water on the roofs. Roofi g materials above the maintenance department, chip processing, and administrative offices ere disintegrating and in need of repairs (Figure 3). Specifi ally, the roof of the maintenance department had holes in the double-patched roofi g material that allowed rain water to be trapped between the layers (Figure 4).

Figure 4. Rain water trapped between two layers of patched roofing materials, September 2014.

We observed damaged roof flashing and caulking at the joints between two buildings and at areas where the walls and roof met. The roof flashing at the joint between the wall and roof of the warehouse building was missing (Figure 5).

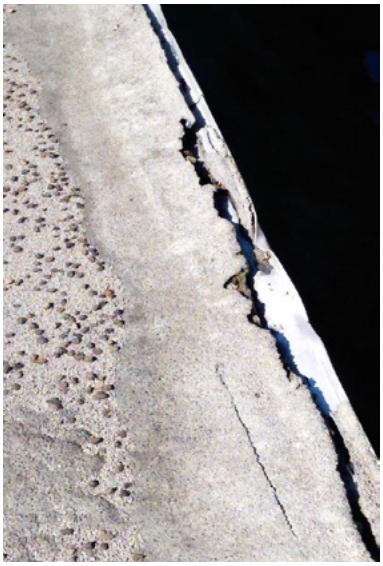

Figure 5. A gap identified at the roof and wall joints of the storage building located near the corn processing area, September 2014.

We observed gaps at joints around the older buildings that possibly allowed rain water intrusion. The flashing and caulking at the wall and roof joint above the corridor by the general and payroll office reas were disintegrated (Figure 6).

Figure 6. Damaged roof flashing and disintegrated caulking on the roof above the accounting and general office areas, September 2014.

The disintegrated flashing and caulking allowed water to get indoors, particularly in the payroll office reas. We also observed cracks on caulking at the roof joint between the maintenance department and repacking area (Figure 7).

Figure 7. Damaged roof flashing and caulking at the joint between the two buildings of the maintenance department and repacking areas, September 2014.

The drainage gutter located above rooms 124 and 125 in the office rea was not properly directed away from the wall and toward the drain. Instead, this spout was open toward the wall, which allowed rain water to run down the wall of the building. The improper drain system and the compromised flashing around the window in room 124 allowed water intrusion into the room around the window (Figure 8).

Figure 8. Water intrusion near an office window, September 2014.

Interior Space Assessment

Water intrusion from the roof was observed in several offices, n the walls of the frying room, and the interior wall between the chip packing and maintenance department. The general office reas and corridor had stained ceiling tiles, peeling paint on the interior walls, and crystalline deposits on the concrete walls above the ceilings, indicating potential water intrusion from the roof. We observed peeling paint on the wall around the window in the room 124, indicating a history of water damage (Figure 8). Using an infrared camera, we identifi d dampness in the walls surrounding the window and observed cooler temperatures compared to the surrounding walls of the office pace, suggesting that residual moisture remained inside the wall. In the chip packing room, three of the ten air-conditioning units had rust on the bottom of the casing, indicating frequent condensation on the surface of the unit during operation. One of the two general exhaust fans in the room containing fryers A and B was broken and not operating at the time of the visit. We observed water stains on the walls outside of the seasoning room and in the chip processing room, indicating past roof leaks.

Bulk Samples

Results from the bulk sample analyses are summarized in Table 1. Diacetyl was present in the sour cream/cheese, natural vinegar, and sour cream/onion seasoning. 2,3-Pentanedione was present in the sour cream/onion seasoning and the popcorn and cheese puff s ack slurries. Small amounts of 2,3-hexanedione were present in the puffed cheese snack flavoring. Capsaicin was present at amounts greater than 100 ppm in jalapeño, spicy/sweet, and chili seasonings.

Table 1. Headspace analysis results for diacetyl (2,3-butanedione), 2,3-pentanedione, 2,3-hexanedione, capsaicin, and dihydrocapsaicin for bulk samples of seasonings and slurries, NIOSH survey, September 2014.

Name	Diacetyl (2,3-Butanedione) *(ppb)*		2,3-Pentanedione *(ppb)*		2,3-Hexanedione *(ppb)*		Capsaicin *(ppm)*	Dihydrocapsaicin *(ppm)*
Slurry‡								
Popcorn butter	<LOD		450		<LOD		<LOD	<LOD
Cheese snack product	<LOD		<LOD		<LOD		<LOD	<LOD
Puffed cheese snack product	<LOD		212		322		<LOD	<LOD
Seasoning§								
	Wet†	*Dry**	*Wet†*	*Dry**	*Wet†*	*Dry**	*Dry**	*Dry**
Sour cream/cheese	5,085	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Vinegar- natural	2,247	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Vinegar- regular	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Jalapeno- natural	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	240	110
Jalapeno- regular	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	120	78
Sour cream/onion	2,109	<LOD	220	<LOD	<LOD	<LOD	<LOD	<LOD
BBQ A¶	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	70	7.3
BBQ B	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	11	<LOD
BBQ C	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	12	<LOD
BBQ D	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
BBQ E	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	9.2	6.4
Sweet/Spicy	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	110	45
Chili	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	230	25
Onion	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	3.7	<LOD
LOD	0.8	0.8	0.9	0.9	0.9	0.9	3	6
LOQ	2.4	2.4	2.7	2.7	2.7	2.7	8.6	21

Note: min: minutes; ppb: parts per billion; ppm: parts per million; LOD: limit of detection; LOQ: limit of quantification.
***Dry: Indicates dry powders.**
†Wet: Indicates powders that were wetted with one milliliter distilled water.
‡Slurry: Refers to an oil based mixture of oil, salt, and specific flavorings, stored in a mixing vat, heated to 110°F and sprayed on final products before packing.
§Seasoning: Refers to powdered products that are added to product in seasoning tumbler.
¶BBQ A – BBQ E in the table refer to a variety of barbeque flavorings.

Evacuated Canister Area Samples

Results from area air sampling from evacuated canisters are shown in Table 2. The NIOSH proposed Recommended Exposure Limit (REL) is 5 ppb for diacetyl and 9.3 ppb for 2,3-pentanedione [NIOSH 2011]. There is no REL for 2,3-hexanedione. We measured levels of diacetyl and 2,3-pentanedione that approached or exceeded the NIOSH proposed REL in the following locations (1) popcorn butter flavor mixing area; (2) cheese snack product mixing

area in the popcorn room; and (3) cheese snack product mixing area in corn processing room. The NIOSH proposed RELs for diacetyl and 2,3-pentanedione are for personal air exposures not area air samples. Results from the area air samples presented below suggest that there are areas where personal air exposures may exceed the NIOSH proposed RELs for diacetyl and 2,3-pentanedione.

Table 2. Evacuated canister air sampling results for diacetyl (2,3-butanedione), 2,3-pentanedione and 2,3-hexanedione in production and packing areas, NIOSH survey, September 2014.

Location	Time (min)	Diacetyl (2,3-butanedione) (ppb)	2,3-Pentanedione (ppb)	2,3-Hexanedione (ppb)
Slurry*				
Popcorn butter flavor mixing area in popcorn room	332	6.7	6.8	5.8
Cheese snack product mixing area in popcorn room	329	9.4	2.5	1.2
Cheese snack product mixing area in corn processing room	337	8.3	11.6	12.6
Seasoning†				
BBQ seasoning addition drum in chips packing	326	3.5	1.8	3.0
Onion seasoning drum	338	2.6	2.4	2.2
Seasoning room; transfer of brown bags into white plastic bins	320	3.3	3.4	4.3
BBQ seasoning addition drum in corn product area§	<1 min	1.6	3.2	0.0
NIOSH REL (for personal samples)		**5.0**	**9.3**	NA
LOD		0.8	0.9	0.9
LOQ		2.5	2.9	3.2

Note: min: minutes; ppb: parts per billion; REL: recommended exposure limit; LOD: limit of detection; LOQ: limit of quantification; NA: not applicable.
***Slurry refers to an oil based mixture of oil, salt and specific flavorings, stored in a mixing vat, heated to 110°F and sprayed on final products before packing.**
† "Seasonings" are powdered products that are added to product in seasoning tumbler.
§This sample was instantaneous grab sample, with a sample collection of less than 30 seconds.

Real Time Monitoring

Real-time monitoring results for respirable and total dust in the corn products area can be seen in Figure 9. Measured dust levels were consistently below 0.5 mg/m^3 of respirable dust and 0.7 mg/m^3 of total dust. Elevated total and respirable dust levels were observed on the corn product packing mezzanine.

Respirable and total dust levels in the potato chip area can be seen in Figure 10. We observed higher levels of respirable and total dust when an employee was pouring a seasoning addition

into the seasoning drums on the mezzanine level. The highest levels of respirable and total dust were observed during an addition of onion and garlic seasoning. Respirable dust concentrations of 20 mg/m^3 and total dust concentrations of 50 mg/m^3 were observed during the onion and garlic seasoning addition. We observed a visible cloud of dust from the top and the base of the seasoning funnel as the employee poured the onion and garlic seasoning.

Total and respirable dust levels measured in the frying room and popcorn production areas were much lower (Figure 10). We measured less than 1 mg/m^3 for respirable and total dust throughout much of the frying room and popcorn production areas. In contrast, near the corn snack product extruder, the respirable dust levels peaked at 10 mg/m^3, and total dust levels peaked at 17 mg/m^3.

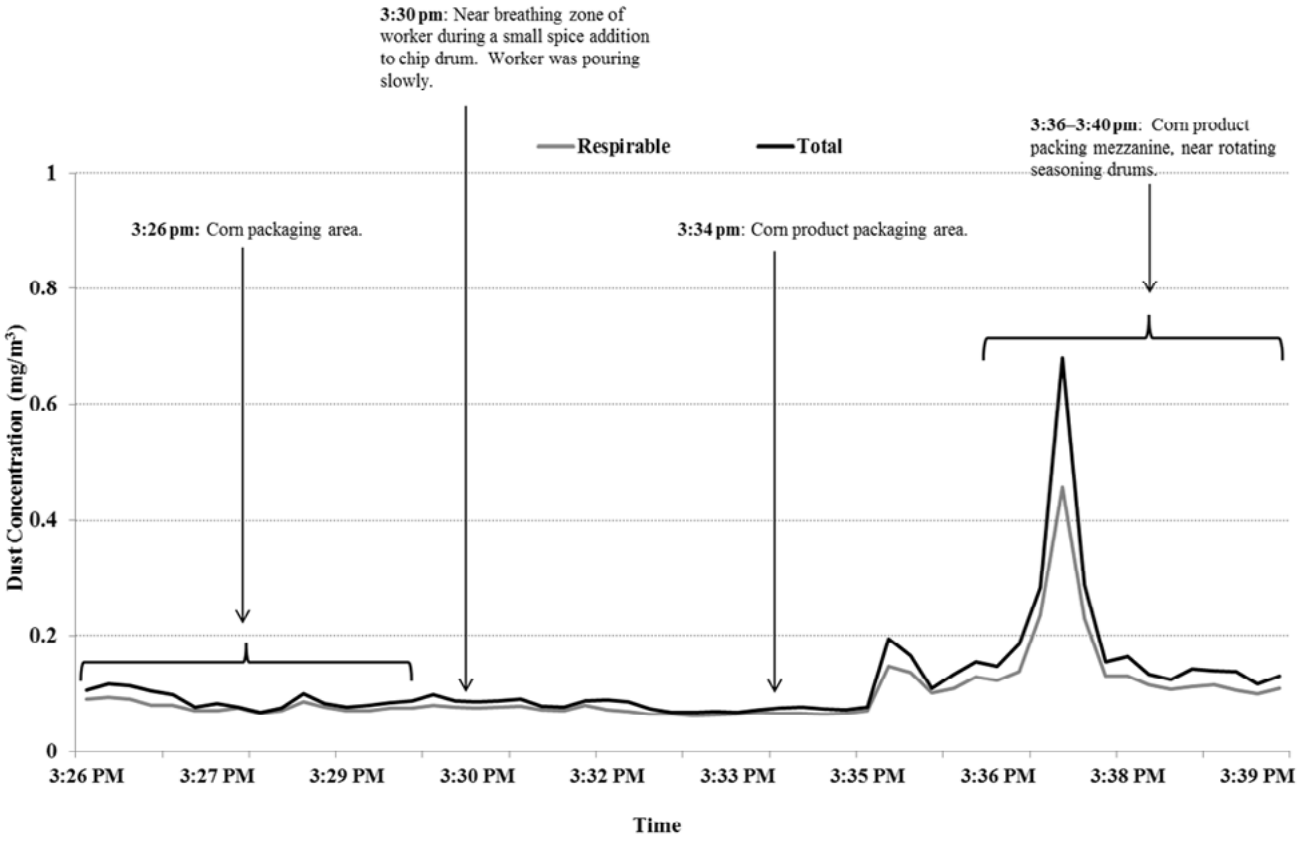

Figure 9. Real-time monitoring results of corn product area; total and respirable dust levels, NIOSH survey, September 18, 2014. Respirable dust levels are shown in grey, and total dust levels are shown in black. Note: mg/m^3: milligrams per cubic meter.

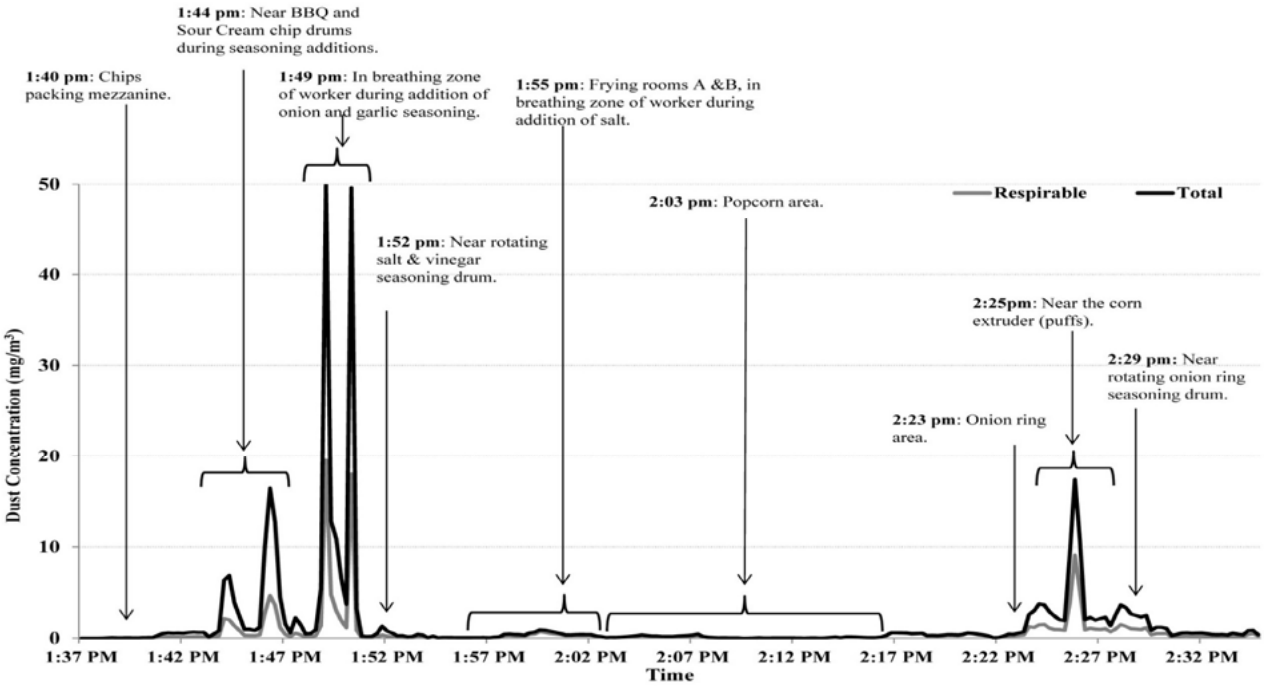

Figure 10. Real-time monitoring results of potato chips area, NIOSH survey, September 18, 2014. Respirable dust levels are shown in grey; total dust levels are shown in black.

Discussion

During our visit to the snack foods manufacturing facility in September 2014, employees shared many health concerns, including effects of seasonings, dust, mold, dampness, cleaning chemicals, heat, and asbestos. The concern about cancer that was listed in the health hazard evaluation request was not emphasized in the employee interviews, and our limited review of medical records did not identify a cancer cluster. We assessed potential indoor environmental quality hazards related to damp building conditions that may support mold growth and/or other harmful biological toxins. We also assessed the potential for occupational exposure to several food flavorings that are associated with an increased risk for respiratory disease in exposed employees. Exposure to indoor environmental quality hazards and food flavorings may result in short and/or long-term health effects. We identify and discuss these and other potential health hazards below.

Indoor Environmental Quality

Water intrusion damages building materials and increases indoor dampness. In this facility, we observed a number of areas with potential for water intrusion into the building. Clogged rooftop drainage, incorrectly routed drainage, failing roofi g materials, flashings, and caulking in various areas of the buildings may have contributed to water intrusion into the occupied indoor spaces. The roof on the office uilding, specifi ally the general and payroll office reas, the maintenance department, and the chip processing areas showed signs of excess age and wear and likely contributed to water intrusion. Joints between walls and the

roof were particularly worn and did not appear water tight. Management stated that the roofi g materials above the office nd chip processing areas would be replaced within a couple of years. Future water leaks may be prevented by (1) installing proper roof flashings and caulking; (2) routinely examining the roofs; and (3) making prompt repairs to damaged materials.

Damp indoor building materials support the growth of bacteria or fungi. Dampness in buildings can occur for a variety of reasons such as high indoor humidity, condensation, and roof leaks. Damp building conditions promote the growth of mold, bacteria, and other microbial agents, as well as dust mites and cockroaches. Dampness can also contribute to the breakdown of building materials and furniture. Musty odors are a sign of microbial contamination. Bacteria or fungi on damp materials could be airborne in certain conditions, as intact spores or cell fragments. Bacteria or fungi can also release microbial VOCs as their primary or secondary metabolites. These VOCs may be detected as a moldy or musty odor. Further, microbial toxins such as endotoxin or mycotoxins can be produced by microorganisms in damp environments [IOM 2004].

NIOSH does not typically recommend air sampling for mold because measurements of mold in air are highly variable and dependent on the mold species' lifecycle stages (e.g., spore formation) [NIOSH 2012]. In many cases, very short-term sampling for mold spores is conducted and spore counts and culture results do not capture the full range of exposures. Additionally, what building occupants may react to is largely unknown. It may be mold, a compound produced by mold, something related to bacteria, or compounds that are released into the air when wet building materials break down.

Multiple employees with pre-existing lung disease (e.g., asthma or chronic obstructive pulmonary disease) indicated that their chest symptoms worsened while at work. Comprehensive reviews have been conducted of previous scientific tudies evaluating health effects of exposure to damp indoor conditions. Damp indoor conditions were associated with asthma development and exacerbation, hypersensitivity pneumonitis, respiratory infections, allergic rhinitis, bronchitis, and eczema [Mendell et al. 2011; WHO 2009]. We found that employees in areas of this facility where there was noticeable water damage and a history of musty odors also reported sinus infections, bronchitis, pneumonia, sneezing, asthma exacerbation, and nasal congestion.

Exposure to dampness and mold can be prevented by identifying and repairing sources of water intrusion and replacing water damaged building materials as early as possible. NIOSH has published an Alert, *Preventing Occupational Respiratory Disease from Exposures Caused by Dampness in Office Buildings, Schools, and Other Nonindustrial Buildings,* that provides information on respiratory disease related to indoor dampness and recommendations for preventing and remediating damp buildings [NIOSH 2012].

Flavoring chemicals (diacetyl and 2,3-pentanedione)
Diacetyl (2,3-butanedione) and 2,3-pentanedione are VOCs with an intense buttery flavor. Diacetyl and 2,3-pentanedione are natural byproducts of fermentation and can also be

synthesized by chemical manufacturers and then added to food products. Exposure to diacetyl is associated with an increased risk for severe lung disease and lung function decline [NIOSH 2003]. Irreversible lung disease, such as obliterative bronchiolitis, has been reported in employees in industries with diacetyl exposures [Kreiss 2007; van Rooy et al. 2007]. Severe airway damage and disease has also been observed in laboratory animals after exposure to diacetyl or 2,3-pentanedione, a diacetyl substitute [Hubbs et al. 2008; Morgan et al. 2012]. Because of the potential health effects associated with diacetyl and 2,3-pentanedione exposure, NIOSH drafted an eight-hour proposed REL and 15-minute proposed short-term exposure limit (STEL) for both of these flavoring chemicals. The NIOSH proposed REL is five ppb for diacetyl with a proposed STEL of 25 ppb. The proposed REL for 2,3-pentanedione is 9.3 ppb, and the proposed STEL is 31 ppb [NIOSH 2011]. The higher proposed REL and STEL for 2,3-pentanedione does not imply that 2,3-pentanedione is of lower toxicity than diacetyl. Rather, the proposed REL and STEL for 2,3-pentanedione is based upon the lowest level at which the substance reliably can be detected using the existing validated analytical method [NIOSH 2011].

Some area air samples, collected using evacuated canisters, in the popcorn and corn product flavor mixing areas approached or exceeded the proposed NIOSH RELs for diacetyl and 2,3-pentanedione. These areas included the (1) popcorn butter flavor and cheese snack mixing area in the popcorn room; and (2) cheese snack product mixing area near the slurry vat in the corn processing room (Table 2). We recommend personal air monitoring be performed to confi m that air concentrations of diacetyl and 2,3-pentanedione are below the proposed NIOSH RELs for diacetyl and 2,3-pentanedione. Personal air monitoring for diacetyl and 2,3-pentanedione should be sampled and analyzed according to OSHA methods 1012 and 1016 [OSHA 2008, 2010]. If personal air sampling cannot confi m that air concentrations are below the proposed NIOSH RELs, we recommend implementing engineering controls, such as local exhaust ventilation, in these areas to lower air levels of diacetyl and 2,3-pentanedione to concentrations below their respective NIOSH REL.

If engineering controls do not reduce personal air sampling levels of diacetyl and 2,3-pentanedione below the proposed NIOSH RELs, we recommend that management require employees performing tasks in those areas to wear respirators fitted with organic vapor cartridges and particulate filters. The choice of respirator (half-face, full-face, or powered air-purifying respirator [PAPR]) should be guided by the concentrations of diacetyl and 2,3-pentanedione on personal air monitoring. A minimum respirator protection factor of 10 would be necessary, if personal air monitoring results indicate air levels from five to 50 ppb for diacetyl or 9.3 to 47 ppb for 2,3-pentanedione. For reference, air-purifying full-face respirators have an assigned protection factor (APF) of 50, and air-purifying half-face respirators have an APF of 10 [OSHA 2009]. Therefore, if air-purifying respirators are used, a half-face NIOSH-certifi d respirator equipped with organic vapor cartridges in combination with particulate filters would be appropriate for personal air concentrations similar to the area air concentrations. Alternatively, there are powered air-purifying respirators (PAPRs) that have APFs of 25, 50, or 1000 [Table 1, 29 CFR 1910.134].

Capsaicin

Capsaicin is a naturally occurring irritant commonly found in many varieties of chili peppers. Exposure to capsaicin is associated with short-term and long-term respiratory effects. Direct effects of capsaicin exposure include irritation of the eyes, mucus membranes, and respiratory tract [Copeland and Nugent 2013]. A study of chili mill employees by Uragoda [1967] highlighted a high frequency of sneezing, watery nose, cough, and a retrosternal burning sensation in 95% of the employees surveyed. A more recent study exposed humans to nebulized capsaicin and reported short-term bronchoconstriction, cough, and chest discomfort in all subjects [Fuller et al. 1985].

Although most studies of the respiratory effects after exposure to capsaicin highlight short-term symptoms that are fast-resolving, several studies have illustrated the potential for long-term effects. A recent case-study reported occupational rhinitis that had developed in a woman after four years of employment at a chili mill [Nam et al. 2012]. Another case study in 2013 highlighted a 47 year old woman who developed airway sensory hyperreactivity syndrome after a single 20 minute exposure to pepper spray [Copeland and Nugent 2013]. Although previous studies of capsaicin exposure observed short-term symptoms that resolved quickly, the 2013 case study reported that the woman developed a cough, wheeze, and difficulty breathing that persisted for months after a single, albeit intense, exposure.

We collected material bulk samples of seasonings that employees often complained about due to their short-term, irritating effects. Capsaicin was present at amounts greater than 100 ppm in many of the bulk samples, including jalapeño, chili, and barbeque seasonings. Because we observed a visible cloud of seasoning dust and peak respirable and total dust concentrations of 50 mg/m^3 near the breathing zone of an employee performing a seasoning addition, we note the potential for high capsaicin exposure during the addition of jalapeño, chili, and barbeque seasonings. Employees in the packing area reported similar symptoms to those noted in previous studies of capsaicin exposure, to include eye watering, sneezing, cough, congestion, runny nose, burning sensation in the nose and throat, bloody nose, difficulty breathing, and shortness of breath. Management should consider supplying N95 disposable filtering-facepiece respirators for voluntary use during seasoning additions and while pouring or transferring seasoning powders. Employees can use these respirators while working with the specific easonings that are most irritating. However, if employees are working with seasons and flavorings that exceed the NIOSH proposed RELs for diacetyl and/or 2,3-pentanedione then respirators with NIOSH-certifi d organic vapor cartridges (for the alpha-diketones) and particulate cartridges/filters (for the dust) would be warranted.

Corn dust

Grain dusts, including corn dust, can contain bacteria, fungi, and inflammatory microbial constituents to include endotoxin and mycotoxins such as aflatoxins [Bothast et al. 1974]. Inflammatory constituents in grain dusts have been associated with acute and chronic airway injury including mucus membrane irritation, asthma, bronchitis, and organic dust toxic syndrome [Clapp et al. 1994]. Corn dust contaminated by fungi and bacteria has also been implicated in past cases of hypersensitivity pneumonitis [Moreno-Ancillo et al. 2004]. The

OSHA permissible exposure limit (PEL) for grain dust is 10 mg/m^3 [https://www.osha.gov/dsg/annotated-pels/tablez-1.html], and the NIOSH REL is four mg/m^3 for cereal grain dusts containing 60%–75% organic matter [NIOSH 2015b].

During interviews, we learned that some employees were concerned about visible corn dust, especially in the corn products processing area. During our visit, we saw that there was little ventilation near the corn snack product extruder, and we observed settled dust on the machines and fl or. We measured peak airborne levels up to 10 mg/m^3 respirable dust and 17 mg/m^3 total dust near the extruder, using real-time dust monitoring equipment. Updated ventilation or local exhaust near this area would lower dust levels. In the interim letter, we recommended the provision of N95 disposable filtering-facepiece respirators for voluntary use during work near the corn snack product extruders in the chips processing area or during cleaning activities that may stir up settled corn dust and potentially generate an inhalational hazard.

Asbestos

Asbestos-containing materials are often observed in older buildings. Some employees expressed concern about their potential past asbestos exposure during previous renovations when a contractor removed asbestos from the facility. Asbestos is made up of microscopic bundles of fibers that may become airborne when asbestos-containing materials are damaged or disturbed. Exposure to airborne friable asbestos might result in a potential health risk because persons breathing the air might breathe in asbestos fibers. Continued exposure can increase the amount of fibers that remain in the lung. Fibers embedded in lung tissue over time might cause serious lung diseases including asbestosis, lung cancer, or mesothelioma. Smoking increases the risk of developing lung cancer from asbestos exposure. Diseases associated with asbestos have a long latency period, which means the development of asbestos-related diseases might take up to 30 years from the time of exposure [NCI 2009].

The state of Pennsylvania's asbestos program includes state and federal guidelines for the purpose of protecting the population from accidental exposure to excessive amounts of airborne asbestos fibers. The Pennsylvania Department of Environmental Protection regulates the collection, removal, disposal, and transportation of asbestos containing products from all commercial and public buildings in Pennsylvania, and the Pennsylvania Department of Labor and Industry requires certifi ation for the following asbestos occupations: contractor, inspector, management planner, project designer, supervisor, and worker. If there is demolition work, repair, or renovations planned in the future, we recommend that management review and ensure they are in compliance with Pennsylvania Department of Environmental Protection and Pennsylvania Department of Labor and Industry asbestos regulations [Pennsylvania Department of Environmental Protection 2014].

Cancer

Cancer is a group of different diseases that share the same feature of uncontrolled growth and spread of abnormal cells. Each different type of cancer may have its own set of causes. Cancer is common in the United States. In the United States, one in two men and one in three women will develop cancer over the course of their lifetimes. Th s does not include basal or squamous

cell skin cancers, which are very common (more than 3 million diagnosed annually), or any in-situ carcinomas other than bladder. If these were included, rates would be even higher. One of every four deaths in the United States is from cancer. Among adults, cancer occurs more frequently with increasing age. Cancer cases may appear to occur with alarming frequency even when the number of cases is not more than would be expected in the general population because cancer is common, the population is aging, and more people are surviving cancer. Th s perception is especially common among a small group of people who have something in common with the cases, such as working in the same building.

Many factors play a role in the development of cancer. The importance of these factors varies for different types of cancer. Most cancers are caused by a combination of several factors. Some of the factors include (a) personal characteristics such as age, sex, and race; (b) family history of cancer; (c) diet; (d) personal habits such as cigarette smoking and alcohol consumption; (e) the presence of certain medical conditions; (f) exposure to cancer-causing agents in the environment; and (g) exposure to cancer-causing agents in the workplace. In many cases, these factors may act together or in sequence to cause cancer. Although some causes of various types of cancer are known, we do not know of all possible causes of cancer. One important point to note is that the absence of a known risk factor does not mean that there is no risk for developing cancer.

In many workplaces, the number of cancer cases is small. A small number of cancer cases makes detecting whether the cases have a common cause difficult, especially when no apparent cancer-causing exposures are present. It is common for the borders of the "cluster" to be drawn around where the cases of cancer are located, instead of defini g the population and geographic area fi st. Th s often leads to "clusters" that are not real. The information we gathered during worker interviews did not indicate a specific ancer risk at the facility. For more information about cancer cluster, please visit the Centers for Disease Control and Prevention (CDC) website at http://www.cdc.gov/nceh/clusters/about.htm [CDC 2012].

Conclusions

Employees reported a history of water intrusion, dampness, and musty odors throughout the facility. During our visit, we identifi d areas of water intrusion and indoor dampness. Upper and lower respiratory symptoms were described by employees who work in the warehouse, packaging and production areas, and the administrative offices here signs of indoor dampness were noted.

Employees expressed concerns about exposure to spicy seasonings. Nearly all employees in packing and process operating with exposure to seasonings reported irritating and acute symptoms. We identifi d the presence of capsaicin in bulk samples of jalapeño, spicy/sweet, and chili seasonings. Although fewer employees reported symptoms attributable to corn dust, we measured peak levels of dust near the corn snack product extruder area and during seasoning additions at the spice addition stations. We also measured flavoring chemicals in area air samples of the workplace air that approached or exceeded NIOSH's proposed

exposure limit for diacetyl and 2-3-pentanedione in the (1) popcorn butter flavor and cheese snack mixing area in the popcorn room; and (2) cheese snack product mixing area near the slurry vat in the corn processing room. NIOSH RELs are specifi d for personal samples (employees wearing samplers); however, these area air samples indicate areas with higher risks for personal exposures that may exceed proposed occupational exposure limits.

Recommendations

We recommend that company management pursue the actions listed below. Because employees are most familiar with the areas and tasks involved, we recommend that management consult with employees that perform the work duties in each respective area when enacting any actions described below. Labor-management health and safety meetings are an opportune environment to discuss department specific ecommendations and develop an action plan.

Our recommendations are based on an approach known as the hierarchy of controls. Th s approach groups actions by how effective they are at removing or reducing hazards. In most cases, the primary approach is to eliminate hazardous materials or processes, and to install engineering controls to reduce exposure or shield employees. Administrative measures and personal protective equipment may be needed until such engineering controls are in place, or if engineering controls are not effective or feasible.

Engineering Controls
Engineering controls can reduce employees' exposures by removing the hazard from the process or by placing a barrier between the hazard and the employee. Engineering controls protect employees effectively without placing primary responsibility of implementation on the employee.

1. Enclose the seasoning funnel base and top of seasoning drum to reduce airborne dust during seasoning additions.
2. Implement local exhaust ventilation to reduce employee exposure to airborne dusts and flavoring chemicals (1) near mixing tanks that have the slurries containing diacetyl and/or 2,3-pentanedione flavorings (2) near the top and base of the seasoning funnels at spice addition stations on the mezzanine level; and (3) above the corn snack product extruders.
3. Regularly clean, inspect, and maintain local exhaust ventilation systems to ensure proper functioning. Inexpensive smoke tests can be used for visualization of airfl w at and near the face of the ventilation system. Additionally, airfl w measurements can be taken with an air velometer and compared to design specifi ations to determine if the ventilation system is operating properly. Consult with a ventilation expert to ensure that systems are appropriately repaired, maintained, and meet the ventilation needs of your building occupants.
4. Inspect and maintain the general exhaust ventilation regularly to ensure proper

functioning.

5. Clean the exhaust and ceiling fans in the fryer room.
6. Consult with a roofi g specialist to replace or repair failing roof materials above the general and payroll office reas, maintenance department, and chip processing areas.
7. Reroute the roof drain spout above rooms 124 and 125 toward the roof drain or directly to the ground with an extended pipe.
8. Relocate the corn solids separator to an enclosed area or exterior location, rather than in a common area. Promptly remove standing water, dampness, and corn residues that allow for bacteria and/or mold growth in the common work area.
9. Remove wetted and damaged materials and make necessary repairs to sources of water intrusion to prevent further water entry into the building. If mold is identifi d on materials, use appropriate remediation guidelines to minimize exposure to remediation workers and building occupants. Criteria for cleaning mold-damaged materials can be found in *Guidelines on Assessment and Remediation of Fungi in Indoor Environments*, developed by the New York City Department of Health and Mental Hygiene [NYCDH&MH 2008].

Administrative Controls

Administrative controls refer to employer-dictated work practices and policies to reduce or prevent hazardous exposures. Their effectiveness depends on employer commitment and employee acceptance. Regular monitoring and reinforcement are necessary to ensure that policies and procedures are followed consistently.

1. Periodically conduct personal air monitoring for diacetyl and 2,3-pentanedione in the popcorn room and corn processing room using OSHA Sampling Method 1012 for diacetyl [OSHA 2008] and OSHA Sampling Method 1016 for 2,3-pentanedione [OSHA 2010]. Because air levels of flavoring chemicals may fluctuate from day to day based on production schedules, we recommend personal air sampling for diacetyl and 2,3-pentanedione over multiple days.
2. If personal sampling air levels approach or exceed the NIOSH proposed RELs or STELs for diacetyl or 2,3-pentanedione despite engineering controls such as local exhaust ventilation, employees should wear respiratory protection.
3. Keep seasoning bins covered with a lid when they are not in use.
4. Schedule frequent cleaning of the corn solids separator system so that solids do not block water drainage systems.
5. Ensure fryers in frying room are adequately maintained, and fl or drains are clean to prevent material build up on fl or and create a slip hazard.
6. Ensure that asbestos containing material is properly contained or encapsulated in accordance with asbestos standards to prevent asbestos fibers from getting into the air. Share asbestos management plan and regulatory obligations with concerned employees. Appropriate state and federal regulations for the management of asbestos-

containing materials should be followed. Information can be found at the following sites:

a. Pennsylvania Department of Environmental Protection: http://www.elibrary.dep.state.pa.us/dsweb/Get/Document-110459/2700-FS-DEP2108.pdf

b. Pennsylvania Department of Labor and Industry: http://www.portal.state.pa.us/portal/server.pt?open=514&objID=553489&mode=2.

c. Federal OSHA

i. Pennsylvania OSHA Area Offices https://www.osha.gov/oshdir/pa.html.

ii. OSHA Asbestos Standards: https://www.osha.gov/SLTC/asbestos/standards.html.

7. Implement an evacuation plan for emergencies, such as when fi es may occur in the fryer room.
8. Schedule regular checks of roofi g materials and drain covers to ensure they are in good condition and that drain covers are not clogged with leaves and other debris.
9. Routinely inspect indoor areas for signs of dampness or mold to identify any potential sources of water intrusion, to include water stains, visible mold, mold odor, damp materials. Repair materials as needed to prevent further water intrusion. If mold growth is not identifi d during visual inspections but is suspected because of musty odors, look for hidden mold behind the walls or above the drop ceiling.
10. Establish an anonymous environmental reporting system for staff o report building related issues.
11. Maintain acceptable indoor environmental quality during construction and renovation activities. To protect employees from contaminants being released during construction/renovation, areas should be isolated using proper containment barriers. Construction areas should be negatively pressurized from occupied areas to prevent migration of contaminated air into work spaces. The NIOSH website for further information on maintaining indoor environmental quality during construction and renovation activities at http://www.cdc.gov/niosh/topics/indoorenv/ConstructionIEQ.html [NIOSH 2013]
12. Establish a communication system with employees when building-related issues arise. Information on response actions, including exposure and environmental assessment reports, should be provided to employees.
13. Ensure employees understand the potential hazards in the food manufacturing industry (such as, flavorings and organic dust) and how to protect themselves. OSHA's Hazard Communication Standard, also known as the "Right to Know Law" [29 CFR 1910.1200] requires that employees are informed and trained of potential work hazards and associated safe practices, procedures, and protective measures. Ensure employees have access to SDSs.

14. Employees should report new, persistent, or worsening symptoms to their personal healthcare provider and, as instructed by their employer, to a designated individual at their workplace. An individualized management plan (such as assigning an affected employee to a different work location) is sometimes required, as indicated by medical fi dings and recommendations of the physician. Employees with symptoms should provide their personal physicians or other healthcare providers with a copy of this report.

Personal Protective Equipment

Personal protective equipment is the least effective means for controlling hazardous exposures. Proper use of personal protective equipment requires a comprehensive program and a high level of employee involvement and commitment. The right personal protective equipment must be chosen for each hazard. Supporting programs such as training, change-out schedules, and medical assessment may be necessary. Personal protective equipment should not be the sole method for controlling hazardous exposures. Rather, personal protective equipment should be used until effective engineering and administrative controls are in place.

<u>Recommended personal protective equipment when working near dust sources</u>

1. Encourage voluntary use of NIOSH-certifi d N95 disposable filtering-facepiece respirators during dusty tasks. Ensure N95s in various sizes are readily available for dusty tasks including but not limited to:

    a. additions of dry seasonings to mezzanine seasoning drums in the packaging and processing areas;

    b. filling and pouring seasoning packages into drums in the seasoning room; and

    c. during sweeping and wet cleaning of settled dust.

2. The corn snack product extruder area in the corn processing room was also dusty. However, air levels by the cheese snack product mixing area near the slurry vat in the corn processing room exceeded the proposed NIOSH RELs for diacetyl and 2,3-pentanedione (Table 2). If follow-up personal air testing for diacetyl and 2,3-pentanedione near the corn snack product extruder area in the corn processing room are below the NIOSH proposed RELs for diacetyl and 2,3-pentanedione, then voluntary N95 use near the corn snack extruder area would be appropriate. If the personal sampling air levels near the corn extruders are above the proposed RELs for diacetyl or 2,3-pentanedione despite engineering controls such as local exhaust ventilation, then NIOSH-certifi d respirators with organic vapor cartridges and particulate cartridges/filters would be warranted.

    PLEASE NOTE: N95s are <u>NOT</u> protective against alpha-diketones (e.g., diacetyl, 2,3-pentanedione, and 2,3-hexanedione). In cases of dual exposure to dust and alpha-diketones, NIOSH-certifi d organic vapor cartridges (for the alpha-diketones) and

particulate cartridges/filters (for the dust) would be warranted.

3. Ensure that each voluntary N95 user receives a copy of Appendix D of the OSHA Respiratory Protection Standard (http://www.osha.gov/pls/oshaweb/owadisp.showdocument?p_table=standards&p_id=9784). A NIOSH document showing how to put on and take off a d sposable respirator correctly can be obtained at http://www.cdc.gov/niosh/docs/2010-133/pdfs/2010-133.pdf. Further information on respirators can be obtained at http://www.cdc.gov/niosh/npptl/topics/respirators/disp_part/RespSource.html.

Recommended personal protective equipment when working with or near flavoring chemicals

Area air levels of diacetyl and/or 2,3-pentanedione exceeded the proposed NIOSH RELs in the (1) popcorn butter flavor and cheese snack mixing area in the popcorn room and (2) cheese snack product mixing area near the slurry vat in the corn processing room. NIOSH RELs are specifi d for personal samples (employees wearing samplers); however, the area air samples indicate areas with higher risks for personal exposures that may exceed proposed occupational exposure limits. If engineering controls do not reduce personal sampling air levels of diacetyl and 2,3-pentanedione below the proposed NIOSH RELs, we recommend that management require employees performing tasks in those areas to wear NIOSH-certifi d respirators fitted with organic vapor cartridges and particulate filters. The choice of respirator (half-face, full-face, or powered air-purifying respirator [PAPR]) should be guided by the concentrations of diacetyl and 2,3-pentanedione on personal air monitoring.

For reference, air-purifying half-face respirators have an APF of 10, and air-purifying full-face respirators have an APF of 50. Also, there are PAPRs that have APFs of 25, 50, or 1000. The OSHA APFs can be found in Table 1 of OSHA Respiratory Protection Standard (29 CFR 1910.134) at https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=12716&p_table=STANDARDS.

It is important to note that APFs are only effective when the employer implements a continuing, effective respirator program as required by 29 CFR 1910.134. An OSHA respiratory protection program includes the following elements:

a) written policy;
b) change-out schedule for cartridges/filters;
c) medical evaluation prior to use to determine fitness;
d) fit testing and training prior to use and annually; and
e) establishment and implementation of procedures for proper respirator use, such as prohibiting use with facial hair when this would impair the seal; ensuring user seal-check and inspection of respirators prior to each use; ensuring proper cleaning, disinfection, and maintenance of respirators; and ensuring proper storage of respirators to protect respirators from damage, contamination, dust, sunlight, and extreme temperatures.

Recommended personal protective equipment when working with or near cleaning chemicals

Ensure that proper personal protective equipment is worn when employees use chemicals to clean the fryers and packing machines. For example, the SDS for the ProCleaner Degreaser which was used to clean the packing machines, recommended a full-face respirator with an organic vapor cartridge or positive-pressure supplied-air respirator if (1) levels of 2-butoxyethanol exceed the NIOSH REL of five ppm or (2) air monitoring cannot confi m that levels of 2-butoxyethanol do not exceed the NIOSH REL of five ppm.

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The Health Hazard Evaluation Program investigates possible health hazards in the workplace under the authority of the Occupational Safety and Health Act of 1970 (29 U.S.C. § 669(a)(6)). The Health Hazard Evaluation Program also provides, upon request, technical assistance to federal, state, and local agencies to invest igate occupational health hazards and to prevent occupational disease or injury. Regulations guiding the Program can be found in Title 42, Code of Federal Regulations, Part 85; Requests for Health Hazard Evaluations (42 CPR Part 85).

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Availability of Report

Copies of this report have been sent to the employer, employees, and union at the facility. The state and local health department and the Occupational Safety and Health Administration Regional Office have also received a copy. This report is not copyrighted and may be freely reproduced.

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