



NIOSH HEALTH HAZARD EVALUATION REPORT

**HETA #2004-0046-2950
Kirkwood Community College
Cedar Rapids, Iowa**

December 2004

**DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health**



PREFACE

The Hazard Evaluation and Technical Assistance Branch (HETAB) of the National Institute for Occupational Safety and Health (NIOSH) conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health (OSHA) Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employers or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

HETAB also provides, upon request, technical and consultative assistance to federal, state, and local agencies; labor; industry; and other groups or individuals to control occupational health hazards and to prevent related trauma and disease. Mention of company names or products does not constitute endorsement by NIOSH.

ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

This report was prepared by Chandran Achutan and Randy L. Tubbs of HETAB, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS). Field assistance was provided by Michael Humann of the Department of Occupational and Environmental Health, University of Iowa College of Public Health, Iowa City, Iowa. Desktop publishing was performed by Shawna Watts. Editorial review was performed by Ellen Galloway.

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For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

Highlights of the NIOSH Health Hazard Evaluation

Noise Exposure at a Swine Confinement Facility

NIOSH investigators were asked to evaluate noise exposures at the Mansfield Swine Education Center (MSEC).

What NIOSH Did

- We measured personal noise exposures on employees.
- We kept a log of activities performed by employees to see how the activities relate to exposures.

What NIOSH Found

- Noise levels were below the daily OSHA permissible exposure limits.
- Noises associated with certain activities such as power washing were found to be excessive by the NIOSH criterion.

What MSEC Managers Can Do

- Begin a hearing conservation program for employees.
- Use non-metal parts for feeding chutes.
- Instruct employees on properly maintaining ear muffs, and provide replacements when needed.

What the MSEC Employees Can Do

- Report to the director when ear muffs are damaged before routine replacement.



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We encourage you to read the full report, If you would like a copy, either ask your health and safety representative to make you a copy or call 1-513-841-4252 and ask for HETA Report #2004-0046-2950



**Health Hazard Evaluation Report 2004-0046-2950
Kirkwood Community College
Cedar Rapids, Iowa
December 2004**

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Randy L. Tubbs, Ph.D.**

SUMMARY

On July 11, 2003, the National Institute for Occupational Safety and Health (NIOSH), received a request from the management of Kirkwood Community College in Cedar Rapids, Iowa, to conduct a Health Hazard Evaluation (HHE) at the Mansfield Swine Education Center (MSEC). The requestor was interested in knowing the noise levels at the facility. NIOSH undertook this study due to the paucity of noise data in agricultural settings. A noise survey was conducted on March 22 and 23, 2004.

Full-shift noise dosimeter measurements were collected on employees over 2 days. NIOSH investigators followed the employees to log their daily activities. In addition, ambient noise levels were stored on a real-time analyzer to capture the noise spectra for different activities.

Seven full-shift dosimeter samples were collected during the evaluation. The daily noise levels were all well below the Occupational Safety and Health Administration's (OSHA) permissible exposure limit (90 decibels on an A-weighted scale [dBA]), but exceeded the NIOSH Recommended Exposure Limit (REL) on three occasions. The potential for high noise exposures is evidenced in the noise dose measured for specific activities such as power washing, ear clipping, and snout snaring. Area samples taken during the various activities are consistent with dosimetry for specific activities.

Because of the high noise levels (as determined by the NIOSH REL), that employees encounter during the course of employment, NIOSH investigators offer recommendations to reduce the risk of occupational hearing loss. These recommendations include enrolling employees in a hearing conservation program, caring for and maintaining hearing protection devices, and padding some metal pieces on feeding chutes with a softer material to reduce the noise produced by metal-to-metal contact.

Keywords: SIC: 0213 (Establishments primarily engaged in the production or feeding of hogs on their own account or on a contract or fee basis), noise, swine confinement, spectral analysis, task-based analysis, power wash, breeding and gestation, snout snaring, ear clipping

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INTRODUCTION

On July 11, 2003, the National Institute for Occupational Safety and Health (NIOSH) received a request from the management of Kirkwood Community College in Cedar Rapids, Iowa, to conduct a Health Hazard Evaluation (HHE) at its Mansfield Swine Education Center (MSEC). The requestor was interested in knowing the noise levels at the facility. NIOSH undertook this study due to the paucity of noise data in agricultural settings.

On March 22 and 23, 2004, NIOSH investigators conducted a noise evaluation at MSEC. On March 22, an opening conference was held with NIOSH representatives and the director of MSEC. Following the opening conference, NIOSH investigators toured the facility with the director and the farm technician. The proceedings from the opening conference were relayed to the farm technician during the tour. On March 22 and 23, 2004, NIOSH measured noise exposure for employees working throughout the facility.

BACKGROUND

Mansfield Swine Education Center

The Mansfield Swine Education Center is a 150-head farrow-to-finish swine confinement center, located on the Kirkwood Community College Campus in Cedar Rapids, Iowa. Farrow-to-finish refers to the breeding and farrowing of sows and raising the piglets until they weigh 200 pounds, at which stage they are sold. The farrow-to-finish operation involves the following processes: breeding and gestation, farrowing, weaning the piglets in nurseries, and finishing. The whole cycle can take up to 11 months. MSEC is a small-scale swine confinement facility used for teaching students at the community college. The day-to-day operations are handled by a farm technician with the assistance of students who work part-time. The facility is run by a veterinarian, who also

examines the animals and assists with chores as needed.

In the breeding and gestation barn, it is determined if sows are ready for breeding. This is done by passing a boar in a cage in front of the sows' pens. Sows that are ready for breeding are quiet, and those that are not, squeal in the presence of the boar. This process is called "heat checking." Sows are inseminated artificially, and the pregnant sows remain in the barn during their gestation period.

Upon giving birth, the sows and their litters are moved to the farrowing rooms, where the piglets are nursed. After a few months, the piglets are moved to the nursery where the males are castrated. In the farrowing and nursery barns, piglets and the mothers are routinely checked for health problems. The animals are also given appropriate vaccinations in these rooms.

As the piglets get bigger, they are moved to the finishing area. The finishing area consists of different barns that house litters of similar age/weight groups. In the finishing area, the hogs have their snouts snared and ears tagged for identification. These activities are usually performed by two individuals, one to round up the animals, and the other who manually performs the snout snaring and ear clipping. Hogs are periodically weighed in the finishing area, and when they have attained the optimal weight (usually 200 pounds), they are sold.

METHODS

Quest[®] Electronics Model Q-300 Noise Dosimeters were worn by a total of seven employees over a 2-day period while they performed their daily activities. Samples were collected throughout the work shifts that ranged from less than an hour to approximately 4 hours. The noise dosimeters were attached to the wearer's belt and a small remote microphone was fastened to the wearer's shirt at a point midway between the ear and the outside of the shoulder. A windscreen provided by the dosimeter manufacturer was placed over the microphone during recordings. At the end of the

sampling period, the dosimeter was removed and paused to stop data collection. The information stored in the dosimeters was downloaded to a personal computer for interpretation with QuestSuite® Professional computer software. The dosimeters were calibrated before and after the measurement periods according to the manufacturer's instructions.

Real time, instantaneous noise monitoring was done by a Quest Electronics Model 2400 Sound Level Meter (SLM). The instrument was set to measure noise levels between 70 and 140 dB, on an A-weighted slow-response scale. The SLM was calibrated before and after the measurement periods according to the manufacturer's instructions. Real time spectral analysis was done with a Larson-Davis Laboratory Model 2800 Real-Time analyzer and a Larson-Davis Laboratory Model 2559 ½-inch random incidence response microphone. The analyzer allows for the analysis of noise into its spectral components in a real-time mode. The ½-inch diameter microphone has a frequency response range (± 2 decibels [dB]) from 4 Hertz (Hz) to 21 kilohertz (kHz) that allows for the analysis of sounds in the region of concern. One-third octave bands consisting of center frequencies from 25 Hz to 20 kHz were integrated for 10-60 seconds and stored in the analyzer.

EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for the assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects even though their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy). In addition, some

hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the criterion. These combined effects are often not considered in the evaluation criteria. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: (1) NIOSH Recommended Exposure Limits (RELs),¹ (2) the American Conference of Governmental Industrial Hygienists' (ACGIH®) Threshold Limit Values (TLVs®),² and (3) the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs).³ Employers are encouraged to follow the OSHA limits, the NIOSH RELs, the ACGIH TLVs, or whichever are the more protective criteria.

OSHA requires an employer to furnish employees a place of employment that is free from recognized hazards that are causing or are likely to cause death or serious physical harm [Occupational Safety and Health Act of 1970, Public Law 91-596, sec. 5(a)(1)]. Thus, employers should understand that not all hazardous chemicals have specific OSHA exposure limits such as PELs and short-term exposure limits (STELs). An employer is still required by OSHA to protect their employees from hazards, even in the absence of a specific OSHA PEL.

Noise-induced loss of hearing is an irreversible, sensorineural condition that progresses with exposure. Although hearing ability declines with age (presbycusis) in all populations, exposure to noise produces hearing loss greater than that resulting from the natural aging process. This noise-induced loss is caused by damage to nerve cells of the inner ear (cochlea) and, unlike some conductive hearing disorders, cannot be treated medically.⁴ While loss of hearing may result from a single exposure to a very brief impulse noise or explosion, such traumatic losses are

rare. In most cases, noise-induced hearing loss is insidious. Typically, it begins to develop at 4000 or 6000 Hz (the hearing range is 20 Hz to 20000 Hz) and spreads to lower and higher frequencies. Often, material impairment has occurred before the condition is clearly recognized. Such impairment is usually severe enough to permanently affect a person's ability to hear and understand speech under everyday conditions. Although the primary frequencies of human speech range from 200 Hz to 2000 Hz, research has shown that the consonant sounds, which enable people to distinguish words such as "fish" from "fist," have still higher frequency components.⁵

The A-weighted decibel [dBA] is the preferred unit for measuring sound levels to assess worker noise exposures. The dBA scale is weighted to approximate the sensory response of the human ear to sound frequencies near the threshold of hearing. The decibel unit is dimensionless, and represents the logarithmic relationship of the measured sound pressure level to an arbitrary reference sound pressure (20 micropascals, the normal threshold of human hearing at a frequency of 1000 Hz). Decibel units are used because of the very large range of sound pressure levels which are audible to the human ear. Because the dBA scale is logarithmic, increases of 3 dBA, 10 dBA, and 20 dBA represent a doubling, tenfold increase, and hundred-fold increase of sound energy, respectively. It should be noted that noise exposures expressed in decibels cannot be averaged by taking the simple arithmetic mean.

The OSHA standard for occupational exposure to noise (29 CFR 1910.95)⁶ specifies a maximum PEL of 90 dBA for a duration of 8 hours per day. The regulation, in calculating the PEL, uses a 5 dB time/intensity trading relationship, or exchange rate. This means that a person may be exposed to noise levels of 95 dBA for no more than 4 hours, to 100 dBA for 2 hours, etc. Conversely, up to 16 hours exposure to 85 dBA is allowed by this exchange rate. The duration and sound level intensities can be combined in order to calculate a worker's daily noise dose according to the formula:

$$\text{Dose} = 100 \times (C_1/T_1 + C_2/T_2 + \dots + C_n/T_n),$$

where C_n indicates the total time of exposure at a specific noise level and T_n indicates the reference duration for that level as given in Table G-16a of the OSHA noise regulation. During any 24-hour period, a worker is allowed up to 100% of his daily noise dose. Doses greater than 100% exceed the OSHA PEL.

The OSHA regulation has an additional action level (AL) of 85 dBA; an employer shall administer a continuing, effective hearing conservation program when the 8-hour time-weighted average (TWA) value exceeds the AL. The program must include monitoring, employee notification, observation, audiometric testing, hearing protectors, training, and record keeping. All of these requirements are included in 29 CFR 1910.95, paragraphs (c) through (o). Finally, the OSHA noise standard states that when workers are exposed to noise levels in excess of the OSHA PEL of 90 dBA, feasible engineering or administrative controls shall be implemented to reduce the workers' exposure levels.

NIOSH, in its Criteria for a Recommended Standard,⁷ and the ACGIH,² propose exposure criteria of 85 dBA as a TWA for 8 hours, 5 dB less than the OSHA standard. The criteria also use a more conservative 3 dB time/intensity trading relationship in calculating exposure limits. Thus, a worker can be exposed to 85 dBA for 8 hours, but to no more than 88 dBA for 4 hours or 91 dBA for 2 hours. The NIOSH REL for 12-hour exposure is 83 dBA or less.

RESULTS

The Quest dosimeters collect data so that one can directly compare the information with the three different noise criteria used in this survey, the OSHA PEL and AL, and the NIOSH REL. The OSHA criteria use a 90 dBA criterion and 5-dB exchange rate. The difference between the two is the threshold level employed, with a 90 dBA threshold for the PEL and an 80 dBA threshold for the AL. The threshold level is the

lower limit of noise values included in the calculation of the criteria; values less than the threshold are ignored by the dosimeter. The NIOSH criterion differs from OSHA in that the criterion is 85 dBA, the threshold is 80 dBA, and it uses a 3-dB exchange rate. Because of the different 8-hour criteria and exchange rates, the dose equations used to calculate the equivalent TWA values are different for the NIOSH and OSHA criteria. The OSHA dose equation is $TWA = 16.61 \times \log_{10} [\text{Dose}/100] + 90$, and the NIOSH equation is $TWA = 10.00 \times \log_{10} [\text{Dose}/100] + 85$.

The results presented describe potential exposures to employees at MSEC during the 2 days of the survey. The workday at MSEC may vary depending on the number of hogs, number of student helpers, and the veterinarian's schedule. On the assumption that the 2 days evaluated were typical workdays at MSEC, the data were analyzed to project an 8-hour dose for each individual. In addition, 8-hour doses for specific tasks were calculated to predict exposures in large-scale confinements.

During the 2 days that NIOSH collected personal dosimetry data, noise exposures exceeded the NIOSH REL for three people for the actual time that they worked in the confinement facility. A summary of the personal dosimetry results is presented in Table 1. When the results were extrapolated to simulate an 8-hour work shift, five of the seven personal dosimetry samples exceeded the NIOSH REL, and two exceeded the OSHA AL (more than 50%). The extrapolation assumes that the percent dose collected during the actual work shift is representative of an 8-hour shift, and the dose has been increased accordingly. These results are presented in Table 2.

The output from the dosimeters also captures the minute-by-minute noise exposures monitored over the sampling period. Each data point represents the integrated average noise for a 1-minute period. Figure 1 is a graph that include on the graph is the employee daily tasks and time at which tasks took place. The dosimeter software calculates the noise exposure and the

corresponding dose for each activity, and allows extrapolating exposures to simulate an 8-hour work day. An analysis of noise exposures by tasks (Table 3) shows that the highest exposures occurred during the power washing job, and during the snout snaring and ear tagging operation. The power washing operation was observed for 29 minutes and snout snaring for 17 minutes. During both operations, the percent dose exceeded the NIOSH criterion for the short time period for at least one of the employees performing the task. When all tasks were extrapolated to an 8-hour work day, the NIOSH criterion was exceeded eight times (128% to 3111%), and the OSHA AL was exceeded four times (178% to 265%) during the snout snaring and the power washing operations, and once during activities at the breeding and gestation barn.

Spectral noise data were collected for the evaluation during various job activities. On the first day of the survey, 10 measurements, each 10 seconds long, were taken at the breeding and gestation barn. Seven of these samples were collected during the heat checking process, with the boar in a cage in front of the sows. The remaining three samples were collected with the feed line turned on. Typical spectral data are shown in Figure 2. On the second day of the survey, numerous 10-second measurements were collected of the snout snaring and ear tagging process in the finishing area, 60-second measurements were collected in the feed mill with the blower on and off and a 60-second measurement was collected during power washing. Figures 3-5 show typical spectral data.

DISCUSSION

Though none of the workers' noise levels in this survey exceeded any regulatory standards, noise levels of two employees exceeded the daily percent dose over the course of the survey, as calculated by the NIOSH criterion. The noise level exceeded one worker's dose on both days that personal samples were collected. An analysis of associated tasks revealed that the power-washing job presents the highest noise hazard at this facility, contributing as much as

104% of the daily dose for approximately 30 minutes of exposure. All employees were wearing ear muffs during the work day, but a close inspection of the ear muffs showed that the cushions were cracked and needed repair.

Over the past several years, there has been a shift from small-scale swine confinements to large-scale production facilities.⁸ At some of these large production facilities, employees perform dedicated chores throughout the work day. For example, employees may be required to power wash pens for a full work shift. The 8-hour task-based results from this survey are useful to characterize potential noise exposures for these employees. Data from this evaluation suggest that some tasks related to swine production may result in excessive noise exposure, and employees should be enrolled in a hearing conservation program.

CONCLUSIONS

There is potential excessive noise exposure to employees at MSEC (as determined by the NIOSH REL) though none of the values measured in this limited survey exceeded the OSHA PEL. However, if employees were to carry out their tasks over an 8-hour work day, the NIOSH REL would have been exceeded five times, and the OSHA AL would have been exceeded twice. The OSHA PEL would not have been exceeded.

An analysis of specific tasks revealed that the power washing, snaring and ear tagging operations were the most hazardous. These jobs exceeded the 100% daily dose for the time period worked, per the NIOSH criteria. When the results from this survey were projected to reflect an 8-hour exposure, the OSHA AL for noise exposure during breeding, power washing, and snaring exceeded 50% of the employees' daily dose.

RECOMMENDATIONS

Based on the observations and findings of this evaluation, the following recommendations are

offered to better protect the hearing of the employees at the MSEC:

1. Establish a hearing conservation program for MSEC employees. Even though the exposures captured by the dosimeters never exceeded the OSHA limits for noise during this evaluation, they exceeded the NIOSH REL on three occasions. The basic elements of the program should, at a minimum, meet the requirements of the OSHA hearing conservation amendment (29 CFR 1910.95). Other sources for defining effective hearing conservation programs are also available.^{9,10,11}
2. Ensure that workers wear hearing protection devices during snaring, power washing, and in the breeding barns. We recommend that the cushions on ear muffs be checked periodically, and replaced at least every 6 months, or sooner if worn out.
3. Replace or pad the metal flap at the end of the metal feed chute with a plastic or rubber material to reduce noise. By continuously lifting the metal flap, the animals created noise exposure from metal to metal contact between the flap and the chute.

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Table 1
Personal Noise Dosimeter Results
Kirkwood Community College
Cedar Rapids, Iowa
March 22 and 23, 2004
HETA 2004-0046-2950

Date	Job Title	Duration (hh:mm:ss)	Dose (Percent)		
			OSHA AL	OSHA PEL	NIOSH/ ACGIH
March 22, 2004	Director	03:37:29	11.7	5.5	42.4
	Farm Technician	03:41:53	10.3	3.0	34.0
	Student I	01:42:14	21.4	20.6	140.4
	Student II	00:48:34	1.7	1.3	13.3
March 23, 2004	Director	03:49:42	13.8	10.9	116.2
	Farm Technician	03:41:38	11.8	7.8	69.1
	Student I	03:38:14	27.7	25.2	219.7

The various dose percentages are the amounts of noise accumulated during a work day, with 100% representing the maximum allowable daily dose.

- OSHA: Occupational Safety and Health Administration
- NIOSH: National Institute for Occupational Safety and Health
- ACGIH: American Conference of Governmental Industrial Hygienists
- AL: Action Level
- PEL: Permissible Exposure Limit

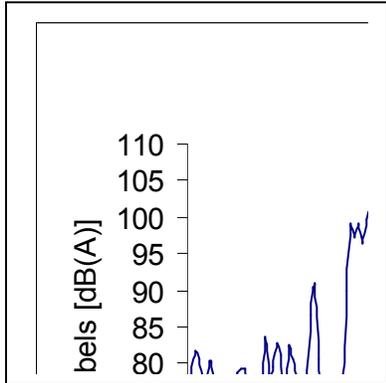
Table 2
Personal Noise Dosimeter Results extrapolated to an 8-hour TWA
Kirkwood Community College
Cedar Rapids, Iowa
March 22 and 23, 2004
HETA 2004-0046-2950

Date	Job Title	Duration (hh:mm:ss)	Dose (Percent)		
			OSHA AL	OSHA PEL	NIOSH/ ACGIH
March 22, 2004	Director	08:00:00	25.9	12.0	93.6
	Farm Technician	08:00:00	22.2	6.5	43.6
	Student I	08:00:00	100.3	96.8	659.3
	Student II	08:00:00	17.3	12.8	131.6
March 23, 2004	Director	08:00:00	28.8	22.2	242.8
	Farm Technician	08:00:00	24.7	16.3	144.4
	Student I	08:00:00	60.8	55.4	482.7

Table 3
Noise exposures, expressed as percent dose, as a function of tasks
Kirkwood Community College
Cedar Rapids, Iowa
March 22 and 23, 2004
HETA 2004-0046-2950

Task	Criterion	Task	Director	Farm Technician	Student I	Student II
Castration	OSHA AL	Exposure time (min)	12			
		% dose for exposure time	0.7			
		Projected % dose for 8 hours	28.4			
	NIOSH REL	Exposure time (min)	12			
		% dose for exposure time	3.2			
		Projected % dose for 8 hours	128.4			
Breeding	OSHA AL	Exposure time (min)	30			
		% dose for exposure time	4.2			
		Projected % dose for 8 hours	67.2			
	NIOSH REL	Exposure time (min)	30			
		% dose for exposure time	14.2			
		Projected % dose for 8 hours	227.8			
Gate Repairs	OSHA AL	Exposure time (min)	41	46	46	47
		% dose for exposure time	1.2	0.9	0.7	1.6
		Projected % dose for 8 hours	13.8	9.3	7.7	16.1
	NIOSH REL	Exposure time (min)	41	46	46	47
		% dose for exposure time	5.7	5.4	3.0	12.5
		Projected % dose for 8 hours	66.3	56.6	31.4	128.1
Power Washing	OSHA AL	Exposure time (min)			29	
		% dose for exposure time			15.2	
		Projected % dose for 8 hours			252.3	
	NIOSH REL	Exposure time (min)			29	
		% dose for exposure time			103.8	
		Projected % dose for 8 hours			1718.6	
Feed Mill	OSHA AL	Exposure time (min)	13	19	8	
		% dose for exposure time	13.8	1.9	0.1	
		Projected % dose for 8 hours	28.8	48.8	5.3	
	NIOSH REL	Exposure time (min)	13	19	8	
		% dose for exposure time	1.7	5.5	0.3	
		Projected % dose for 8 hours	63.8	139.5	16.7	
Snaring	OSHA AL	Exposure time (min)	17	16	17	
		% dose for exposure time	8.5	5.9	9.4	
		Projected % dose for 8 hours	238.9	177.9	264.9	
	NIOSH REL	Exposure time (min)	17	16	17	
		% dose for exposure time	93.5	54.3	110.2	
		Projected % dose for 8 hours	1496.4	745.1	3111.4	

Figure 1
Profile of employee noise exposure at a swine confinement
Kirkwood Community College
March 22 and 23, 2004
HETA 2004-0046-2950



Label	Time range	Activity
1	8:57 to 9:14	Snaring
2	9:21 to 9:29	Feed mill operation
3	9:33 to 10:02	Power washing

Figure 2
Spectral Noise Data in the Breeding and Gestation Barn
Kirkwood Community College
March 22 and 23, 2004
HETA 2004-0046-2950

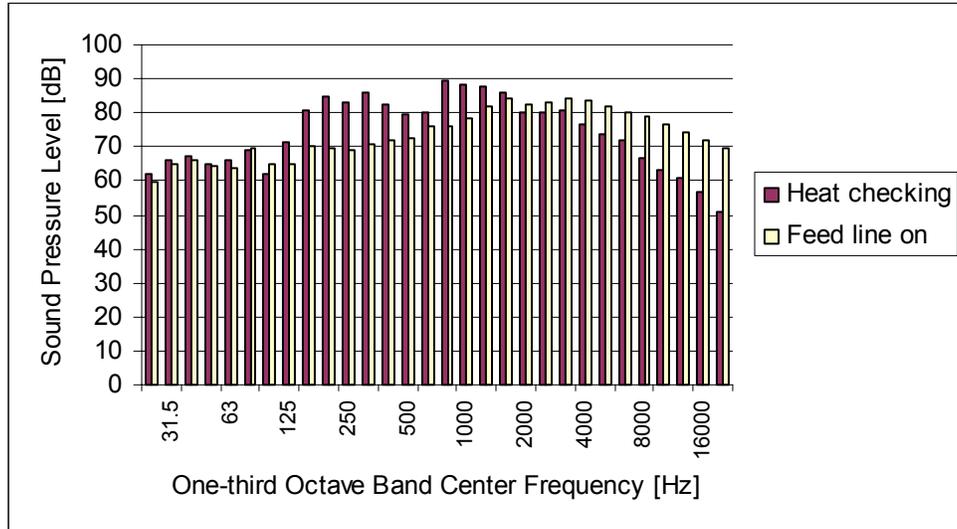


Figure 3
Spectral Noise Data in the Feed Mill
Kirkwood Community College
March 22 and 23, 2004
HETA 2004-0046-2950

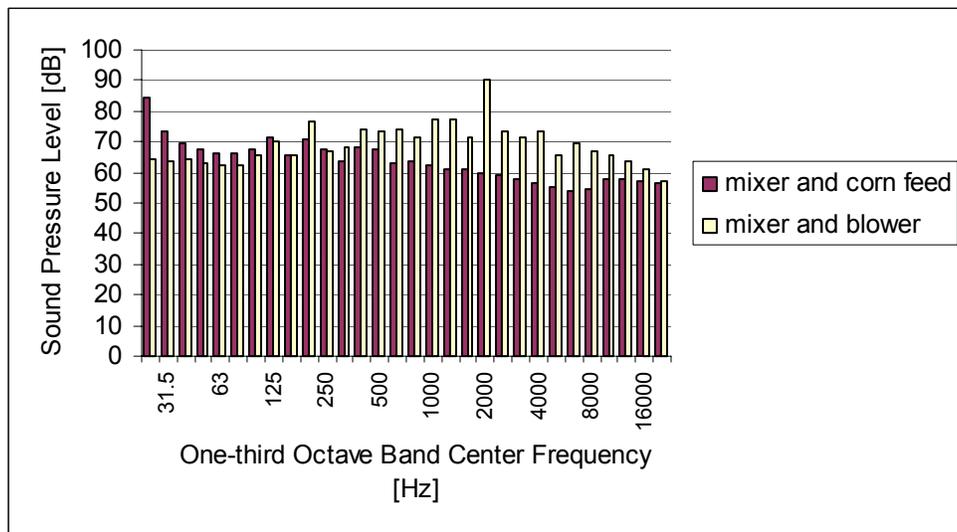


Figure 4
Spectral Noise Data in the Finishing Area
Kirkwood Community College
March 22 and 23, 2004
HETA 2004-0046-2950

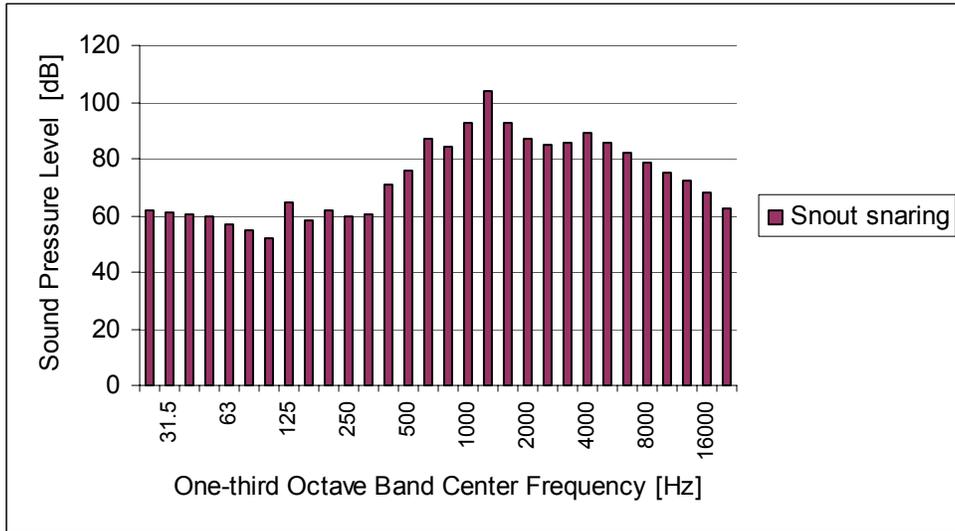
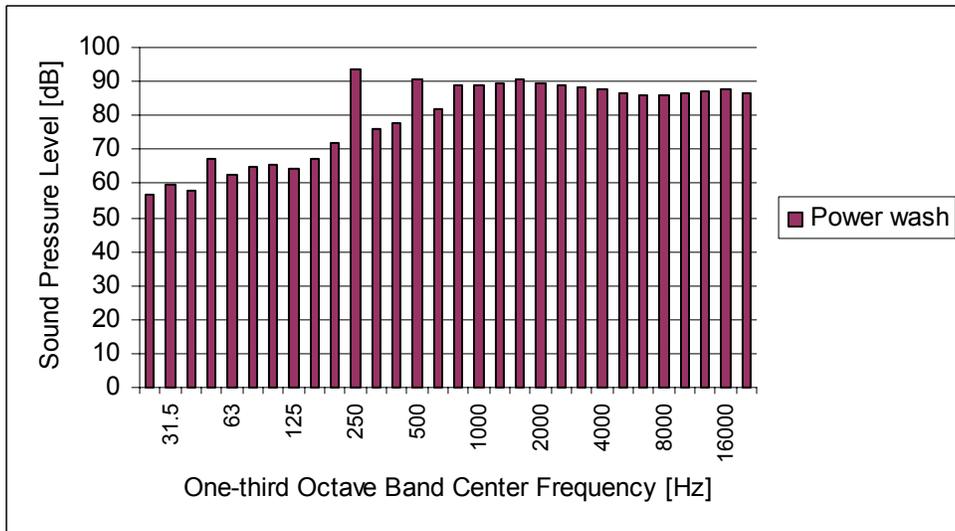
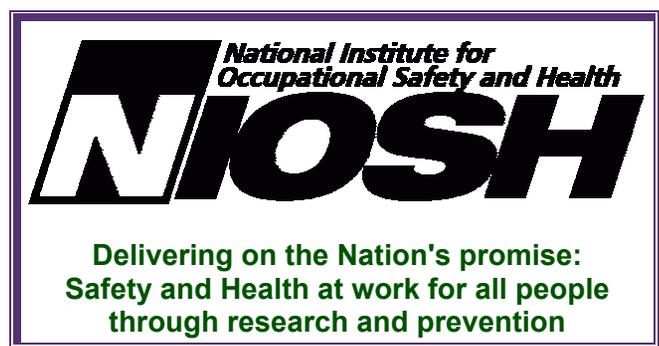


Figure 5
Spectral Noise Data during Power Wash
Kirkwood Community College
March 22 and 23, 2004
HETA 2004-0046-2950



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