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Assessing Occupational Noise Exposure of Service members in Aerospace Ground Equipment (AGE) Maintenance

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Assessing Occupational Noise Exposure of Service members in Aerospace Ground Equipment (AGE) Maintenance.

by

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of the requirements for the degree of
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List of Abbreviations

ACGIH American Conference of Governmental Industrial Hygienists

AFOSH Air Force Occupational Safety and Health Standard

AGE Aerospace Ground Equipment

APU Auxiliary Power Unit

dBA Decibels, A-weighting

HHE Health Hazard Evaluation

NIHL Noise-Induced Hearing Loss

NIOSH National Institutes for Occupational Safety and Health

NRAC Naval Research Advisory Committee

OSHA Occupational Safety and Health Administration

PEL Permissible Exposure Limit

PPE Personal Protective Equipment

SLM Sound Level Meter

STD Standard Deviation

TLV Threshold Limit Value

TTS Temporary Threshold Shift

TWA Time Weighted Average

USAF United States Air force

Abstract

Noise exposure is one of the most common hazards in the work force. There are multiple occupations that experience large amounts of noise exposure to its employees on a regular basis. Flight ground crews and flight maintenance personnel are among the nosiest jobs that exist. Despite the mandatory hearing protection requirements for a job of this caliber, there still remains a chance of an over exposure to noise. Most of the exposure comes from the different types of loud repair equipment and tools, but the greatest exposure comes from a jet engine that can reach 140 decibels. Flight maintenance personnel often work in an environment where the hours are long and there is continuous noise at high decibels. Flight maintenance personnel are typically in multiple places throughout a workday because of the maintenance responsibilities of different equipment, trucks, and planes.

This study will examine the noise exposure levels of the service members in the Aerospace Ground Equipment (AGE) department on a United States Air Force base. The study will help determine if the service members in the AGE department are being over exposed to noise from their daily routines as flight repair personnel. There has been previous noise sampling done on the AGE department and there will be a comparison of data due to different equipment, change in personnel, and standard operating procedures for the department. The bioengineering/ environmental department is typically responsible for sampling of the AGE department. They have had a difficult time with suggesting engineering controls due to the constant mobility of the maintenance crews. As

a result, they have to rely heavily on administrative controls and effective Personal Protective Equipment (PPE).

This study will include sampling for a standard workday including day and night shift for the AGE department. The sampling will be done by using personal noise dosimeters and a sound level meter will be used to conduct area sampling for equipment in AGE shop. The AGE department on the Air Force base agreed to allow personnel from their shop to participate in this study. In this study, we will adhere to the Air force safety regulations and sampling techniques

Introduction

Background

The United States Air force (USAF) has multiple maintenance squadrons that are attached to each base. The vast majority of these maintenance squadrons work on or in close proximity to the flight line. The flight line on every air force base poses the largest noise hazard that many airmen on base will encounter. All of the flight lines encountered on a standard Air Force base have the capability to house and launch multiple types of jets. Jet engines can reach up to 140 decibels (dB). Exposure to high decibels have been shown to greatly increase the possibility of noise induced hearing loss Many of the maintenance squadrons on base that work on or near the flight line have a higher exposure than other squadrons because they have the flight line exposure in addition to noise exposure from other equipment in their shops. These exposures can include: large vehicles, multiple power tools, generators, compressors, munitions lifting equipment, air conditioners, and other maintenance equipment.

The Aerospace Ground Equipment (AGE) shop is one of the most critical departments for the daily function of the flight line crews on base. They are tasked with supporting all active aircraft on base with assisting the launching and landing operations. AGE responsibilities are servicing multiple different maintenance groups and providing and repairing equipment for five different hangars. The landing strips are over 12,000 ft and the hangars are on average 25,000 sq ft per hangar. Figure -1 is a layout that gives the areas of responsibility of the AGE service members. The service members provide daily inspections for all equipment. Other important services include maintaining the diesel generators. The diesel generators provide a fuel-efficient means to power the aircraft. The crew must ensure that the plane controls are working properly without having to run the aircraft. It is important to take note that the normal working areas of the AGE department are in close proximity of the flight line. This location receives an increased amount of hazardous noise.

The AGE department has a day shift and a night shift with a large group of personnel maintaining it. The duties of AGE personnel are separated in to driver and floor man. Although AGE is responsible for five hangars and flight line services, they do some of their repairs and inspections in their own shop. This shop is where the bulk of their services are rendered and most of their time is spent. Since half of the staff is mobile there is a likely chance most of their exposure will come from outside their shop.

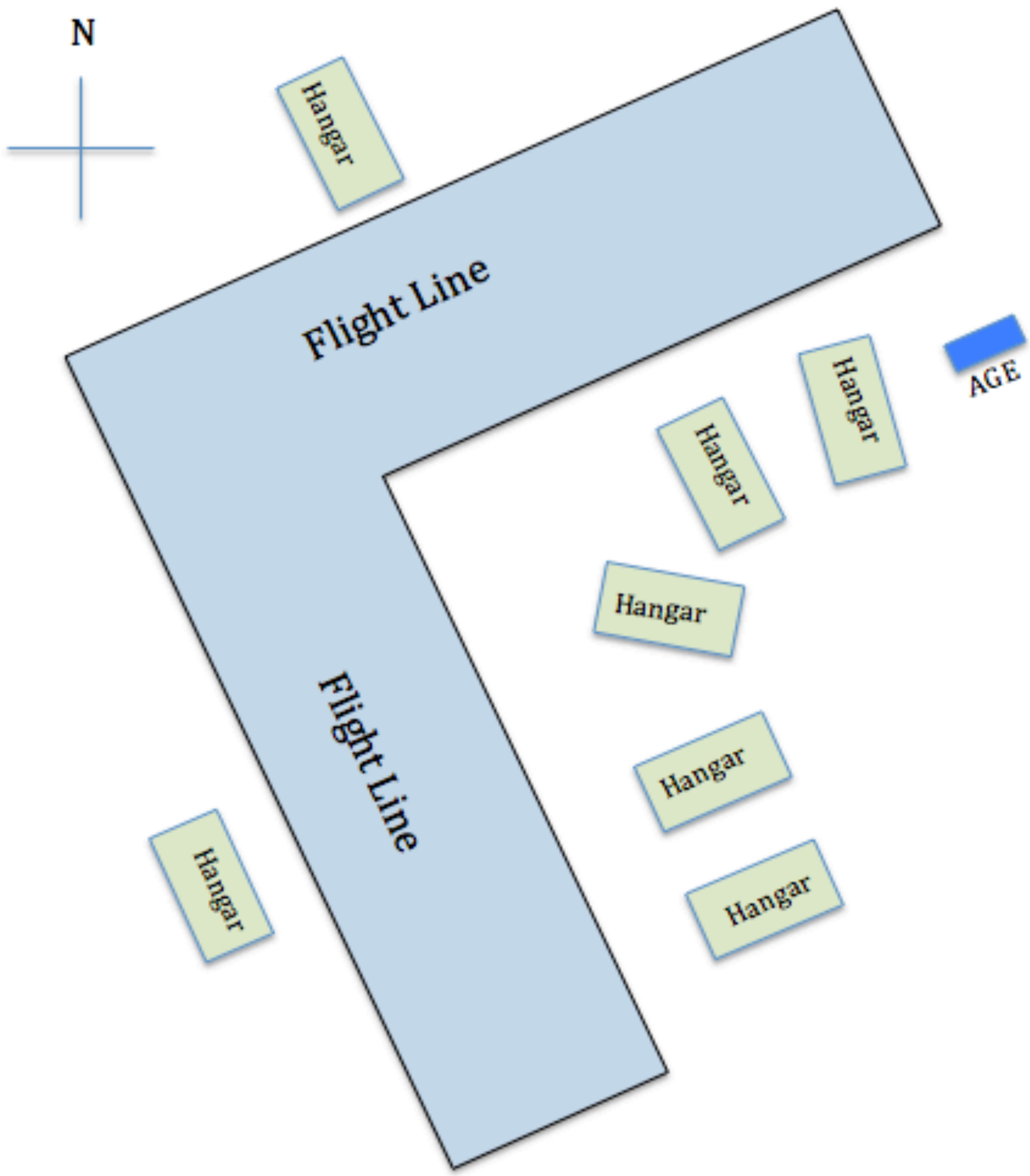
<u>Purpose</u>

The purpose of this study is to collect data on the service members of the AGE department on MacDill Air force and determine if they are exposed to excessive noise levels during a normal work shift. We will also compare previous noise sampling data with the new data collected. The Bio-environmental/engineering department on the Air force base allowed the use of their equipment and programs for the study.

The objectives of this study are:

1. To collect individual noise data on AGE service members in two different shifts for a day and make a comparison of the results with the OSHA permissible Exposure Limit (PEL) over an 8hr TWA.

2. Compare the Data collected with the previous data taken on the shop to see if effective noise reduction action has taken place.
3. Determine peak noise levels.



**** Hangars average 25,000 SQFT in size****

FIGURE 1- AREA OF RESPONSIBILITY FOR AGE

Literature Review

Every year over 30 million people in the US are occupationally exposed to hazardous noise (OSHA, 2012). Occupational noise is known to be one of the most common exposures that exist in the work force (OSHA, 2012). Although most hearing loss in the workplace is preventable, there are increasing numbers of individuals that sustain significant amounts of permanent hearing loss. Once hearing is lost, it is permanent and there is no medical procedure or hearing aid that can correct this type of hearing loss (OSHA, 2012). To have a basic understanding of how hearing loss impacts hearing, it is critical to understand the anatomy of the ear. When sound waves enter the ear, the vibrations impact the eardrum, which is transmitted to the middle and inner ear (OSHA, 2012). In the middle ear there are three bones: malleus, incus, and the stapes. These bones have the responsibly of transmitting the vibrations created by the inner ear (OSHA, 2012). The inner ear has a snail like structure, which is called the cochlea. This fluid filled structure is lined with tiny hairs that move the vibrations and covert the sound waves into nerve impulses (OSHA, 2012). This process allows us to hear. The issue with hearing loss is the fact that these tiny hairs are destroyed with high exposures of loud noise. Once the hairs are destroyed they cannot be repaired (OSHA, 2012).

<u>Hearing Status Among Aircraft Maintenance Personnel.</u>

Smedje (2011) completed a study that examined the possible hearing loss in aircraft maintenance personnel and identify predictors. The predictors were determined by a work environment survey done on 327 personnel. They were also able to locate these predictors as aging, genetic heredity, head injury, infections, certain drugs, high blood pressure, tobacco smoking and noise in both occupational and personal time. They were able to gather sampling data on pilots as well as cabin crew from a previous study and determined that with similar age thresholds they were both evenly exposed to same amount of noise, which was below the 85db threshold. Another noise exposure group was established as the aircraft maintenance workers. This group included: aircraft maintenance, airport firemen, police, ground staff, and airport civil servants. They did find a high prevalence of high frequency loss was 65% in the aircraft maintenance workers this appeared to be the highest.

Noise Exposure to Airline Ramp Employees

NIOSH received a request of health hazard evaluation (HHE) because of employees at a major airline were concerned about possible noise exposure while working on a ramp area that received inbound and out bound aircraft. The major noise concern was that from the jet aircraft and auxiliary power unit (APU). The employees of concerned worked as luggage handlers, aircraft maintenance personnel, and lavatory service and catering. The employees were concerned that the noise exposure took place while the planes were being taken to there designated parking places by the aircraft taxi and the APU was still running. Personal noise dosimeters were placed on employees during the day shift at the airport. Octave bands were also done. It was found that the employees had an overall mean-8hr TWA 92.2dBA (Tharr, 2010).

Jet Engine Noise Reduction.

The Naval research Advisory Committee (NRAC) (2009) initiated a study that involved the jet engine noise problem on the flight deck. This noise issue involved U.S. Navy and Marine Corps personnel on aircraft carriers and amphibious assault ships. The purpose was to reduce existing noise in tactical jet aircraft engines for all military personnel on the flight deck of Naval vessels. The Navy flight deck is one of the most hazardous places on the ship regarding noise exposure because it reaches noise levels up to 150+ decibels. This drastically hinders the ability of available hearing protection to decrease the noise to safe levels for the amount of time military personnel are working on the flight deck. Although the noise levels of commercial jets have decreased, tactical jet engine noise has not. In fact, tactical jet noise was increased because of added velocity to produce added thrust. This particular study first determined the noise problem. These noise problems were recognized as near field health issues and the far field community issues. They determined from the study there would have to be a multiple ways to reduce the noise. These include: reducing jet engine noise source, developing a requirement for noise in future tactical jet aircraft, constantly improving hearing protection, finding ways to limit excessive exposure noise levels and developing better ways to monitor noise exposure and hearing loss on military personnel (NRAC, 2009).

Methods

There were several steps required in the process of completing this study. The first critical step was site selection for the noise study. Obtaining data from a previously completed study helped me to determine the particular shop I would be surveying. The previous data was taken in 2008 by the Bioengineering department on the Air force base. The participant selection in this study will be similar to that of the previous study. The supervisor of the AGE shop will determine who will participate in the study based on availability and job duties.

The supervisor of this area selected two service members from the day shift and two service members from the night shift. On day shift one participant was labeled "Dayshift driver" and "Day shift floor man." On the night shift they were labeled "Night shift driver" and "Night shift floor man." The duties of the drivers include: removing equipment from rotation, bringing requested equipment to a requested destination, driving the retrieval trucks. Floor man responsibilities include: Maintenance on broken equipment, equipment inspections, ordering and unpacking of all new equipment, prepping new equipment for rotation.

<u>Personal Sampling</u>

The personal noise sampling was completed with a 3M the edge model dosimeter. All techniques utilized in the methods were completed per the Air force standard operating procedures. This would allow better comparison to the previous data if same methods were followed. Pre calibration was done on the sampling devices before. Sampling parameters were as follows: A weighted (slow response) there was an 80dB threshold with a 3db exchange rate (Air force uses NIOSH, ACGIH exchange rate). The Personal dosimeters were attached to each participant's collar for an 8hr work period and were electronically timed to stop once the 8hrs had elapsed for the devices. Two devices were given to the day shift. One device was given to the designated floor man and the other device given to the designated driver. The same process was completed for the night shift as well.

Noise Source

The noise source sampling was measured on all critical equipment that an individual in the AGE department may encounter within a standard 8-hour work shift. All noise source measurements were taken using a Sound level meter (SLM). The measurements were taken by holding the SLM at the equipment users operating level. Once a piece of equipment was in use, steps were counted until the decibels on the SLM reached 85dBA. This helped determined a safe distance to be with out hearing protection. All of the major stationary equipment had taped boundaries for double or single hearing protection requirements.

Results

Single Protection:

$$\text{Estimated Exposure (dBA)} = \text{TWA (dBC)} - [\text{NRR} \times 50\%], \text{ or}$$

$$\text{Estimated Exposure (dBA)} = \text{TWA (dBA)} - [(\text{NRR} - 7) \times 50\%]$$

Dual Protection:

$$\text{Estimated Exposure (dBA)} = \text{TWA (dBC)} - [(\text{NRR}_h \times 50\%) + 5], \text{ or}$$

$$\text{Estimated Exposure (dBA)} = \text{TWA (dBA)} - \{[(\text{NRR}_h - 7) \times 50\%] + 5\}$$

FIGURE 2- NOISE REDUCTION RATE EQUATION (NRR)

Hearing protection device for Age department: 3M Taper fit earplugs NRR= 32, Tasco Golden Eagle earmuff NRR= 29

For all calculations used dBA , so the -7 correction factor inserted

TABLE I- PREVIOUS STUDY VS. NEW STUDY

Study days TWA (dBA)							
Year	**2008**	**2016**					
Job Duty	**Day 1**	**Day1**	**Day 2**	**Day 3**	**Day 4**	**Day 5**	**Day 6**
Driver	*98.3	80.4	77.4	82.5	82	*90.8	78.6
Floor man	*96.2	72.5	71.3	84.4	*90.8	84.3	*85.7
Noise Reduction (Single 3M Taper Fit earplugs) TWA (dBA)							
Year	**2008**	**2016**					
Job Duty	**Day 1**	**Day1**	**Day 2**	**Day 3**	**Day 4**	**Day 5**	**Day 6**
Driver	73.3	55.4	52.4	57.5	57	65.8	53.6
Floor man	71.2	47.5	46.3	59.4	65.8	59.3	60.7

*****Measurement Parameters: 8hr TWA, 80dBA criteria threshold, 3dBexchange rate.***

****Over the 85dBA for 8hr TWA***

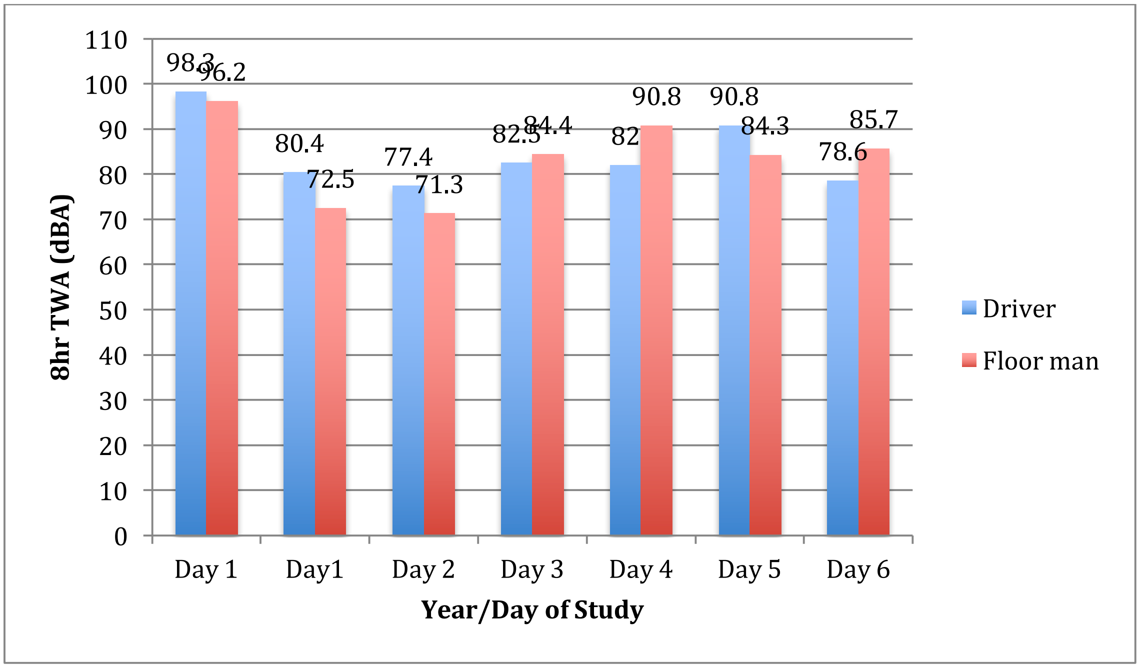


FIGURE 3-8HR TWA COMPARISON OF PREVIOUS STUDY AND NEW STUDY

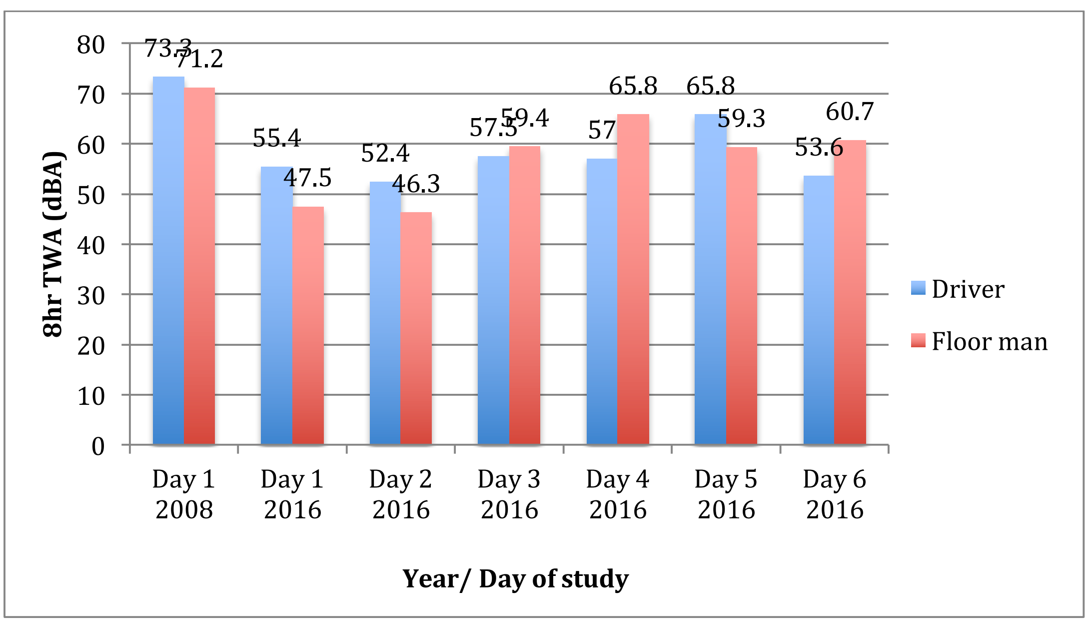


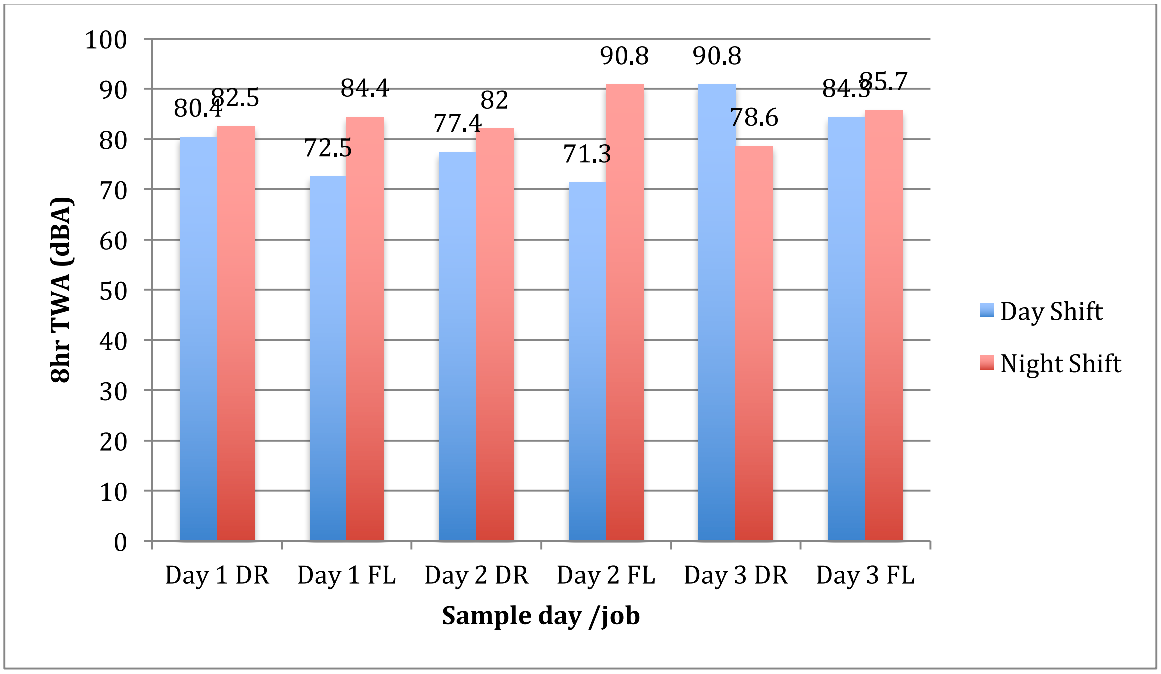
FIGURE 4 -8HR TWA COMPARISON OF PREVIOUS STUDY AND NEW STUDY W/ NOISE REDUCTION

TABLE II- DAY SHIFT VS. NIGHT SHIFT DATA

TWA (dBA)				
	Day shift		Night Shift	
	Driver	Floor man	Driver	Floor man
Day 1	80.4	72.5	82.5	84.4
Day 2	77.4	71.3	82	90.8
Day 3	90.8	84.3	78.6	85.7
TWA (dBA) Noise reduction				
	Day shift		Night Shift	
	Driver	Floor man	Driver	Floor man
Day 1	55.4	47.5	57.5	59.4
Day 2	52.4	46.3	57	65.8
Day 3	65.8	59.3	53.6	60.7
Dose %				
	Day shift		Night Shift	
	Driver	Floor man	Driver	Floor man
Day 1	9.60%	1.50%	56.30%	87.90%
Day 2	17.70%	4.20%	50.60%	386.70%
Day 3	382.80%	85.50%	23.20%	118.30%
Peak Noise (dBA)				
	Day shift		Night Shift	
	Driver	Floor man	Driver	Floor man
Day 1	114.2	111.5	130.9	127
Day 2	141.2	141.2	134.7	141.2
Day 3	126.6	141.2	141.2	137.2

Measurement Parameters: 8hr TWA, 80dBA criteria threshold, 3dBexchange rate.

***Over the 85dBA for 8hr TWA**



DR= Driver/ FL= Floor man

FIGURE 5- DAY SHIFT VS. NIGHT SHIFT SAMPLING

TABLE III- DRIVER VS. FLOOR MAN DATA COMPARISON

		Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
TWA (dBA)	Driver	80.4	77.4	82.5	82	90.8	78.6
	Floor man	72.5	71.3	84.4	90.8	84.3	85.7
NRD (dBA)	Driver	55.4	52.4	57.5	57	65.8	53.6
	Floor man	47.5	46.3	59.4	65.8	59.3	60.7
Dose %	Driver	9.60%	17.70%	56.30%	50.60%	382.80%	23.20%
	Floor man	1.50%	4.20%	87.90%	386.70%	85.50%	118.30%
Peak (dBA)	Driver	114.2	141.2	130.9	134.7	126.6	141.2
	Floor man	111.5	141.2	127	141.2	141.2	137.2

***Measurement Parameters: 8hr TWA, 80dBA criteria threshold, 3dBexchange rate.**
**Over the 85dBA for 8hr TWA*

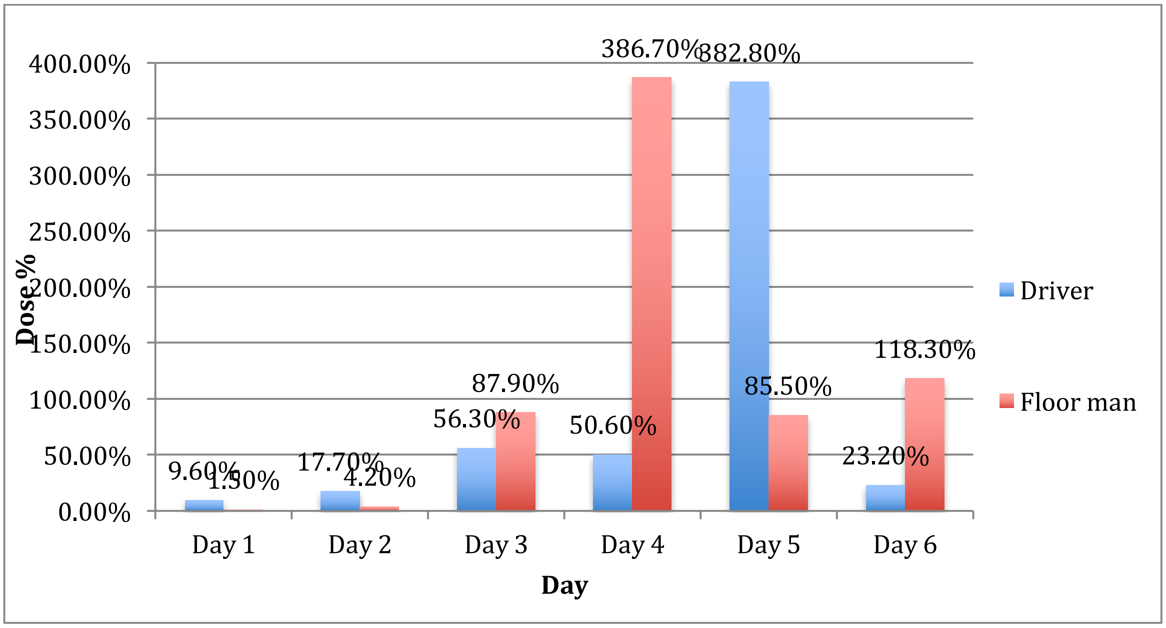


FIGURE 6- DOSE % COMPARISON

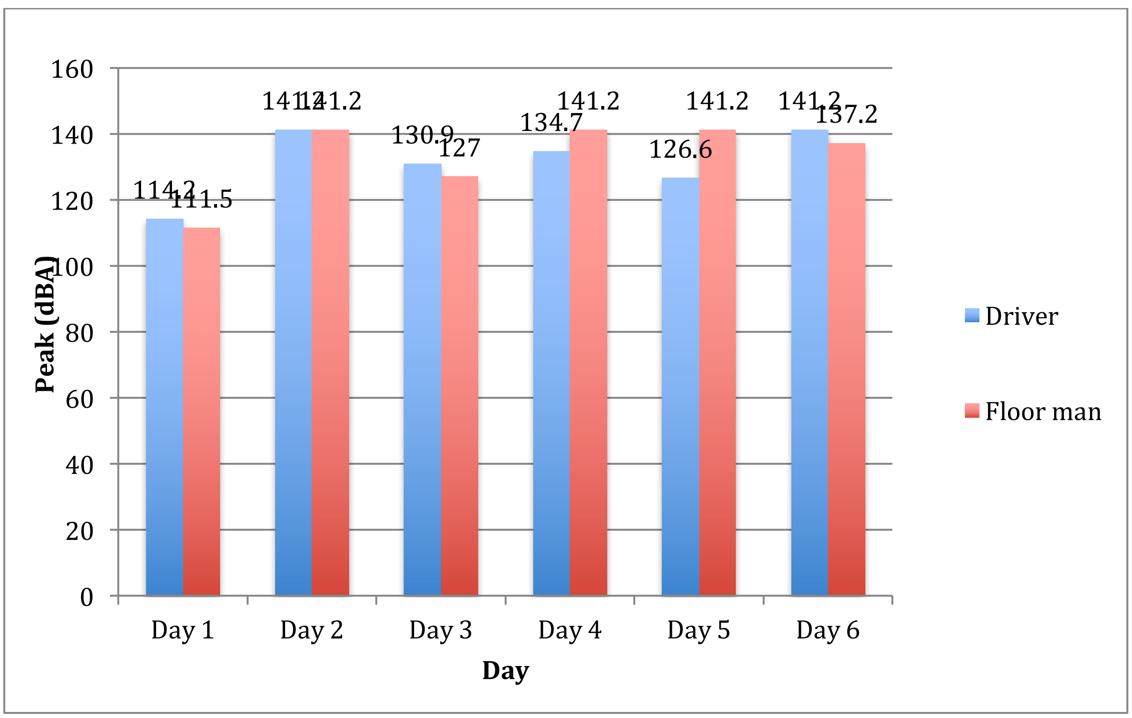


FIGURE 7- PEAK NOISE COMPARISON

TABLE IV- NOISE SOURCE SAMPLING

HAZARDOUS NOISE SOURCE	NOISE LEVEL (dBA)	HAZARD DISTANCE[1] (ft)	Noise Reduction Rate (Single) (dBA)	Noise Reduction rate (Double)
KC-135 Aircraft Nose-take off	*108.8	150		78.8
KC-135 Aircraft Nose-idle	95.2	60	70.2	
Dash 60 Power cart/Air load	*107.1	145		77.1
SGNC Nitrogen Cart	*101	120		71
MA-3D Air Conditioner	99	17	74	
MC7 Air Compressor/New	96	15	71	
MC7 Air Compressor/Old	96	15	71	
A/M 32A-86 Diesel power cart	96	15	71	
A/M 32C/10C/D Air Conditioner	94	14	69	
MC2A Air compressor	94	13	69	
MJ2A-1 Hydraulics test stand	94	13	69	
MHU-83C/E Munitions lift truck	94	12	69	
MJ1B Munitions lift truck/	92	10	67	
3/8" Pneumatic ratchet	91	10	66	
Tug Pusher while driving	91	10	66	
TTU-228 Test Sound	91	10	66	
1/2"Impact wrench	88	5	63	
1/2" Electric Drill	88	3	63	
1/2" Pneumatic impact wrench	86	1	61	
C-5 Air Conditioner	86	1	61	

Over 100dBA (AFOSH) double bearing protection required

Discussion

Personal Sampling

Old and new study comparison. The 2008 study completed was similar to the study completed in the 2016 sampling of the AGE department. The 8hr TWA of the 2008 study ranged from 96.2dBA to 98.3dBA between the driver and the floor man. The 2016 study 8hr TWA ranged form 71.3 to 90.8dBA between the driver and the floor man. The percent difference between the highest recorded 98.3dBA in the 2008 study and the 2016 study 90.8dBA is 7.93%. The difference between the lowest recorded 96.2dBA in the 2008 study and the 2016 study 71.3dBA is a percent difference of 29.7%. The standard deviation of the TWA dBA data of the driver and floor man of the 2008 study is 1.48 while the standard deviation of the new data between the driver and the floor man for 2016 data is 6.17. The driver of the 2008 study had an 8hr TWA of 98. 3dBA while the average of the drivers in the 2016 study had a TWA of 81dBA.

The floor man of the 2008 study had an 8hr TWA of 96.2 and the average of the 8hr TWAs in the 2016 study was 81.5dBA. Both data sets, without considering noise reduction calculations, have multiple shifts of 8hr TWA that exceed the OSHA standard for a hearing conservation program of 85dBA. Also the data shows that there is a difference in the exposure based on the job each service member performed. According to the data, the driver has a higher exposure level than the floor man. Also, the previous study shows the driver had an higher exposure level than the floor man.

The noise reduction calculations (Figure-1) have to be considered because the data changes when service members wear their hearing protection devices (HPD). The calculations for single hearing protection were determined by using the equation using dBA. (TWA- (NRR-7)). A -7 correction factor was used because dBA was used instead of dBC. The HPD utilized by the AGE department is an ear bud (3Mtaper fit earplugs) it has a NRR of 32. Also they use an earmuff (Tasco Golden Eagle Earmuff), which has a NRR of 29. Using the HPD changes, the 8hr TWA for the driver changes from 98.3dBA to 73.3dBA and the floor man 96.2dBA to 71.2dBA in the 2008 study, which is a percent different of 29% for both jobs. The average in the 2016 study statistically decreases in the 2016 study. The driver in the 2016 study decreases from an average of 81.9dBA to 56.95dBA and the floor man from 81.5dBA to 56.5dBA with a percent different of 35% for both jobs.

The major differences in the studies appear to be the variations between the recorded TWAs. Although the 2008 study only had two recorded 8hr TWAs, the driver and the floor man had very similar exposure amounts with and without the NRD. The 2016 study shows an array of different exposure levels for noise per shift and job. There is also statistically significant data that shows the difference in decibel from 2008 to 2016. The 2008 study has higher levels of exposure than the 2016 study. This could be due to different equipment used in between the time periods. The AGE department understands the noise exposure their service members face. Typically, all the equipment they are responsible for testing, repairing and inspecting poses as noise hazards. The AGE department works hard to ensure that they are current with latest noise reduction equipment. Thus, the decrease can possibly be attributed to consistently acquiring improved noise reduction equipment over the span of 8yrs.

Day and night shift comparison. The data for day shift between the floor man and driver without HPD ranged from 90.8dBA to 71.3dBA with a STD of 7.37. The night shift ranged from 90.8dBA to 78.6dBA with a STD of 4.11. The data using the HPD for day shift ranged from 65.8dBA to 46.3dBA and night shift 65.8dBA to 53.6dBA. The day shift and night shift had an array of dose percentages for the sampling days. Day shift had a max dose percent of 382% on day 3 and the night shift had a dose percent of 386.7% on day 2. In regards to peak noise, day and night shift experienced maximum peak noise of 141.2dBA. In the three days sampled on the day shift, the floor man and the driver had a combined mean of 129.4dBA. The night shift experienced higher levels of peak noise with a combined mean of 135.3dBA between the floor man and the driver.

Both shifts had noise exposure that exceeded 85dBA for hearing conservation program. Over the sampling period for three days for each shift, the night shift appeared to have higher noise exposure levels with an average of 84dBA compared to day shift 79.4dBA. There was an expectation that day shift would have the higher noise exposure due to the higher level of scheduled activity that exist within the AGE shop and the normal flight operations. One possible explanation of the higher noise level on night shift could be contributed to the days that the sampling took place. There was a higher level of flight activity on the night shift due to an annual air show and practice flights were taking place. So the increased flight operations were in higher volume than it normally would be on a normal day. The noise reduction data for day and night shift shows that if the HPD are worn properly service members are well below the for 8hr TWA for occupational noise exposure.

Driver and floor man comparison. The data comparison between the driver and the floor man combine over a 6-day period. Each day tested two service members, a driver and a floor man for exposure over an 8hr TWA. The driver noise data ranged from 90.8dBA to 77.4dBA with out HPD. The mean of the of the driver noise data was 81.9dBA with a STD of 4.7. The floor man data ranged from 90.8dBA to 71.3dBA with out HPD. The mean of the floor man data was 81.5dBA with a STD of 7.8. The data of the driver with HPD ranged from 65.8dBA to 52.4 BA with a mean of 56.9dBA. The floor man data ranged from 65.8dBA to 47.5dBA with a mean of 56.5dBA. The driver on day five had a dose percent of 382 and the floor man had a max dose percent of 386.7 on day four of the study. The STD of the dose percentages for the driver and the floor man were relatively similar. The STD for the driver was 1.44 while the floor man STD was 1.41. Both the driver and the floor man hit max peak noise of 141.2dBA. The driver peak noise mean was 131dBA with a STD of 10.2, while the floor man had a mean of 133dBA with a STD of 11.

The driver and the floor man without wearing HPD both had 8hr TWA that exceeded the 85dBA for hearing conservation. The floor man had the greater variation in data with a higher STD of 7.8 compared to the driver 4.7. Considering the mean and the STD, statistically the driver appears to have had a higher exposure level than the floor man. Although, the floor man had higher peak noise mean of 133dBA compared to the driver 131. Due to the job responsibilities of the driver, there was an expectation that the driver would have a higher exposure level. At any given moment, the driver has exposure to noise from equipment, the flight line, and other vehicles they conduct. The peak noises of the floor man can possibly be contributed to training session from flight crews for the local air show. The training sessions increased the frequency of flight schedules. This is important because the training made the AGE building, which is the main location for floor man, louder than normal. It is also important to understand the significance of the data with regards to either wearing or not wearing HPD. When the drivers wore HPDs, the 8hr TWA was decrease from 81.9 dBA to 56.9dBA, which is a 36% difference. The floor man 8hr TWA mean decreased from 81.5dBA to 56.5dBA, which is also a 36% difference. This data highlights the difference that the HPD makes in the workplace for both the driver and the floor man. It also displays the amount of risk the service members in the AGE department are exposed to if their HPDs are not worn or if worn improperly.

Noise Source

The noise source data gives an idea of the type of hazardous noise equipment that the service members in the AGE department are exposed to. In addition to its close proximity to hazardous noise equipment, the AGE department is in close proximity to the flight line on base. During the noise source sampling the decibels ranged from 108.8dBA (KC-135 Aircraft Nose in take off mode / hazard distance 150ft) to 86dBA (1/2''Pnueumatic impact wrench/C-5 Air conditioner/ hazard distance 1ft). There were three noise sources that required double hearing protection because the noise levels exceeded 100dBA (AFOSH). The double hearing protection required sources were as follows: KC-135 Aircraft Nose (in take off mode) 108.8dBA with a hazardous distance of 150ft, Dash 60 Power car/ air load (generator) 107.1dBA with a hazard distance of 145ft, and the SGNC nitrogen cart 101dBA with a hazard distance of 120ft. Every noise source was above the 85dBA for hearing conservation when considering no HPD is worn. Also, each noise source had a hazard distance (ft), which determined a safe distance with out

HPD (Table-IV). At the safe distance there was tape barriers informing service members that hearing protection must be worn whether it was single or double depending on the equipment.

The noise reduction calculations were considered when determining the exposure levels (Figure -2). The three noise sources that required double hearing protection were all decreased. The loudest was the KC-135 Aircraft Nose (takeoff mode), decreased from 108.8dBA to 78.8dBA with a 31.9% difference. The Dash 60 power cart/air load (generator) decreased from 107.1dBA to 77. 1dBA with a 32.5% difference. The SGNC nitrogen cart decreased from 101dBA to 71dBA with a 34% difference. The single hearing protection reduction calculations have similar results by decreasing the dBAs (Table-IV) all the other noise sources by an average of 31.3% difference. The noise reduction calculations for the single protection decreased all equipment noise to fall within the 85dBA standard requirement for hearing conservation.

Conclusion

Study Limitations

Sampling from the previous study was completed in one day, which included day shift and night shift. Although it may have been more beneficial to sample over multiple days to get a good variation in the data for the old study, the sampling procedures from the previous study could not be duplicated to make a more accurate comparison. For this study, six days of sampling was completed. This helped to insure there was a variety in data when determining exposure. Also, AGE has a strict work schedule and protocol that makes it difficult to organized multiple sampling days. So, the Bio-engineering/ environmental department had a difficult time getting multiple sampling results from the previous study. The lack of access demanded detailed scheduling. So, the sampling days were done on days with routine process versus days that had little to no activity.

All hazardous shops on the Mac Dill Air force base are governed by the Air force Occupational Safety and Health standard (AFOSH). This Air Force instruction is responsible for outlining all the rules and regulations regarding the hearing conservation program on base. In regards to the data in this study, keep in mind that most of the data collected was during the time of heavier than normal flight operations. The more frequent flight schedules were due large in part to the air show that was scheduled in the following weeks after the study. So this could contribute to higher peak noises as well as overall 8-hr TWAs for each day sampled. Additionally, the noise reduction calculations are purely based on the idea that each service member is properly wearing the HPD during processes. There is a possibility that the data for exposure with NRD can be inaccurate if the service members are not following protocol for HPD. Following HPD protocol is important because all of the equipment in the noise source sampling exceed the 85 dBA with out HPD. Also, some of the sampling for day/night shift and driver/floor man exceeded the 8hr TWA of 85 dBA for hearing conservation. Therefore if the HPD protocol is not adhered to, there is a very high risk of noise induced hearing loss in this department.

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Appendices

<u>Appendix A: Equipment List</u>

3M Edge 5 Personal Noise Dosimeter
Model No: eg5
Serial No.: ESK110041
ECN: 016718
Manufacturer Calibration Date: 08/20/2014
3M Detection Solutions
1060 Corporate Center Drive
Oconomowoc, WI 53066

3M Edge 5 Personal Noise Dosimeter
Model No: eg5
Serial No.: ESK110043
ECN: 016716
Manufacturer Calibration Date: 08/20/2014
3M Detection Solutions
1060 Corporate Center Drive
Oconomowoc, WI 53066

3M Edge 5 Personal Noise Dosimeter
Model No: eg5
Serial No.: ESK110042
ECN: 016717
Manufacturer Calibration Date: 08/20/2014
3M Detection Solutions
1060 Corporate Center Drive
Oconomowoc, WI 53066

3M Edge 5 Personal Noise Dosimeter
Model No: eg5
Serial No.: ESK110051
ECN: 016714
Manufacturer Calibration Date: 08/20/2014
3M Detection Solutions
1060 Corporate Center Drive
Oconomowoc, WI 53066

Appendix B: Data Output

Study Report

2/11/2016

Study 1

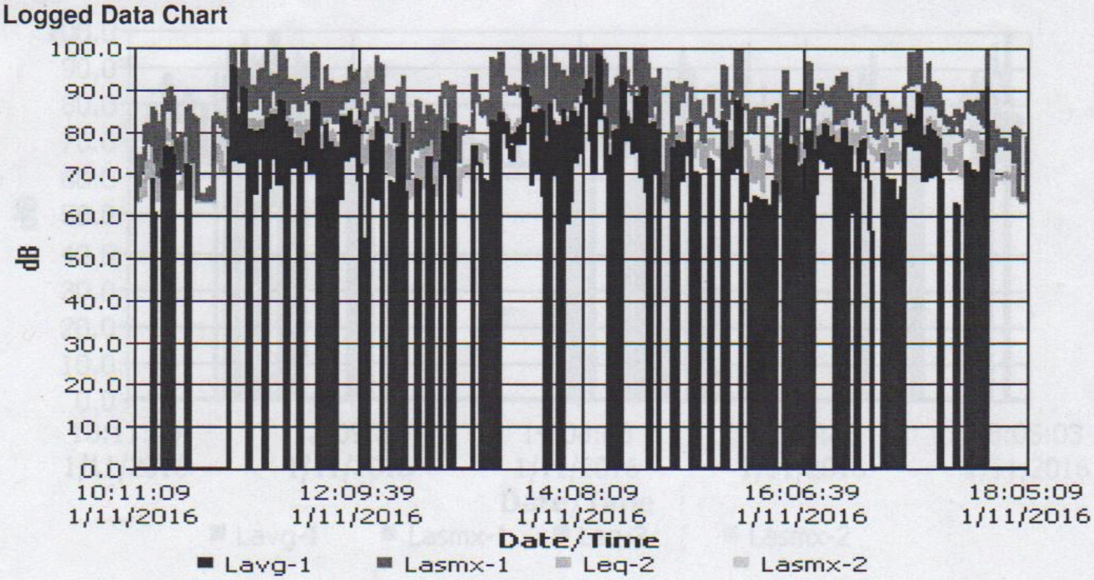
Information Panel

Name	Study 1
Comments	
Start Time	Monday, January 11, 2016 10:10:09
Stop Time	Monday, January 11, 2016 18:05:24
Location	
Parent Session	ESK110041_20160112_145956
User Name	

General Data Panel

Description	Meter	Value	Description	Meter	Value
Dose	1	9.6 %	Lavg	1	79.8 dB
Leq	1	--	Lcpk	1	--
Lzpk	1	--	PKtime	1	1/11/2016
12:15:23 PM					
Lasmx	1	114.2 dB	Lafmx	1	--
Lcsmx	1	--	Lcfmx	1	--
Lasmn	1	63.1 dB	Lafmn	1	--
Lcsmn	1	--	Lcfmn	1	--
Exchange Rate	1	3 dB	Response	1	SLOW
Log Rate	1	60 s	Dose	2	43.1 %
Lavg	2	--	Leq	2	81.3 dB
Lcpk	2	--	Lzpk	2	--
Lasmx	2	114.2 dB	Lafmx	2	--
Lcsmx	2	--	Lcfmx	2	--
Lasmn	2	63.1 dB	Lafmn	2	--
Lcsmn	2	--	Lcfmn	2	--
Weighting	2	A	Response	2	SLOW
Exchange Rate	2	3 dB			

Logged Data Chart



Study Report

2/11/2016

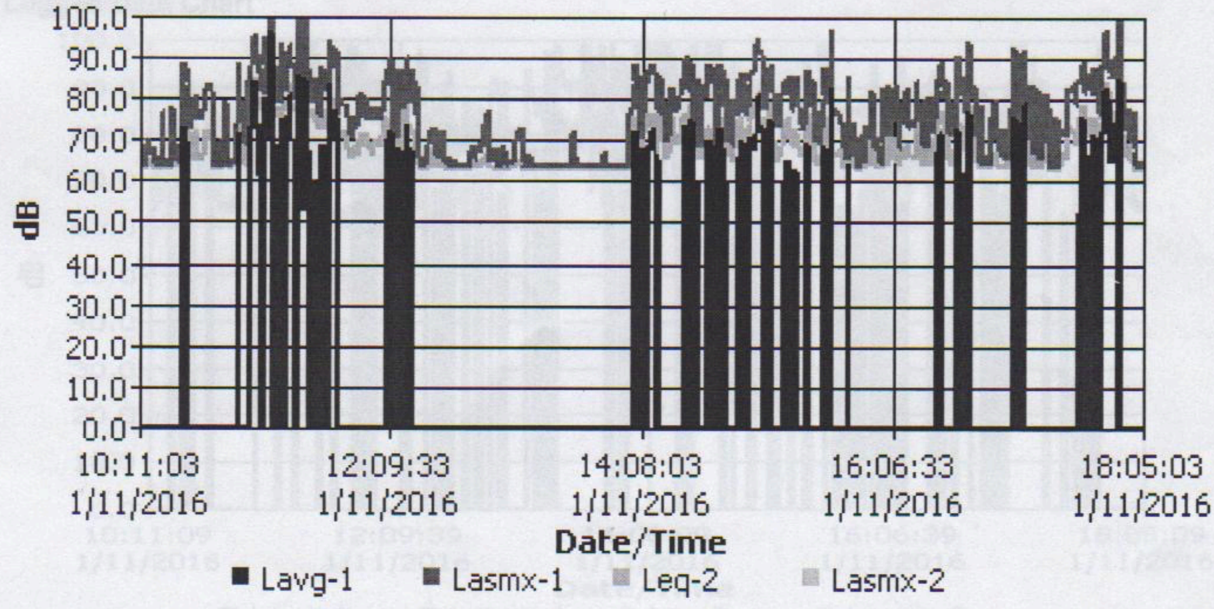
Information Panel

Name	Study 1
Comments	
Start Time	Monday, January 11, 2016 10:10:03
Stop Time	Monday, January 11, 2016 18:05:29
Location	
Parent Session	ESK110042_20160112_150049
User Name	

General Data Panel

Description	Meter	Value	Description	Meter	Value
Dose	1	1.5 %	Lavg	1	71.9 dB
Leq	1	--	Lcpk	1	--
Lzpk	1	--	PKtime	1	1/11/2016
5:53:59 PM					
Lasmx	1	111.5 dB	Lafmx	1	--
Lcsmx	1	--	Lcfmx	1	--
Lasmn	1	63.1 dB	Lafmn	1	--
Lcsmn	1	--	Lcfmn	1	--
Exchange Rate	1	3 dB	Response	1	SLOW
Log Rate	1	60 s	Dose	2	8.7 %
Lavg	2	--	Leq	2	74.4 dB
Lcpk	2	--	Lzpk	2	--
Lasmx	2	111.5 dB	Lafmx	2	--
Lcsmx	2	--	Lcfmx	2	--
Lasmn	2	63.1 dB	Lafmn	2	--
Lcsmn	2	--	Lcfmn	2	--
Weighting	2	A	Response	2	SLOW
Exchange Rate	2	3 dB			

Logged Data Chart



AGE member 2 day shift

2/11/2016

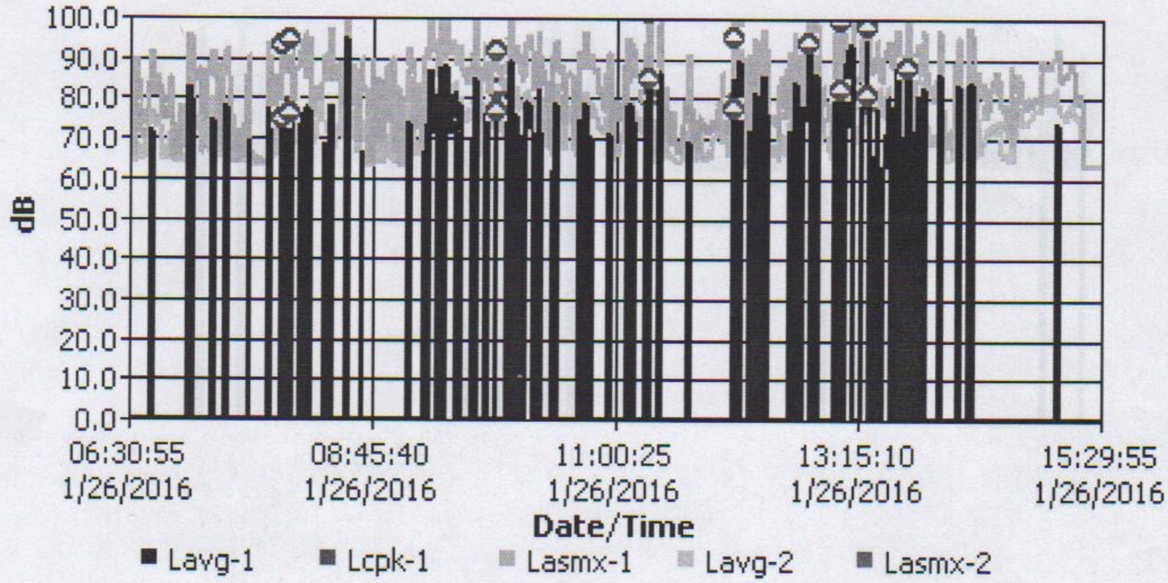
Information Panel

Name	Study 1
Comments	
Start Time	Tuesday, January 26, 2016 06:29:55
Stop Time	Tuesday, January 26, 2016 15:30:38
Location	
Parent Session	ESK110051_20160128_123028
User Name	

General Data Panel

Description	Meter	Value	Description	Meter	Value
Dose	1	17.7 %	Lavg	1	76.9 dB
Lcpk	1	141.2 dB	PKtime	1	1/26/2016
11:18:46 AM					
Lasmx	1	111.5 dB	Lasmn	1	63.1 dB
TWA	1	77.4 dB	Exchange Rate	1	3 dB
Response	1	SLOW	Log Rate	1	60 s

Logged Data Chart



AGE Member 1 day shift

2/11/2016

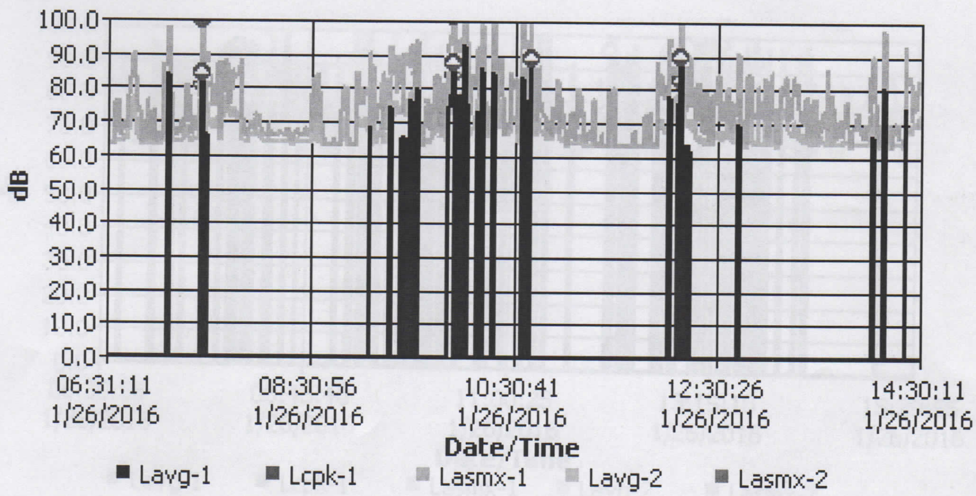
Information Panel

Name	AGE Member 1- Day Shift
Comments	
Start Time	Tuesday, January 26, 2016 06:30:11
Stop Time	Tuesday, January 26, 2016 14:30:11
Location	
Parent Session	ESK110042_20160128_123007
User Name	

General Data Panel

Description	Meter	Value	Description	Meter	Value
Dose	1	4.2 %	Lavg	1	71.3 dB
Lcpk	1	141.2 dB	PKtime	1	1/26/2016
9:53:38 AM					
Lasmx	1	106.2 dB	Lasmn	1	59.6 dB
TWA	1	71.3 dB	Exchange Rate	1	3 dB
Response	1	SLOW	Log Rate	1	60 s

Logged Data Chart



1

AGE afternoon 2- floor

2/11/2016

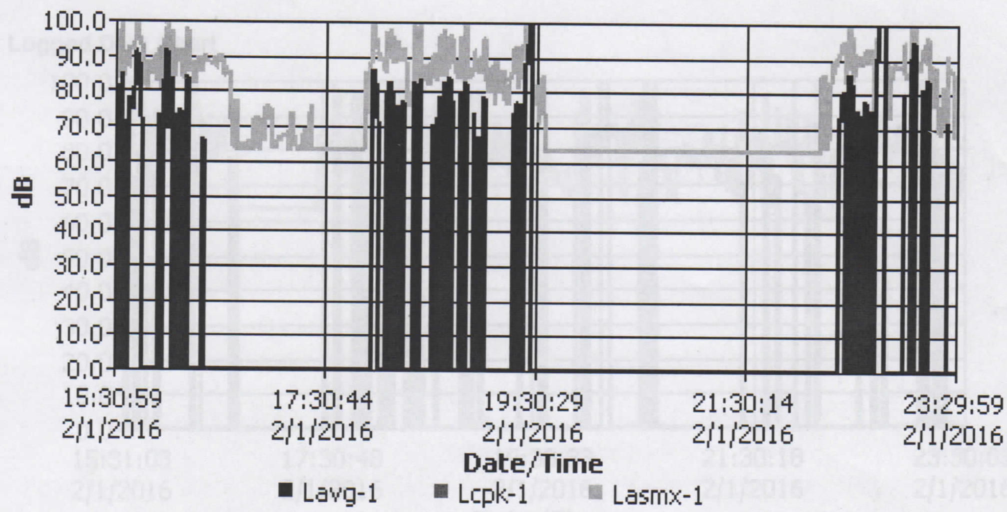
Information Panel

Name	Study 1
Start Time	Monday, February 01, 2016 15:29:59
Stop Time	Tuesday, February 02, 2016 06:51:07
Parent Session	ESK110051_20160202_100302

General Data Panel

Description	Meter	Value	Description	Meter	Value
Dose	1	87.9 %	Lavg	1	81.6 dB
Lcpk	1	127 dB	PKtime	1	2/1/2016
10:47:27 PM					
Lasmx	1	109.8 dB	Lasmn	1	63.1 dB
TWA	1	84.4 dB	Exchange Rate	1	3 dB
Response	1	SLOW	Log Rate	1	60 s

Logged Data Chart



1

AGE afternoon 1- driver

2/11/2016

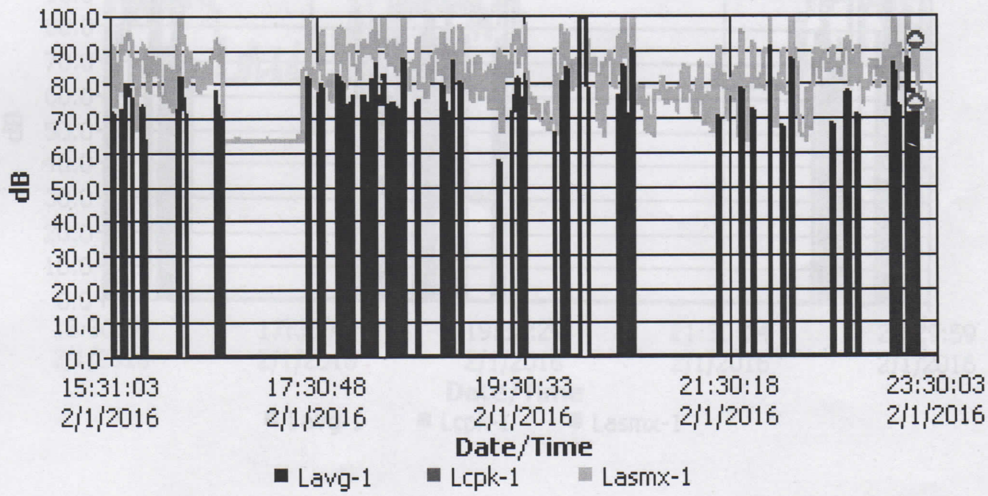
Information Panel

Name	AGE Afternoon 1- Driver
Comments	
Start Time	Monday, February 01, 2016 15:30:03
Stop Time	Tuesday, February 02, 2016 06:51:05
Location	
Parent Session	ESK110042_20160202_100327
User Name	

General Data Panel

Description	Meter	Value	Description	Meter	Value
Dose	1	56.3 %	Lavg	1	79.6 dB
Lcpk	1	130.9 dB	PKtime	1	2/1/2016
6:09:42 PM					
Lasmx	1	106.2 dB	Lasmn	1	63.1 dB
TWA	1	82.5 dB	Exchange Rate	1	3 dB
Response	1	SLOW	Log Rate	1	60 s

Logged Data Chart



1

AGE Afternoon Driver

2/12/2016

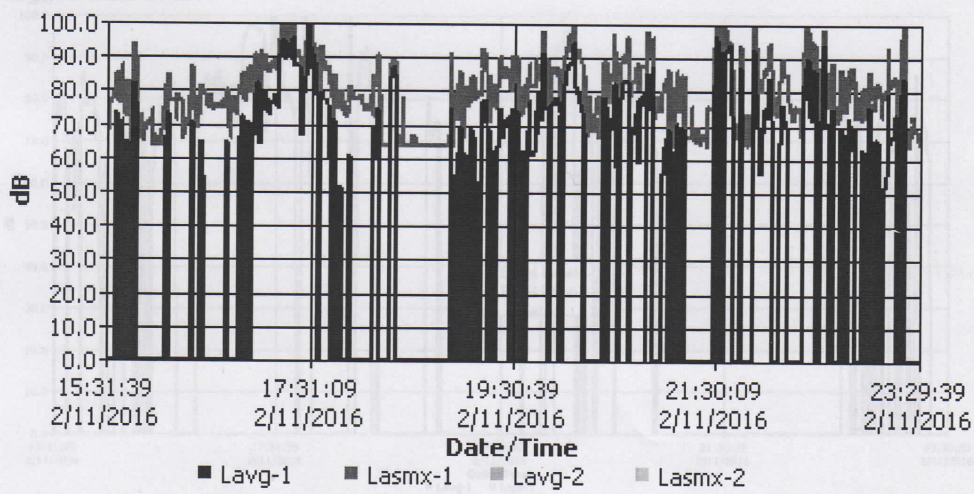
Information Panel

Name	Study 1
Comments	
Start Time	Thursday, February 11, 2016 15:30:39
Stop Time	Friday, February 12, 2016 06:36:02
Location	
Parent Session	ESK110042_20160212_065325
User Name	

General Data Panel

Description	Meter	Value	Description	Meter	Value
Dose	1	50.6 %	Lavg	1	79.2 dB
PKtime	1	2/11/2016 11:20:05 PM	Dose	2	50.6 %
Lavg	2	79.2 dB	Lasmx	2	110.2 dB
Lasmn	2	63.1 dB	TWA	1	82 dB
Lapk	1	134.7 dB	Exchange Rate	1	3 dB
Response	1	SLOW	Log Rate	1	60 s
Weighting	2	A	Response	2	SLOW
Exchange Rate	2	3 dB			

Logged Data Chart



1

AGE Afternoon Floorman

2/12/2016

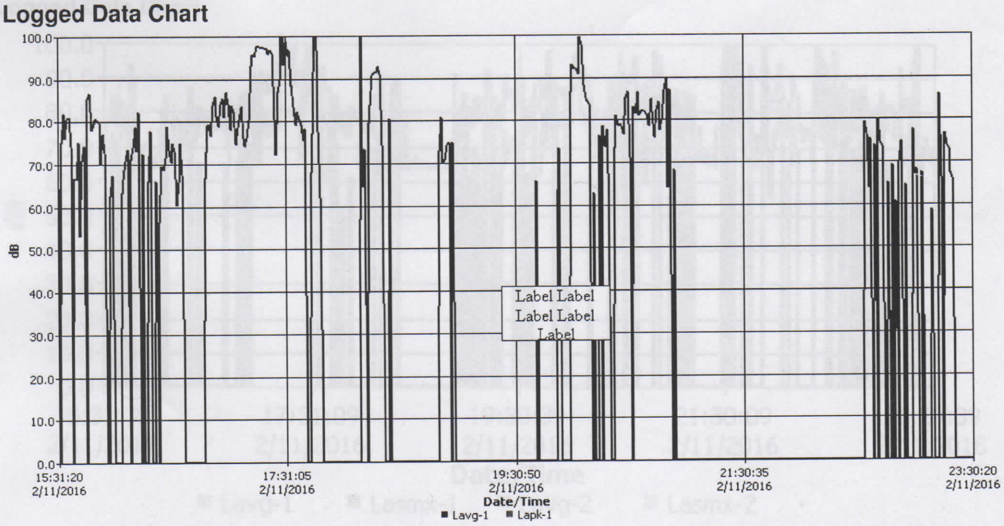
Information Panel

Name	Study 1
Comments	
Start Time	Thursday, February 11, 2016 15:30:20
Stop Time	Friday, February 12, 2016 06:35:34
Location	
Parent Session	ESK110041_20160212_065347
User Name	

General Data Panel

Description	Meter	Value	Description	Meter	Value
PKtime	1	2/11/2016 6:10:09 PM	Dose	2	386.7 %
Lavg	2	88.1 dB	Lasmx	2	130.4 dB
Lasmn	2	63.1 dB	TWA	1	90.8 dB
Lavg	1	88.1 dB	Dose	1	386.7 %
Lapk	1	141.2 dB	Exchange Rate	1	3 dB
Response	1	SLOW	Log Rate	1	60 s
Weighting	2	A	Response	2	SLOW
Exchange Rate	2	3 dB			

Logged Data Chart



1

AGE Morning 110043

2/12/2016

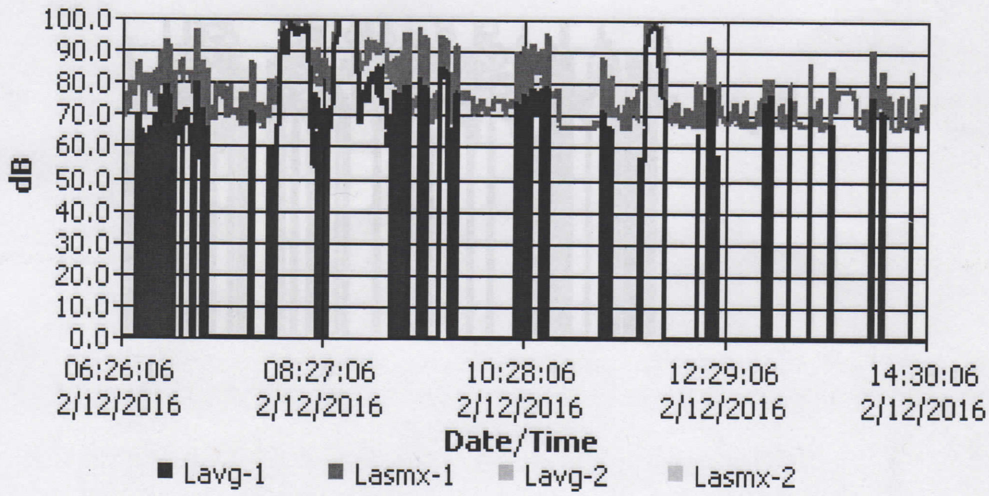
Information Panel

Name	Study 1
Comments	
Start Time	Friday, February 12, 2016 06:25:06
Stop Time	Friday, February 12, 2016 14:54:12
Location	
Parent Session	ESK110043_20160212_150446
User Name	

General Data Panel

Description	Meter	Value	Description	Meter	Value
Dose	1	382.8 %	Lavg	1	90.5 dB
PKtime	1	2/12/2016 8:40:39 AM	Lasmx	1	111.4 dB
Lasmn	1	63.1 dB	Dose	2	382.8 %
Lavg	2	90.5 dB	Lasmx	2	111.4 dB
Lasmn	2	63.1 dB	TWA	1	90.8 dB
Lapk	1	126.6 dB	Exchange Rate	1	3 dB
Response	1	SLOW	Log Rate	1	60 s
Weighting	2	A	Response	2	SLOW
Exchange Rate	2	3 dB			

Logged Data Chart



1

AGE Morning 110051

2/12/2016

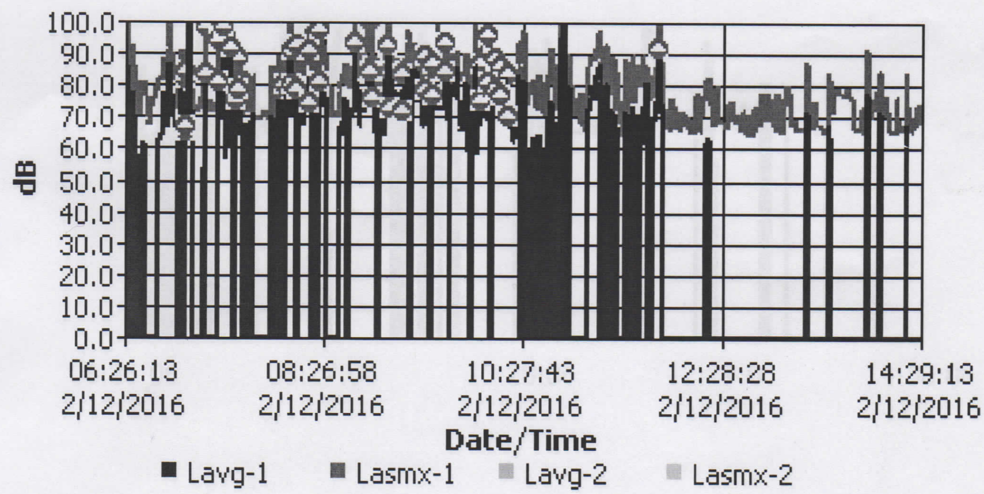
Information Panel

Name	Study 1
Comments	
Start Time	Friday, February 12, 2016 06:25:13
Stop Time	Friday, February 12, 2016 14:54:13
Location	
Parent Session	ESK110051_20160212_150503
User Name	

General Data Panel

Description	Meter	Value	Description	Meter	Value
Dose	1	85.5 %	Lavg	1	84 dB
PKtime	1	2/12/2016 8:44:48 AM	Lasmx	1	121.3 dB
Lasmn	1	63.1 dB	Dose	2	85.5 %
Lavg	2	84 dB	Lasmx	2	121.3 dB
Lasmn	2	63.1 dB	TWA	1	84.3 dB
Lapk	1	141.2 dB	Exchange Rate	1	3 dB
Response	1	SLOW	Log Rate	1	60 s
Weighting	2	A	Response	2	SLOW
Exchange Rate	2	3 dB			

Logged Data Chart



1

AGE Afternoon Driver

2/17/2016

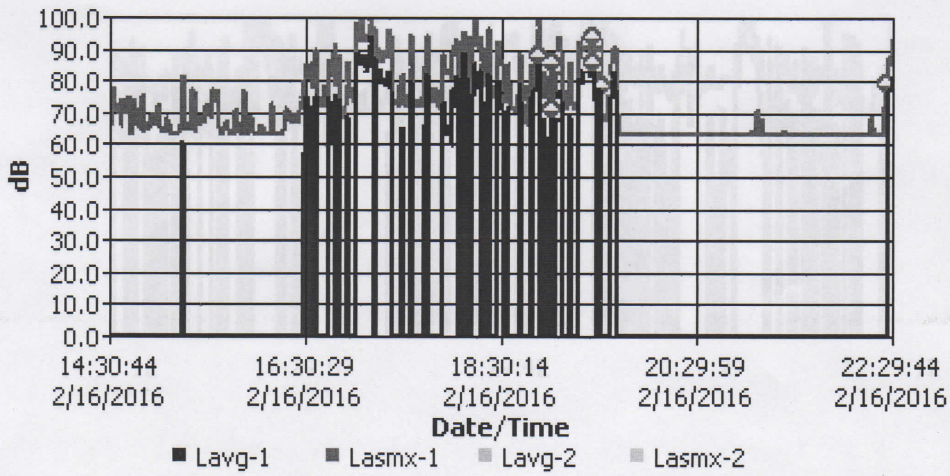
Information Panel

Name	Study 1
Comments	
Start Time	Tuesday, February 16, 2016 14:15:44
Stop Time	Wednesday, February 17, 2016 07:27:13
Location	
Parent Session	ESK110042_20160217_073116
User Name	

General Data Panel

Description	Meter	Value	Description	Meter	Value
Dose	1	23.2 %	Lavg	1	75.3 dB
PKtime	1	2/16/2016 6:53:24 PM	Lasmx	1	107.7 dB
Lasmn	1	63.1 dB	Dose	2	23.2 %
Lavg	2	75.3 dB	Lasmx	2	107.7 dB
Lasmn	2	63.1 dB	TWA	1	78.6 dB
Lapk	1	141.2 dB	Exchange Rate	1	3 dB
Response	1	SLOW	Log Rate	1	60 s
Weighting	2	A	Response	2	SLOW
Exchange Rate	2	3 dB			

Logged Data Chart



1

AGE Afternnon Floorman

2/17/2016

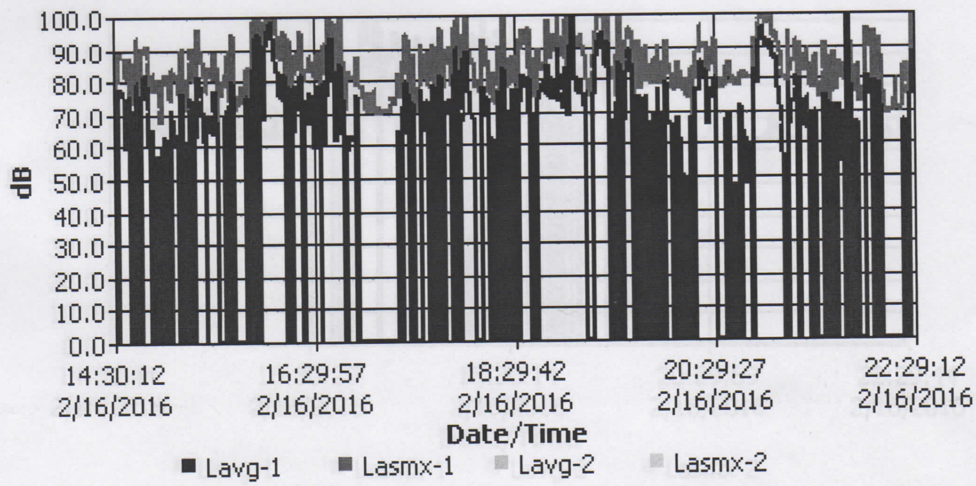
Information Panel

Name	Study 1
Comments	
Start Time	Tuesday, February 16, 2016 14:15:12
Stop Time	Wednesday, February 17, 2016 07:26:45
Location	
Parent Session	ESK110041_20160217_073140
User Name	

General Data Panel

Description	Meter	Value	Description	Meter	Value
Dose	1	118.3 %	Lavg	1	82.4 dB
PKtime	1	2/16/2016 2:25:49 PM	Lasmx	1	115.6 dB
Lasmn	1	63.1 dB	Dose	2	118.3 %
Lavg	2	82.4 dB	Lasmx	2	115.6 dB
Lasmn	2	63.1 dB	Lapk	1	137.2 dB
TWA	1	85.7 dB	Exchange Rate	1	3 dB
Response	1	SLOW	Log Rate	1	60 s
Weighting	2	A	Response	2	SLOW
Exchange Rate	2	3 dB			

Logged Data Chart



1