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A Systematic Methodology to Ensure OSHA Noise Level Compliance When Production Processes are Changed (A Health & Safety Case Study)

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Abstract: Hearing loss remains one of the top ten injuries reported by occupational health workers. This loss may or may not be a direct result of occupational exposure. In 2008, *"A Methodology to Attain Noise Compliance for a Small Company (A Health & Safety Case Study)*"was presented at the 13th International Conference on Industrial Engineering Theory, Applications and Practice. By following OSHA guidelines the micro-brewery successfully met compliance. The micro-brewery has increased its production space by adding two 3,000 gallon brewing vats and three new processing lines (a 12/22 ounce bottling line, a repacking line, and a 25 or 7.5 gallon keg line). Due alteration and obtaining compliance the average noise levels throughout the facility was significantly higher ((over 76 dBA) (δ = 5.23 dBA)). Peak noise levels for the brewing and bottling processes, especially the 12 oz. bottling line exceeded the allowable levels of 115 dBA).

Key Words: Systematic Methodology, OSHA Noise Compliance

Figure 1 below is the noise contour map of the facility done in 2008 (Yearout, Barrow, McKenzie, Garza Garcia, and Villafuerte, 2008).

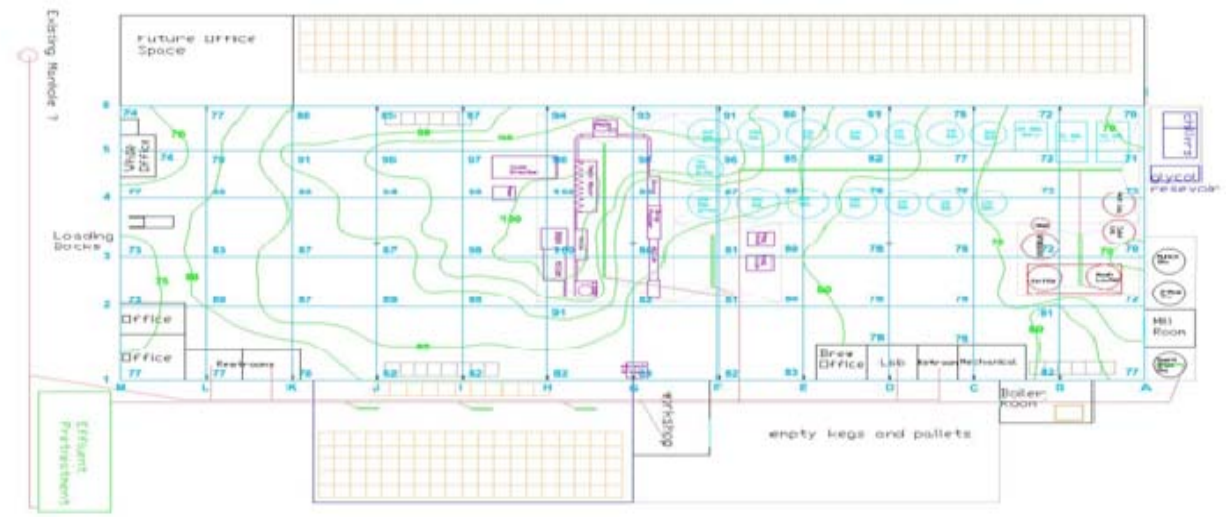

Figure 1. Noise Level Contour (2008)

1.2 Update

Highland noise abatement program has led to changes in their facility since the study performed in 2008. The first of which was the noise from air bleed off from pneumatic lines attached to the machinery. Although it was not the largest contributor to the constant noise, it was a very quick and easy adjustment to make. This bleed off creates a loud resonant sound wave that can travel a good distance from the source. In an effort to quiet pneumatic machinery, the air pressure was reduced to the lowest limit possible, still allowing the machine to function properly. Bottles contact is the largest source of noise in the brewery. To address this issue foam sound barriers were then placed around portions of the keg line and bottling line to absorb or disrupt some of the sound discharged by the bottles clanking together and water jets for cleaning kegs. Ear protection is also required in the bottling area on days which bottling is in progress. Replacement of vibrators for collection tables and some equipment on the line also aided in this effort. Production growth led to the addition of an electric fork lift bringing the total to 3 lifts, one propane lift and 2 electric lifts. The horn on each of these lifts is approximately 119 dbl, adding to the peak noise in the facility.

1.3 Purpose

The purpose of this study is to ensure the Highland brewery is compliant with OSHA regulations. OSHA regulations state that the noise study must be done on a regular time interval or when updates to the facility are made. Highland has grown since the 2008 study was performed. The bottling and keg lines were updated and refigured to improve efficiency. Part of this improved efficiency is the ability to fill both 12 and 22 oz. bottles by machine. Each of these can be packed in 12 count packs by machine while the 12oz bottle can be packed in a 24 pack as well. A bottle lift was added allowing for an entire pallet of 12oz bottles to be placed on the conveyor at a time. To increase capacity to meet higher demand two new fermentation tanks were added, each being capable of holding 200 barrels of beer (3,000 gallons). In adding these items, production has increased to 30,000 barrels per year, making them the largest brewery in the region at this point in time. The addition of this equipment it has reduced free space for sound waves to travel. This changes the contour of the sound patterns in the facility. It also gives more surfaces in which sound waves can bounce off. This along with increased activity in the brewery has increased the peak noise levels, while the efforts in noise abatement have reduced the time weight average of the noise in the facility.

1.3.1 NIOSH/OSHA Standard

Legislation was passed to establish permissible noise level exposure based on a sliding scale starting at 85 dBA for no more than 16 hours per day and ending at 115 dBA for no more than 0.25 hours per day (Occupational Safety and Health Administration (OSHA), 1989, and US Department of Health and Human Services: 1998). This regulation specifies that the permissible time is halved for every 5 dBA and that and level greater than 115 dBA is not permissible. The exception to the 115 dBA limit is sounds that are pulse or impact noise, which cannot exceed 140 dBA peak pressures even when hearing protection is used. Pulse or impact levels cannot exceed one continuous second. For the peak sound to qualify as a pulse the duration of the peak can only be a faction of a second. Although the permissible levels listed in more liberal, guidelines

requiring noise conservations program any time work shifts are in excess of 8 hours (Centers for Disease Control and Prevention/NIOSH, 1998). Thus the 85 dBA TWA allowance is reduced due to the logarithmic nature of noise levels. For example, exposures in excess of 83.4 dBA for a 10-hour work shift and exposures in excess of 82.1 dBA for a 12-hour work shift necessitate inclusion in a hearing conservation program.

All NIOSH/OSHA standards were met by Highland Brewery in 2008. However, an ongoing noise exposure evaluation program is required under OSHA Standard for Occupational Noise Exposure (29 CFR 1910.95) not when "information indicates that any employee's exposure may equal or exceed an 8 hour Time-Weighted Average of 85 dBA. Monitoring shall be repeated whenever a change in production, process, equipment or control increases noise exposure to the extent that: 1) Additional employees may be exposed at or above the action level, or 2) the attenuation provided by the hearing protectors being used by the employees may be rendered inadequate." A complete sound survey of the plant is recommended at least every two years.

2. Methodology

The OSHA courtesy inspection determined that the bottling operation, which is a three-days-per-week operation, was the source of noise levels that failed to comply with OSHA regulations. In order to ensure the safety of employees at Highland Brewing Company, a hearing conservation program was needed. Data collection was conducted during the days that the bottling process was in operation. An implementation process began once the sound survey of the plant was completed.

2.1 Spot Meter Reading

For the purpose of collecting data on noise levels, seventy-eight equidistant points within the 240 feet by 90 feet {21,600 ft^2} facility were used as reference points. A data collection sheet was prepared with 13 north-south columns labeled alphabetically and 6 east-west rows labeled numerically. The data for each point was collected with a GenRad Permissible Sound Level Meter Type 1565-B. Twenty separate observations of point noise level data were collected. Noise contours were then plotted on a to-scale drawing of the facility. Prior to the beginning of data collection instrument was calibrated to ensure accuracy. Data was collected from the time the operation began until each day's operation was complete. Following this initial assessment, a re-assessment will be required at least every two years. The data was recorded and analyzed. Inconsistent data, such as when the bottling process was halted during the test time, were separated out for consistency. The data was then compared to OSHA regulations.

2.2 Dosimeter

Also during five different bottling operation days a Quest Electronics Permissible Noise Dosimeter MICRO-15 (Quest Technologies, 2008) was attached to the clothing of one of the four primary workers on the bottling line. This collects the noise levels the employee was exposed to over the entire shift. Using this information we are able to document the peak noise levels occurring in his or her station, as well as the time weighted average of the noise exposure. The peak levels are then analyzed and compared to OSHA regulations for compliance. The device was calibrated daily to ensure accuracy. The microphone was placed a on the employees clothes as close to ear level as possible.

2.3 Noise Level Contour

From the data collected an updated noise level contour was complete (Figure 2).

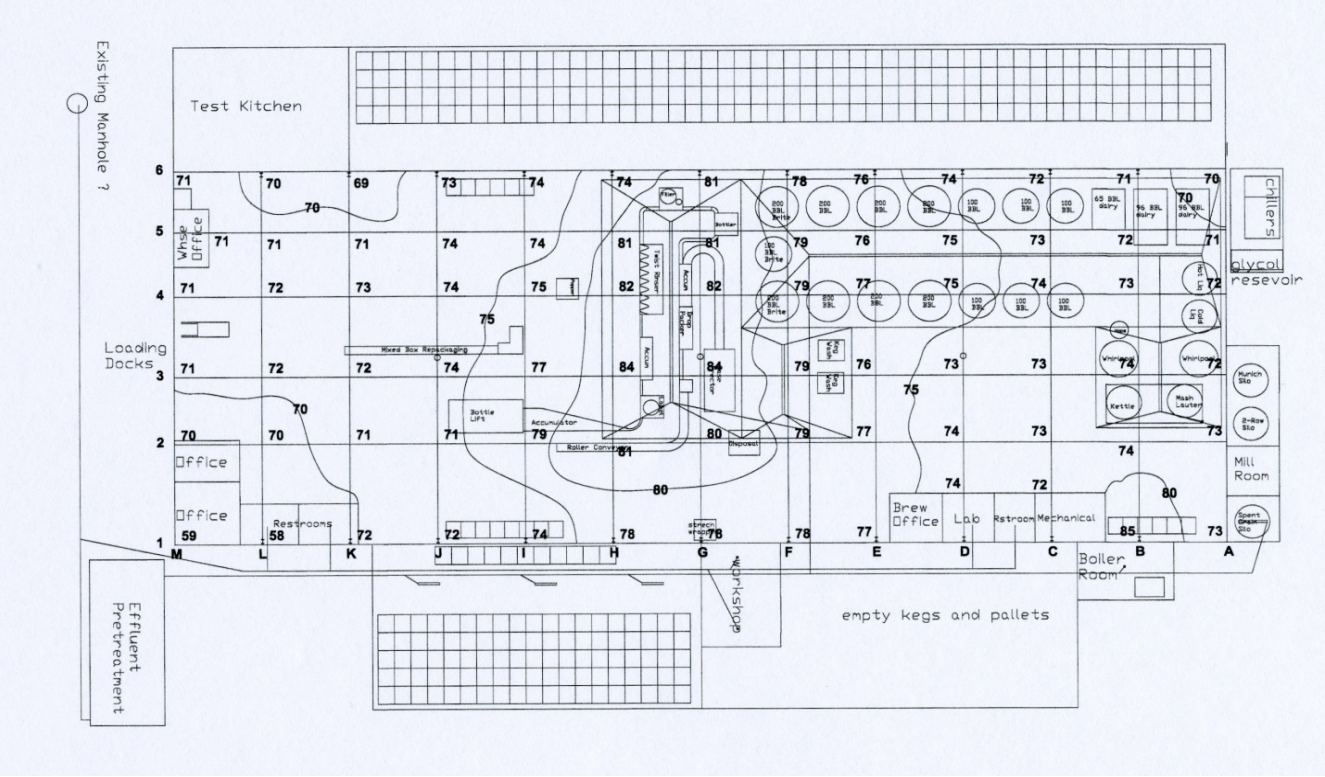

Figure 2. Noise Contour Diagram (2012)

3. Results

The mean and standard deviations for essential noise dosage data as recorded by the noise dosimeter MICRO-15 were as follows: Peak Level = 119.9 (σ = 3.27 dBA), 3dB SEL = 125.27 ($\sigma\ \delta$ = 4.78 dBA), and 3dB LEQ = 84.5 (σ = 4.22 dBA). It must be noted that a peak level of 121.5 dBA was recorded during one specific day's data collection session. A level of this magnitude is not permitted by OSHA. The point average noise level (μ) recorded by the sound level meter Type 1565-B throughout the facility was 76 dBA (σ (s-bar) = 1.864 dBA).

4. Analysis

4.1 Analysis of Point Noise Levels

The point noise level data (1716 spot measurements) was then placed into a standard deviation chart (s-bar chart) to determine if there were any irregularities in the variation for each point (Figure 3). This Generated 3-Sigma Control Chart indicates that all but 5 points' variation is within a significance level of 0.00135 (Leavenworth and Grant, 1996). The five points that are not in control are biased by a peak noise during collection data for those specific points. Thus the collected data shows homogeneity when peaks noise levels has not biased the averages. Figure 2 is the contour diagram using these point values.

4.2 Peak Levels

The peak level of Highland is a large point of concern in this particular study. The limit of 140 dBA when using hearing protection is not exceeded with a peak of 121.5 dBA. The problem it the pulse or impact limit of 140 dBA is for a fraction of a second. In the study, one peak of 119 dBA is much lower than the 140dBA limit, but the duration was 2 seconds. This duration is considered a constant noise, and not to exceed 115 dBA. Exceeding the 115 dBA limit happened on all but one day of the study. Some of the peaks could be considered pulse or impact noise while others were to long in duration either way close attention should be paid to the peak noise levels.

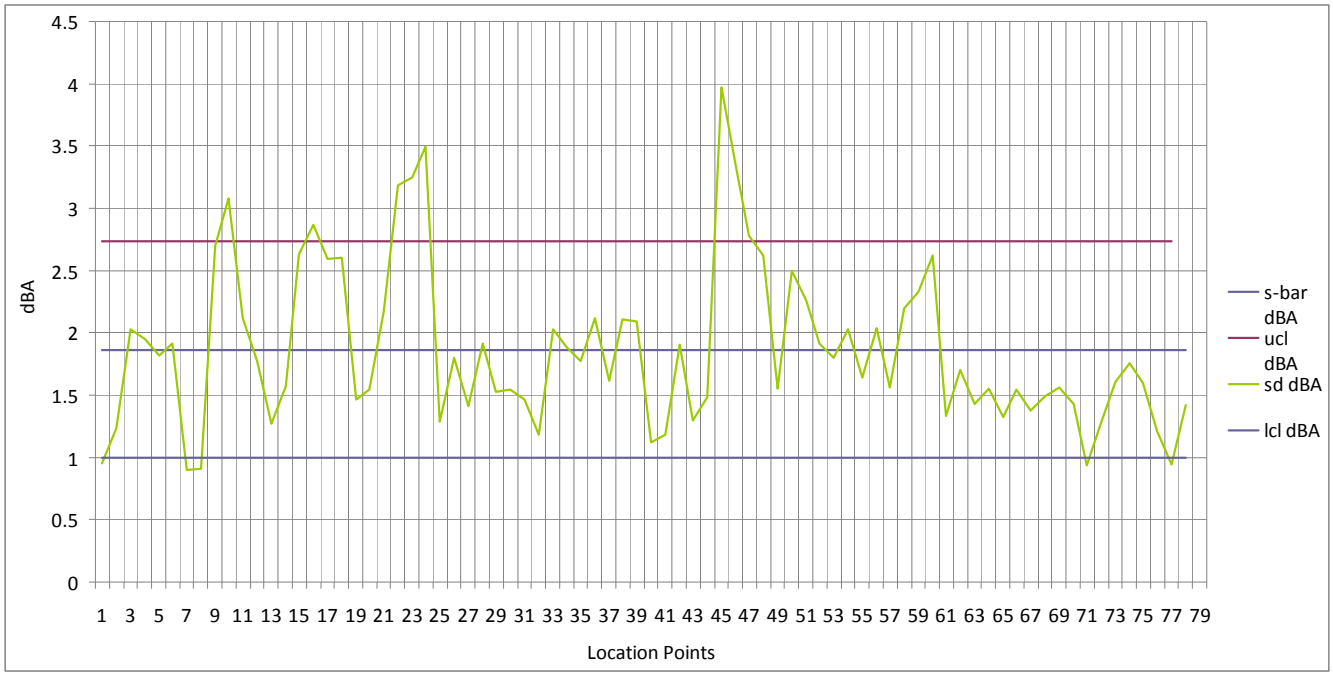

Figure 3. s-Bar 3-Sigma Control Chart

5. Discussion

The efforts of the noise abatement program are evident in the reduction of the average noise level of the facility. The peak noise level has risen however due to the increase in production. With the increase in production there are processes happening that in the past would have happened on different days to the bottling line. Things like washing the tanks, filtering the beer, more forklift traffic and running the grain mill. These activities are not extremely loud but can have peaks or short bursts of noise, like the horn on the forklift or bleeding pressure off of the fermentation vats. When fermentation vats are less than 50% there appears to be an increase in resonance, thus increasing the overall noise levels. In some cases these peaks are unavoidable, like the horn on the forklift needing to be loud for safety concerns. OSHA standards dictate the noise levels that employees can be exposed to at work. This does not account for the exposure these employees may receive outside of the workplace. In discussions with the employees of Highland 68% of the workers in the production area said they do like to listen to loud music in their car and at home. Some studies have also suggested that exposure to loud noise at work will lead to a person to turn the volume up on the radio or TV after work. To test for this, the spot meter was used to record the sound level in some employee's vehicles at Highland as they left work for lunch. The meter was placed at ear level and recorded. For two days three cars were checked, the average was 95 dBA. This is certainly loud but inconclusive to say that it is a result of their working conditions.

6. Conclusions and Recommendations

6. 1 Conclusions

After collecting noise data on several occasions a map was made of the noise levels throughout the brewery to illustrate high-risk areas. Those high-risk areas are in and around the bottling line. In the vicinity of the bottling line, the peak level recorded was 121.5 dBA and the average level recorded was 82 dBA. The first level of exposure is not acceptable for any period of time. The second, the average level, required the brewery to implement a hearing conservation program. This program was to include hearing tests on all affected employees (both baseline and annual), training on the hearing conservation program, and accurate record keeping. The brewery was successful in the implementation of the hearing conservation program and is now compliant with all OSHA regulations. Highland must continually be aware of the noise levels in the brewery and stay up to date with monitoring changes in noise levels. It is also imperative for the employees at Highland Brewing Company to continue to wear the appropriate hearing protection in order to conserve their hearing long term. Even though there are other factors that could be affecting hearing loss, such as leisure activities, their exposure to an 8-hour time weighted average of 85 dBA or more for an extended period of time could be very damaging in the long term.

6.2 Recommendations

It was determined, after collection and analysis of noise data on the days bottling occurs, that all employees must continue to be included in a hearing conservation program. Since the average noise level during bottling was recorded at 84.5 dBA with an average peak of 119.9 dBA, it is essential to require an all-encompassing hearing conservation program. An effective hearing conservation program is defined by OSHA to include: (a) an assessment of noise exposure (This consisted of taking accurate measurements throughout the building during bottling. A noise dosimeter was used to collect data from four workers during an eight-hour period. Two of the five workers were exposed to more than 85 dBA.), (b) annual audiometric tests of exposed workers, (c) maintenance of noise and hearing data records, (d) noise abatement and/or administrative controls, (e) availability of hearing protectors, and (f) employee training and education. The focus of this paper's portion of the project was the assessment of noise exposure. Since the noise level on the bottling line was relatively close to 90 dBA, it is important that Highland continue look into engineering and administrative measures to reduce noise, with a focus on the items responsible for the high level peaks. Engineering measures begin with contacting the equipment manufacturer for noise abatement suggestions. A more expensive and less practical option would be the purchase of quieter equipment or routine maintenance to reduce noise levels. The most common and practical method would be the reduction of noise level at the source. Other suggestions are to increase the size of the facility allowing sound waves to dissipate rather than be reflected back into the area of high exposure. Working to identify and correct peak noise producers, such as bleeding pressure off the fermentation vats. If that could be vented out the roof it would greatly reduce peak noise levels. Peak noise levels are some of the most difficult to reduce as often they are random one time occurrences. The dropping of a keg or something falling would be an example of this. Proper handling and storage procedures help to reduce this type of occurrence.

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