Student Arc Welding Noise Exposures in Agricultural Mechanics Laboratories

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Vocational agriculture teachers should be concerned with student exposure to noise in agricultural mechanics laboratories. "Instruction in agricultural mechanics is basic to all specialized programs in vocational agriculture" (Zurbrick, 1973). Zurbrick found that over 86% of the employees in all agricultural job titles required one or more skills in agricultural mechanics. Studies have shown that noise levels in laboratories often exceed the safety limits for noise set by Occupational Safety and Health Administration (OSHA) (1981), as documented by Bates (1983), Bear (1969), Madou-Bangurah (1978), Shell (1972). Wall and Jessee (1971), and Weston and Stewart (1980). Because vocational agriculture laboratories are noisy, students may be exposed to dangerous noise levels while performing agricultural mechanics skills.

Teachers need to be aware of the noise generated by power tools, such as a circular saw which produces 105 decibels, a wood planer, 98 to 110 decibels, and a chain saw, 110 decibels (Miller, 1986). A concrete mixer charged with coarse aggregate and water may expose students to as much as 110 decibels: a student grinding wheel with a portable grinder or a floor stand grinder may experience between 108 and 110 decibels (Miller, 1987). The OSHA (1981) allowable maximum exposure to a wood planer generating 110 decibels (or any source generating 110 decibels) is 30 minutes in 8 hours. Recently, a student grinding the plates which commonly form the surface of a welding table took 23.19 minutes to accomplish the task. During that time his maximum exposure to noise was 110.1 decibels and his cumulative exposure equalled 25% of the allowable total exposure OSHA allows for a 8 hour period (OSHA, 1981).

Daniels (1985) and Jewel1 (1977) documented reduced student performance as s result of noise. Generally, reduced performance begins around 90 dB(A) (Harris, 1979). Devices are available to protect students from exposure to noise. Weston and Adams (1935), Hartley (1974) and Miller (1986), found improved performance when subjects wore hearing protection devices (HPD's). Are these hearing protection devices necessary when students are arc welding? After an extensive review of literature, no published literature on welding noise was found save that of Miller, Montone, and Oviatt in 1980. Miller measured stick welding noise at 80-89 decibels, MIG welding noise at 85-102 decibels, and carbon arc welding noise at 102-118 decibels as measured in an industrial setting (Miller et al, 1980). Industrial settings generally have less acoustical treatment than vocational laboratories. Do the noise levels for arc welding in a typical agricultural mechanics educational laboratory enter the range where performance will be reduced or students will be exposed to dangerous levels?

Purpose

The purpose was to survey noise levels in a typicalagriculturalmechanics educational laboratory while students completed common arc welds. The investigation addressed the following questions: What was the maximum noise level students were exposed to while arc welding in the flat position? What percentage of the maximum dose recommended by OSHA did the students receive? Did the average noise level for arc welding exceed that considered to be potentially performance reducing (90 dB(A)?

Procedures

Noise was measured in a university agricultural mechanics laboratory. The laboratory was constructed in approximately 1940 and extensively remodeled in the 1970's. The construction was brick and block with concrete floors and a ten foot suspended ceiling of acoustical tiles. The welding booths were free standing 3' x 4' enclosures made of pipe and steel. The booth contained an exhaust system, a welding table with an open grate, and sand below. Booths were adjacent to a brick wall with windows beginning at four feet and extending to the acoustical tile ceiling.

Agricultural Education 100A, Agricultural Mechanics, was selected as a typical agricultural mechanics class which includes instruction of welding skills. Students in the class were beginning welders who completed a stringer bead plate, a padding plate, a butt weld, and a horizontal fillet weld in the flat position.

A Simpson model 893 Noise Dosimeter/Sound Level Meter was used to monitor the noise in one arc welding booth. The meter was connected to a Simpson Model 894 Memory Storage Unit. A Simpson Model 895 Printer Unit was used to generate a histograph of the accumulated data.

To accurately determine dosage using a sound level meter requires the total length of exposure at each dB level to be weighted and summed (accumulated).
The formula is:

$$D = \frac{C1}{T1} + \frac{C2}{T2} + \cdots \frac{Cn}{Tn}$$

Thedosimeter makes these calculations automatically based on the formula:

$$\text{Dose} = 1/8 \int_0^T 10\exp[(L - Lc)/q]dt$$

where: L = the A weighted time varying sound pressure level
T = time in hours
Lc = criterion sound level [80 dB(A)]
q = exchange rate (5/log2) (Simpson, 1984).

The reading the meter produces is a dose percentage based upon a criterion sound level of 80 dB(A) or the maximum allowed by OSHA over an eight-hour period. The dosimeter is a very accurate and functional meter (Simpson, 1984). A calibrating device was purchased with the meter to insure continued accuracy during use. The accuracy was further enhanced bv the building of a remote microphone holder which placed the microphone near the student's ear while data were collected.

Data were collected while the sixteen students completed required welds. Each student had the device in the booth for two class periods while basic welds were completed. The device was installed in the booth, not worn by the student. Data were collected while padding plates and butt welds were being completed.

Results

Data were successfully collected over a period of 14 class meetings. Table 1 summarizes the collected data by SPL maximum (Sound Pressure Level), L-8 hr (percent dose based upon the criterion level of 80 dB(A) and the OSHA formula), and time (elapsed time).

Table 1
Individual Student Noise Exposure by: Collection Date, SPL Max, L-8hr, and Elapsed Time

1987	SPL Max-dB(A)	L-8hr %OSHA/80dB(A)	et-hr
9/22	97.4	3.4	2.29
9/24	94.3	1.5	2.31
10/1	99.2	5.0	2.55
10/6	105.0	5.8	2.04
10/8	111.2	8.9	2.25
10/13	104.8	4.2	2.21
10/15	110.2	7.2	2.48
10/20	108.2	5.9	2.07
10/22	108.9	3.5	2.09
10/27	103.7	3.7	2.02
10/29	107.7	4.9	2.40
11/3	101.9	2.8	2.26
11/5	101.4	3.2	2.37
11/10	96.1	2.8	1.26
Average	103.6	4.2	2.18

Typical student data is represented in Table 1 (collected 10-22). The data show that the student was exposed to a maximum of 108.9 dB(A) while the total exposure exceeding 80 dB(A) was 3.5% for the 2.09 hours of exposure. Individual differences between students also are evident in Table 1. Students who spent less time welding registered lower percentages of the L-8hr % OSHA/80 dB(A). Differences in SPL Max are likely the result of student differences in the aggressiveness of weld chipping.

The maximum pact noise or impulsive noise level allowed by OSHA (1981) is 140 dB(A). No noise exposure recorded exceeded this OSHA standard. The percent dose based upon the criterion level of 80 dB(A) and the OSHA formula revealed only 4.24% exposure to OSHA recommended levels. In other words, welding exposed the students on average to only 4.24% of the maximum OSHA level for a twenty four hour period.

Table 2 shows the 5 minute average levels in dB(A) and is presented in the form of a histographs. According to the five-minute average, no five-minute period had an accumulated average greater than 88 dB(A) for the student represented during the hour of data collection. This level is approaching the area of concern for reduction of student performance. The computation for the five-minute averages is referred to as L-OSHA. These are accumulated averages. The true average while the actual skill is being conducted is somewhat higher, as illustrated by Table 3. To prepare Table 3, the interval between 25 and 30 minutes from the first hour was averaged by adding the five readings together and dividing by five.

Table 2
Level Greater than 80 dB(A) 5 minute averages for October 8, 1987

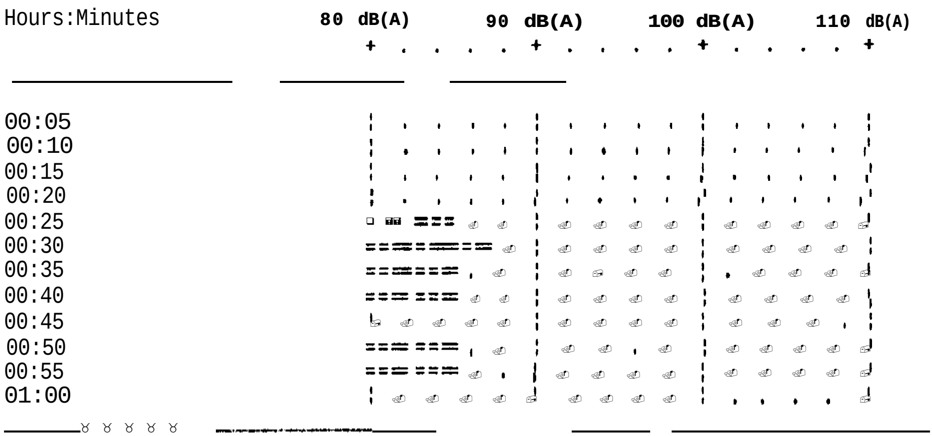

Table 3
One Minute Readings From 25 to 30 Minutes for the First Hour of Exposure from the Data in Table 2

Hours:Minutes	Maximum Level dB(A)	L-OSHA dB(A)
00:26	101.0	91.0
00:27	86.4	80.0
00:28	101.5	91.5
00:29	98.7	88.1
00:30	98.0	82.5
Average	97.1	86.6

The average maximum level taken over one-minute intervals exceeds levels potentially disruptive to student performance (Miller, 1986). The OSHA average for this interval is also close to the relative level of 90 decibels where student performance is affected (Broadbent, 1979).

Conclusions and Recommendations

The time a student spent in the arc welding booth completing required welds for AED 100A at the University Agricultural Mechanics Laboratory nosed no threat to hearing. Maximum noise measured was well below the 140 dB(A) impulse level set by OSHA. The percentage of noise exceeding 80 dB(A) computed over a eight-hour exposure was also low. It must be remembered that only noise within the booth associated with welding and chipping and the exhaust system was measured. If the student left the booth to grind or break welds, the additional exposure was not included in the overall exposure. Parallel measurements of laboratory noise taken in the center of the laboratory were even lower than those in the welding booth, but these readings were a considerable distance from the grinding and welding area. It appears the noise level students are exposed to while actually welding approaches the levels recognized in the research as reducing student performance. It may be the case that improved student performance of as much as 13% in the cognitive area and 4% in the psychomotor area could be achieved if students were protected from arc welding noise in agricultural mechanics laboratories (Miller, 1986).

Further research to measure the effect of arc welding noise on student performance is recommended due to the possibility of reduced performance. The use of hearing protection devices while arc welding solely to prevent hearing damage within the welding booth under these conditions is probably unnecessary. The reader must remember that other noise within the laboratory could impact on the second recommendation. The benefits of a hearing protection device on performance may be great enough to recommend they be worn when students are arc welding.

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