CONCENTRATION OF SMOKE AND DUST PARTICULATE IN SELECTED VOCATIONAL AGRICULTURE LABORATORIES IN MISSOURI

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Recently there has been an increased concern about the relationship between the quality of the environment and the health of American workers. This concern was responsible, in part, for the passage of the Williams-Steiger Occupational Safety and Health Act of 1970. This same general concern relates to the health of the teacher and the students who are in vocational programs. Currently, larger school facilities are being equipped with new and more sophisticated equipment which better reflects modern agricultural industry. The use of this equipment has created a potential for environmental problems in the school. Concern about the health and safety of the teacher and students led to the investigation of the level of smoke and dust in vocational agriculture laboratories.

Poorly designed or maintained facilities have been found to affect the health of students and teachers as well as to have a negative influence on student learning. Key (1976) reported that the effectiveness of a program can be influenced by poor facilities. Wall and Jessee (1971) conducted a study to evaluate occupational health hazards in agricultural education laboratories in Virginia. They indicated that air pollution levels in selected laboratories were high enough to be potentially hazardous to health. Recently, the National Institute of Occupational Safety and Health (1979) indicated that schools have both a legal and a moral responsibility to maintain a positive work environment. Schools should be concerned with the health and safety of both teachers and students.

A wealth of information is available concerning the environment and pollution in industrial settings. Much of the research has been conducted following the passage of the Williams-Steiger Occupational Safety and Health Act of 1970, commonly referred to as OSHA. The expressed purpose of the law was to assure, as far as possible, every working man and woman in the nation safe and healthful working conditions and to preserve our human resources (U. S. Department of Labor, 1976).

In a review of industry-oriented related literature, air pollution was defined as the emission into the atmosphere of a waste gas stream containing one or more contaminants such as dust, gases, vapors, mists, or fumes in concentration sufficient to be injurious to human, animal, or plant health. Smoke pollution was defined as the presence of smoke in the air which is detrimental to the health and/or welfare of man. Solids were defined as fine pulverized particles of earth or other matter

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sometimes reduced to minute portions (Silverman, 1962). Several variables were identified in the studies which were related to the effects of air pollution from smoke and dust (Hesketh, 1972; Davies, 1960; Einbrodt and Ant, 1969). There was a great deal of information available concerning the environmental quality of industrial settings and the effect on laboratory animals and human health (Lillie, 1972; Scott, 1964; Langmann, 1967). On the other hand, much less research was identified which described or recommended a course of action dealing with air contaminants, smoke, or particulate levels in vocational agriculture laboratories.

Purpose of Study

The primary purpose of the study was to provide a better information base about smoke and dust levels as a potential health hazard for students and instructors involved in vocational agriculture laboratory operations.

Specifically, the study was designed to answer the following questions:

1. What was the level of smoke pollution in the vocational agriculture laboratories?
2. What was the level of dust pollution in the vocational agriculture laboratories?
3. Did the level of smoke pollution in the vocational agriculture laboratories exceed the standards established by OSHA?
4. Did the level of dust pollution in the vocational agriculture laboratories exceed the standards established by OSHA?

Population and Design

The population involved in the study consisted of 36 schools in central Missouri offering the advanced course, agricultural construction. This agricultural mechanics course is involved in fabrication of equipment using both wood and metal. The laboratory environment resembles the fabrication and repair shops found in agricultural industry. The sample consisted of ten randomly selected high schools in central Missouri offering a course in agricultural construction. Each of the facilities in the study are modifications of Plan I or Plan II, Missouri Vocational Agriculture Facilities (1956). The laboratories contained approximately 2,400-2,800 square feet. The arc welding area was typically located along the end wall, and the radial arm saw was positioned near the center of the laboratories.

This study was descriptive in nature, detailing school facilities and equipment, temperatures inside and outside the labora-

tories, and providing data about smoke and dust levels present in each laboratory. The areas of potential health hazards were determined by comparing the threshold level values found in the study to the specified maximum standards established by OSHA regulations.

Procedures

The data for the study were collected in a 14-day period during the fall semester of 1977. The data for each school were collected during a one-day period.

Smoke and dust measurements were taken in each of the vocational agriculture laboratories. During the test, all intake and exhaust fans were operated, and two windows opposite the fan and one door on the down-wind side were opened about two inches to provide a normal air flow.

Samples to determine smoke levels were taken from three locations in the laboratories during the operation of five arc welders. The E6011 electrode was used for the test. Samples to determine dust levels were taken from three locations during the operation of the radial arm saw. The job consisted of crosscutting air-dry oak lumber. Samples to determine peak air pollution levels were taken at two locations with five arc welders and the radial arm saw in normal operation. Samples for smoke, dust, and peak air pollution were taken using the Air Hog 200 hi-volume air sampler. Standard laboratory procedures were used in determining the total particulate in each sample.

Particulate Concentration Standards

The standard for smoke and for peak air pollution was reported in terms of total particulates and was found to have a threshold value of 5 mg/m^3 (American Conference of Governmental Industrial Hygienists, 1976:44). The standard for wood dust was found to be 5 mg/m^3 (U. S. Department of Labor, 1976:510).

Findings and Conclusions

The following findings and conclusions were formulated as a result of the data collected for this study.

The threshold values for smoke in seven schools did not exceed the standard of 5 mg/m^3, as noted in Table 1. The schools that exceeded the standard were those schools which had no ventilation system, a system that did not work, or a system incorrectly positioned in the laboratory. Therefore, it was concluded that levels of smoke particulate can be controlled by proper ventilation.

Table 1

LEVELS OF SMOKE AND DUST BY SCHOOLS DURING OPERATION OF MACHINES

	Center of Laboratory				On Work Table				Opposite Side of Laboratory			
School	Smoke*		Dust		Smoke*		Dust		Smoke*		Dust	
	Grams	mg/m^3	Grams	mg/m^3	Grams	mg/m^3	Grams	mg/m^3	Grams	mg/m^3	Grams	mg/m^3
1	.0085	2.30	.0237	6.40**	.0108	3.20	.0973	22.60**	.0031	0.80	.0202	5.10**
2	.0018	0.60	.0014	0.35	.0123	4.00	.0120	3.00	.0043	1.60	.0068	2.30
3	.0192	2.70	.0014	3.40	.0293	9.20**	.0561	14.00**	.0271	8.70**	.0404	10.00**
4	.0042	1.20	.0212	5.70**	.0070	1.90	.0591	14.00**	.0043	1.10	.0143	3.60
5	.0080	2.20	.0362	10.60**	.0217	7.00**	.0398	12.80**	.0020	0.50	.0237	6.00**
6	.0049	1.30	.0344	9.30**	.0035	1.00	.0533	9.50**	.0002	0.05	.0070	1.80
7	.0085	2.30	.0332	9.00**	.0082	2.20	.0712	17.80**	.0070	1.90	.0115	3.10
8	.0028	0.80	.0208	5.60**	.0078	2.30	.0270	6.75**	.0055	1.50	.0210	5.10**
9	.0085	2.30	.0050	1.50	.0244	7.00**	.0782	19.90**	.0075	2.00	.0180	4.60
10	.0019	3.50	.0079	2.10	.0162	5.00	.0088	2.10	.0087	2.40	.0086	2.20

*Reading taken with five machines operating continuously for 30 minutes.
**Exceeds specified OSHA standards of 5 mg/m^3.

Table 2

LEVELS OF PEAK AIR POLLUTION BY SCHOOLS DURING OPERATION OF MACHINES*

	Center of Shop		Welding Area		Opposite of Welding Area	
School	Grams	mg/m^3	Grams	mg/m^3	Grams	mg/m^3
1	.0161	4.40	.0541	17.10**	.0011	0.21
2	.0017	0.43	.0172	4.60	.0047	1.40
3	.0146	3.90	.0427	12.60**	.0338	1.70
4	.0125	3.40	.0331	9.70**	.0082	2.00
5	.0163	4.40	.0021	0.50	.0013	0.31
6	.0191	5.20**	.0284	7.70**	.0036	1.00
7	.0209	6.10**	.0393	10.60**	.0009	0.21
8	.0254	7.50**	.0065	1.50	.0051	1.40
9	.0034	0.81	.0999	32.00**	.0068	1.70
10	.0083	2.10	.0125	3.40	.0081	2.00

*Reading taken with five welders and radial arm saw operating continuously for 30 minutes.
**Exceeds specified OSHA standard of 5 mg/m^3.

The findings for dust concentration, as reported in Table 1, indicated that the standard was exceeded in three schools when the samples were collected during the operation of the machines in each of three locations. The standard was exceeded in eight schools when the samples were taken on the work table. Therefore, it was concluded that a potential dust problem existed in laboratories during the operation of the radial arm saw and that the potential problem from dust was greater for the operator.

Peak air pollution samples, as reported in Table 2, exceeded the standard in three laboratories when taken in the center of the laboratory. Therefore, it was concluded that the magnitude of any potential air pollution problem is related to the location of the machines and the area occupied by the subjects. Any problem would be greater for the operators or for those working by the work table of the machines.

The findings of this study support the statement by the American Conference of Government Industrial Hygienists (1976:45) that "most welding operations with primitive ventilation, do not produce smoke that will exceed 5 mg/m^3." In this study, the three schools that exceeded the standards either had no ventilation, a system that did not work adequately, or a system incorrectly positioned in the shop.

Peak air pollution level results were highest in the metal area. The standard was also exceeded by three schools from readings taken at the center of the laboratory. Most likely, this was due to the position of the arc welders and the radial arm saw. That is, when the welders were located along the outside wall by the two opened windows, less smoke fumes were picked up by the instrument. The same situation was true in other locations for the radial arm saw.

A logical next step in programmatic research is to plan and conduct studies to determine the relative effectiveness and efficiency of ventilation systems in use in vocational agriculture facilities. In addition, cost effectiveness data should also be compiled to aid educational planners in determining the most appropriate ventilation system to install.

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