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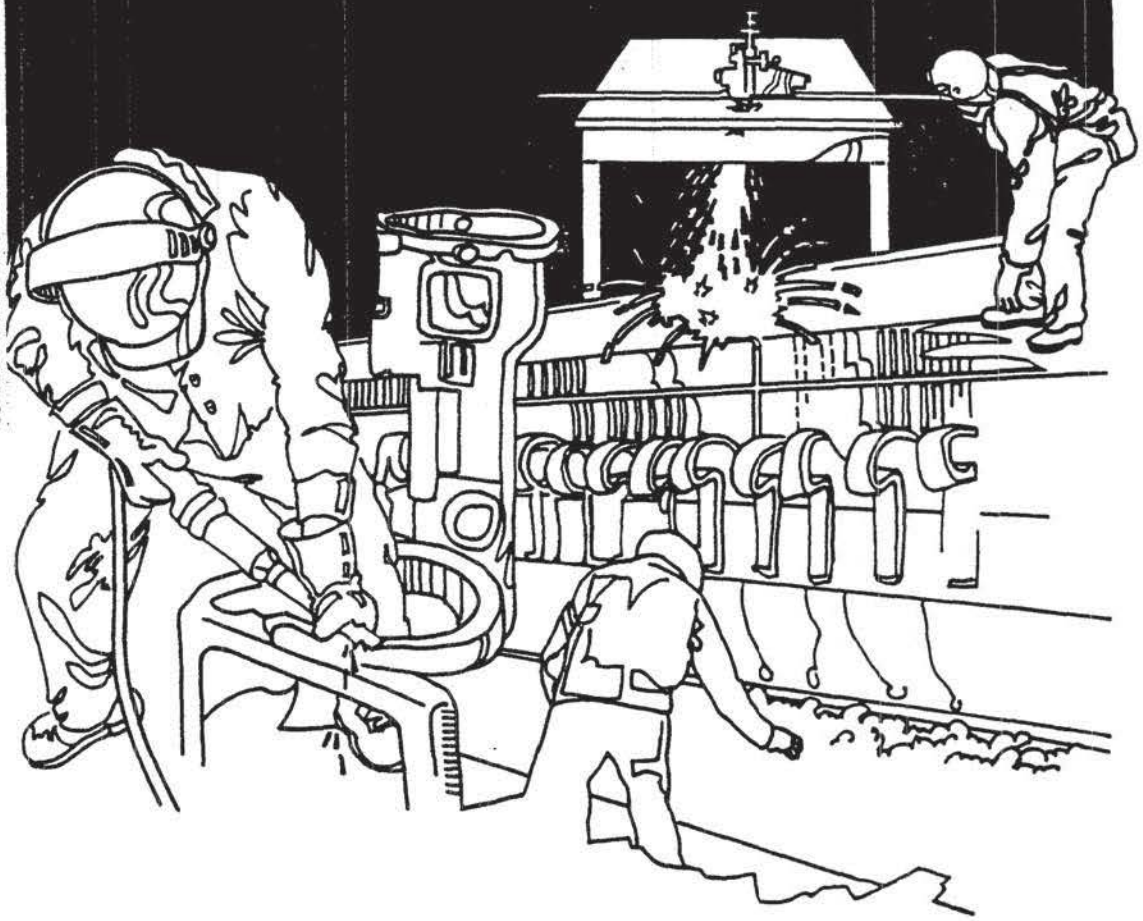
Centers for Disease Control National Institute for Occupational Safety and Health

NIOSH



Health Hazard Evaluation Report

80-213-759

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October 1980
Alabama Oxygen, Inc.
Bessemer, Alabama

NIOSH INVESTIGATOR:
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I. SUMMARY

A request was received July 24, 1980 by the National Institute for Occupational Safety and Health (NIOSH) from an authorized representitive of United Steelworkers of America (USWA) Local 4203, for a health hazard evaluation concerning noise levels at Alabama Oxygen, Inc. The facility is an air reduction process which separates oxygen, nitrogen, and argon from the ambient atmosphere. Employees are exposed during the course of their work to noise produced by two large compressor units and from various pressure relief systems.

Area and personal noise measurements were made. An octave band analysis was performed to isolate dominant frequencies. Analysis of the results of the personal noise dosimetry indicated that the present noise levels pose a hazard to the hearing of the employees at Alabama Oxygen, Inc. All but one employee was subject to sound pressure levels exceeding the NIOSH recommended 85 dBA. Personal noise exposure for the six workers evaluated ranged from 84.1 to 94.8 dBA. No area of the plant had noise levels exceeding 115 dBA.

On the basis of the data obtained in this investigation, NIOSH determined that a hazard from overexposure to noise did exist at the time of the survey.

Recommendations for the reduction of employee noise exposure and for a comprehensive hearing conservation program are incorporated into the report.

KEYWORDS: SIC 2813 (industrial gases), noise.

II. INTRODUCTION

On July 24, 1980, a request for a health hazard evaluation was received from an authorized representative of United Steelworkers of America (USWA) Local 4203, Bessemer, Alabama. The basis of the request was a concern regarding the noise levels generated by machinery at Alabama Oxygen, Inc., Bessemer, Alabama.

III. BACKGROUND

Alabama Oxygen, Inc. is an air-reduction facility which separates gases from the ambient atmosphere for industrial and medical applications. Air is filtered for particulates then reduced in volume by the compressor units. The air is refrigerated to -40^{0}F (-11^{0}C) and compressed to 540 psi. A controlled but rapid decrease in pressure to 80 psi and then 12 psi condenses the gases to a liquid. The material then enters a distillation column which separates the gases on the basis of boiling point. Final temperatures are approximately -300^{0}F (-135^{0}C).

Liquified gases can be transferred in bulk in special tank trucks. They may be dispensed into gas cylinders at 2250 psi from manifolds. Some gas receives further refinement into medical or analytical grades and are also shipped in cylinders.

The facility is a two-phase operation; production and shipping. Production is continuous. It is housed in a corrugated metal building 50'X40'X30' LWH. The operation is controlled from an enclosed room which maintains the requisite switching and sensing systems. This room is accessed by a single door. The wall facing the operation has a sheet glass window 4' X 6'. There are three shifts per day, with an operator and an assistant responsible for maintaining production. Primary duties include: monitoring the system and making necessary adjustments, inspecting the machines, making mechanical corrections, and basic maintenance. The amount of time spent in the actual compressor area varies, but can be extensive in the advent of a mechanical failure. Invariably at least one of the compressors is in service.

Employee time in service in this area ranged from 3 years to 18 years. Many of the men had worked in the older plant immediately adjacent to the present operation which was described as being much more noisy than the new facility.

Two employees complained of reduction in hearing acuity. Compressible foam insert hearing protection was available, although it was observed to be infrequently used.

Shipping area duties include the refurbishing of gas cylinders as well as filling. Old paint is shot-blasted off the cylinders. New paint is rolled on and the tanks are then pressure tested and inspected. Cylinders are filled from multi-manifold lines of the various gases. These cylinders are then safety capped and rolled to the loading docks for truck shipment. Tank reconditioning and loading involve much banging and clanging of cylinders against each other. This noise is intermittent and although distracting, was not intense. Alabama Oxygen, Inc. also purchases nitrous oxide (N_2O) and helium for redistribution but these account for only a minor percentage of activity.

IV. METHODS AND MATERIALS

Sound level measurements were made on an area and a personal basis. Personal noise exposure was evaluated with dB 301 Metrologger (Metrosonics, Inc., Rochester, New York) and Dupont Permissible Audio Dosimeter (E. I. Dupont, Wilmington, Delaware) devices. An eight hour sampling period was attempted for all personal dosimetry.

General area sampling and octave band analysis was performed with a General Radio GR 1982 Sound Level Meter with octave band filters (General Radio Corporation, Concord, Massachusetts). Octave band center frequencies through 31 and 16,000 Hertz (Hz) were examined.

The Metrosonic and General Radio equipment was dynamically calibrated prior to use. All shifts in each department were evaluated during the survey.

V. EVALUATION CRITERIA

Noise exposure can be evaluated in several manners, depending upon the circumstances. The Occupational Safety and Health Administration (OSHA) has set an acceptible noise level exposure of 90 decibels (dB) measured on the "A" scale with slow meter response as an 8-hour time weighted average exposure limit. Protection against the effects of noise is required when exposure exceeds that sound level. Additionally, Part 1910.95 states that when employees are subjected to sound levels exceeding those listed in Table G-16, feasible administrative or engineering controls shall be utilized. If such controls fail to reduce sound levels within the levels specified, personal protective equipment shall be provided and used to reduce sound levels within the requisite levels.

Variations in noise level maxima at intervals of 1 second or less are considered continuous noise. In all cases where sound levels exceed the legal values, a continuing, effective, hearing conservation program shall be administered.

Although the letter of the law is the accepted industry-wide standard, recommended levels based on current scientific research are presented by NIOSH and the American Conference of Governmental Industrial Hygienists (ACGIH). Their threshold limit values (TLV) for sound pressure level exposure are about one-half, or 5 dB less, than the OSHA standard. It is believed that nearly all workers may be repeatedly exposed at these levels without adverse effect on their ability to hear and understand normal speech. The medical profession had defined hearing impairment as an average hearing threshold level loss in excess of 25 decibels at 500, 1000, and 2000 Hz, and the limits which are given have been established to prevent a hearing loss in excess of this level. The values should be used as guides in the control of noise exposure and due to individual susceptibility, should not be regarded as fine lines between safe and dangerous levels.

NIOSH currently recommends the same exposure criteria as ACGIH. As recommendations, it should be recognized that the application of TLV for noise will not protect all workers from adverse effects of noise exposure. A hearing conservation program with audiometric testing is necessary when workers are exposed to noise at or near the TLV levels.

VI. RESULTS

Results of the sound pressure level survey and octave band analysis are displayed in Tables 1 and 2. A listing of the current NIOSH, ACGIH, and OSHA standards are presented in Table 3. The log average level of noise exposure for compressor room employees was 91.1 dBA, as measured with the Metrosonic Dosimeter. Values for the four samples ranged from 88.7 dBA to 94.8 dBA.

Compressor room noise was continuous and uniform in intensity. With both compressors operating the noise level was 103 dBA in the immediate vicinity of the machines. When one compressor was idled, the level decreased to 97 dBA. It was not determined if the refrigeration unit added appreciably to the noise level. Structural post TI 808 is directly in front of the control room, opposite the compressors. Average levels in the control room were approximately 75 dBA. The maximum recorded there reflects the door being opened.

Outside and adjacent to the plant is the condensation tower. In between this tower and the compressor building is an exhaust vent about 30 feet above the ground which discharges high-pressure air. The discharge shears the surrounding air and produces a low frequency noise of 100 dBA.

Ultimately, the liquid gases are pumped about 120 feet to a bulk-loading terminal. Pressure relief valves throughout this area produce a continuous noise level of 82-86 dBA.

Filling and shipping are well removed from the manufacturing area. The nature of the noise present here is basically from the banging of tanks against each other, with residual noise from the truck loading terminal making the remainder. The primary noise here is intermittent, while the secondary source is continuous. An employee on the dock was measured at an average exposure of 84 dBA. A worker engaged in tank refurbishing was shown to have an average exposure of 90.1 dBA.

VII. DISCUSSION AND CONCLUSIONS

In addition to the concern for preventing noise-induced hearing damage and loss, there are several salient points regarding the total health of the worker which should also be considered. Exposure to intense noise causes hearing losses which may be temporary, permanent, or a combination of the two. These impairments are reflected by elevated thresholds of audiability for discrete frequency sounds, with the increase in dB required to hear such sounds being used as a measure of the loss. Temporary hearing losses, also called auditory fatigue, represent threshold losses which are recoverable after a period of time away from the noise. Such losses may occur after only a few minutes of exposure to intense noise. With prolonged or repeated exposures (months or years) to the same noise level, there may be only partial recovery of the threshold losses, the residual loss being indicative of a developing permanent hearing impairment. Continual noise can also cause annoyance, stress, and reduced worker performance. The total worker rejoinder to occupational noise and an integrated noise control program are the primary interest of NIOSH.

With the newer solid state personal noise dosimeters, it is now possible to accurately transcribe the noise levels and frequency of exposure that a worker is exposed to during his work period. Duration of exposure at various sound pressure levels is a valuable parameter to examine in noisy situations. Table 1 gives the percentage of time spent by workers in an environment with a noise level at or exceeding 80 dBA. Although 90 dBA is the legal limit, and 85 dBA is the recommended limit, it is feasible to insist that personal hearing protection be provided and used when employee exposure exceeds 50% of his workday exposed to levels at or above 80 dBA. This will circumvent any lack of engineering controls not required by law until an 8 hour, 90 dBA time-weighted-average (TWA) is achieved.

In general, noise control at this facility is inadequate. It is interesting to note that if the Dupont dosimeters were to be used for TLV or compliance purposes in an area of continuous, non-impact noise, the values would give an inaccurate picture of the noise exposure situation. The three side by side area comparisons between the Metrosonic dosimeter and Dupont dosimeter showed the Duponts consistently lower by 2-6%. For those employees evaluated at an average of 91.1 dBA, it can be assumed that the Dupont measurement would be less than 90 dBA. An additional benefit of the Metrosonic scheme is that it is easy to determine if a sample has been intentionally placed in a noisy area.

Octave band analysis showed that the predominant frequencies in the compressor room were in the range of 500-8000 Hz (Table II). Outside, the noise from the high-pressure shear was a low frequency band at 125 Hz. With "A-weighting" applied to the octave bands 1000-8000 Hz, sound pressure levels still exceed the recommended 85dB. It is these higher frequencies which initiate the most damage to hearing.

The shipping area results from the Dupont equipment may be misleading because of the nature of the noise generated there. Sound levels recorded were due to impact noise from the banging of cylinders. The Dupont dosimeters gave values far exceeding any noise level recorded in the plant. Dupont's dosimeters are Type II devices, which means they have cumulative error in their measurements. This may be why the values are exaggerated. Metrosonic equipment is of a Type I variety, which does not manifest cumulative error.

VIII. RECOMMENDATIONS

A comprehensive noise control program should be undertaken by the management of Alabama Oxygen, Inc. at Bessemer, Alabama. Engineering, administrative, and personal noise control measures include:

1. A pre-placement requirement for those who will be or are subject to occupational exposure, or for those who will be or are employed in regulated areas:

   A. Baseline audiogram, which includes

      1) aural medical history
      2) last exposure to high level (>90 dBA) noise
      3) type of exposure
      4) noise level experienced

   B. Biennially thereafter

   Refer to Reference① for specific levels for testing and additional details.

2. Total noise exposure can be reduced by engineered modifications of the control room to lower the noise level inside. This may be accomplished by;

   A. Modification of the control room window

      Glass windows are often the weak link in an otherwise good sound barrier. Acceptible sound transmission loss can be achieved in most cases by a proper selection of glass. Mounting of the glass in the frame should be done with care to eliminate noise leaks and to reduce the glass plate vibrations. Acoustical performance of glass is often improved by a plastic inner layer in an air gap. Tables 12 and 13 of the reference give sound damping values for various schemes.

   B. Modification of the control room door

      Sound transmission loss depends on material and construction. If the steel door is hollow, sound adsorbing batts may be added. The door seal may be improved by gasket strip along the edge. If these methods do not sufficiently improve the performance, a better door design may become necessary.

   C. Sound damping material around the exterior of the control room;

      These materials include: foam, felt, glass fiber materials, mineral fiber materials, spray-on materials, composites, mastics, quilted materials, plain and mass loaded plastics, and others. The references will elucidate the particular applications best suited for the situation.

   D. Free-standing barrier in front of the control room constructed out of suitable noise absorptive material.②

3. Total noise exposure may be reduced by the administrative control of dividing the duties necessary in the control room equally between the operator and assistant operator so that the percentage of time spent in the noisy area is roughly equivalent.

4. Personal hearing protection in the form of earmuffs should be provided. Since there is frequent passage of employees between the control room and the compressor room, a sanitary and convenient form of protection is desired. Earmuffs provide good damping over the critical frequencies of 500-4000 Hz. If facial hair or glasses interfere with the efficiency of earmuffs, then compressible foam-insert hearing protection is recommended. Companies which supply earmuffs that provide damping in the low and critical frequency ranges may be had upon request.③

5. The compressors may be modified according to the suggestions in References 6, 7, and 8.

6. Periodic safety meetings which review the progress made toward noise suppression, control, and protection should be held. Included in the discussions should be an evaluation of efforts made by management and employees toward hearing conservation. Adherence to the aforementioned recommendations is expected to reduce personal noise exposure to acceptable and tolerable levels.

IX. AUTHORSHIP AND ACKNOWLEDGEMENTS

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X. REFERENCES

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TABLE I

NOISE SURVEY
ALABAMA OXYGEN, INC.
BESSEMER, ALABAMA

September 24-26, 1980

HE 80-213

Instrument*	Sample Type	Location or Job Title	Sampling Time (hr/min)	Average Sound Level (dBA)	Maximum Level (dBA)	% Sample Time @ 80 dBA & Above	Dupont Dosimeter Equivalent (dBA)	% Metrosonic Average
MD	area	in between compressors A & B, both running	3:10	102.2	103		99.9	98
SLM	area	in between compressors A & B, A running		97				
MD	area	post TI 808 in front of control room	3:05	95.3	100		91.5	96
MD	area	control room	7:55	74.8	81			
MD	area	outside plant, in front of condensation column exhaust, chest level	8:00	100.0	102		95.6	94
MD	area	truck loading terminal LOX tank #3	8:00	82.2	86			
MD	area	east side compressor A, both running	2:59	100.2	101			
MD	pers	assistant operator	7:29	88.7	107	49		
MD	pers	operator	7:31	90.4	105	64		
MD	pers	assistant operator	8:00	94.8	103	88		
MD	pers	assistant operator	8:00	90.7	103	71		
MD	pers	shipping/tank loading	7:05	84.1	102	69		
MD	pers	paint machine/operator	7:05	90.1	104	91		
DD	pers	paint machine/assistant	7:00				111.8	
DD	pers	tank testing	7:00				102.4	

* MD - Metrosonic Dosimeter
SLM - Sound Level Meter
DD - Dupont Dosimeter

TABLE II

OCTAVE BAND ANALYSIS
ALABAMA OXYGEN, INC.
BESSEMER, ALABAMA

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Location	Reference Sound Level (dBA slow)	Octave Band Center Frequency (Hz) Linear Scale, Slow Response, d									
		31	63	125	250	500	1000	2000	4K	8K	16
in between and equidistant from compressors and refrigeration unit (1 compressor running)	97	84	82-86	89-91	89	90	89	90	90	90	8
A-weighted		44.6	55.7-59.7	72.9-74.9	80 4	86.8	89	91.2	91	88.9	78.
in front of entrance to control room	93	79-81	81	84-85	86	85	85	86	87	87	8
A-weighted		39.6-41.6	54.8	67.9-68.9	77.4	81.8	85	87.2	88	85.9	74.
outside of compressor building facing air exhaust	98	75-76	75-78	94-97	89	87	85-86	82-86	83	81	7
A-weighted		35.6-36.6	48.8-51.8	77.9-80.9	80.4	83.8	85-86	83.2-87.2	84	79.9	72.
*A-frequency-weighting adjustment		-39.4	-26.2	-16.1	-8.6	-3.2	0.0	+1.2	+1.0	-1.1	-6.

*American Standard Specification for General Purpose Sound Level Meters, S1.4-1971, American National Standards Institute, 1430 Broadway, New York.

TABLE III

NOISE LEVEL STANDARDS
ALABAMA OXYGEN, INC.
BESSEMER, ALABAMA

HE 80-213

		NIOSH①/ACGIH②	OSHA③
Exposure Period (hours)	16	80	
	8	85	90
	4	90	95
	2	95	100
	1	100	105
	1/2	105	110
	1/4	110	115
	1/8	115*	

① NIOSH. Criteria for a Recommended Standard Occupational Exposure to Noise, DHEW Pub. No. 73-11001 (1972).

② Threshold Limit Value. American Conference of Governmental Industrial Hygienists (1980).

③ Occupational Safety and Health Administration 29 CFR 1910.95, Table G-16 (1978).

* No continuous exposure to exceed 115 dBA.