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Underground-Noise Interference Effects of the Personal Respirable Coal-Mine-Dust Sampler

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UNDERGROUND-NOISE INTERFERENCE EFFECTS OF THE PERSONAL RESPIRABLE COAL-MINE-DUST SAMPLER

by

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ABSTRACT

The noise interference effects of the Mine Safety Appliance (MSA) and Bendix[2] personal respirable coal mine dust samplers are investigated. The noise radiated by these devices is characterized and compared to underground warning signals and voice communication signals. The health hazard potential for hearing loss due to dust sampler noise is also examined.

INTRODUCTION

The primary purpose of this study is to determine the potential interference effects of the noise emitted by the MSA Model G and Bendix Model 3900 personal respirable coal mine dust samplers in relation to underground warning and communication signals. The first part of the investigation involves the acoustical characterization of noise radiated by the dust samplers in terms of noise level and spectral content. In the second part of the study, these data are compared to the noise levels and octave band spectra of warning signals (roof talk and emergency alarms) and voice communication signals. Finally, the health hazard potential for hearing loss due to dust sampler noise is examined.

CHARACTERIZATION OF DUST SAMPLER NOISE

Noise measurements were conducted on a collection of 25 Model G and 25 Bendix Model 3900 dust samplers. All of the units had previous in-mine usage and ranged in age from 1-2 years. Two dust samplers, the noisiest of each brand, were selected for this study. The investigation began by determining the spatial distribution of noise level (dBA) in the vicinity of 1-6 feet from the dust sampler using a sound level meter. For these measurements a semi-reverberant condition was used. The dust sampler, vibrationally isolated from the environment, was situated about 4 feet

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[2] Reference to specific brands, equipment, or trade names in this report is made to facilitate understanding and does not imply endorsement by the Mine Safety and Health Adminstration.

feet from the floor and 12 locations around it were measured. The results are shown in figure 1. From this figure it can be seen that the MSA dust sampler is noisier than the Bendix and that each of them acts as a directional noise source, emitting more noise in some directions than others. The spatially averaged dBA noise levels, as derived from the data in figure 1, are given in table 1.

TABLE 1. - Average noise level emitted by the MSA and Bendix dust samplers

Distance, feet	Bendix	MSA
1	53.0 dBA	61.3 dBA
3	49.0 dBA	52.3 dBA
6	47.0 dBA	51.0 dBA

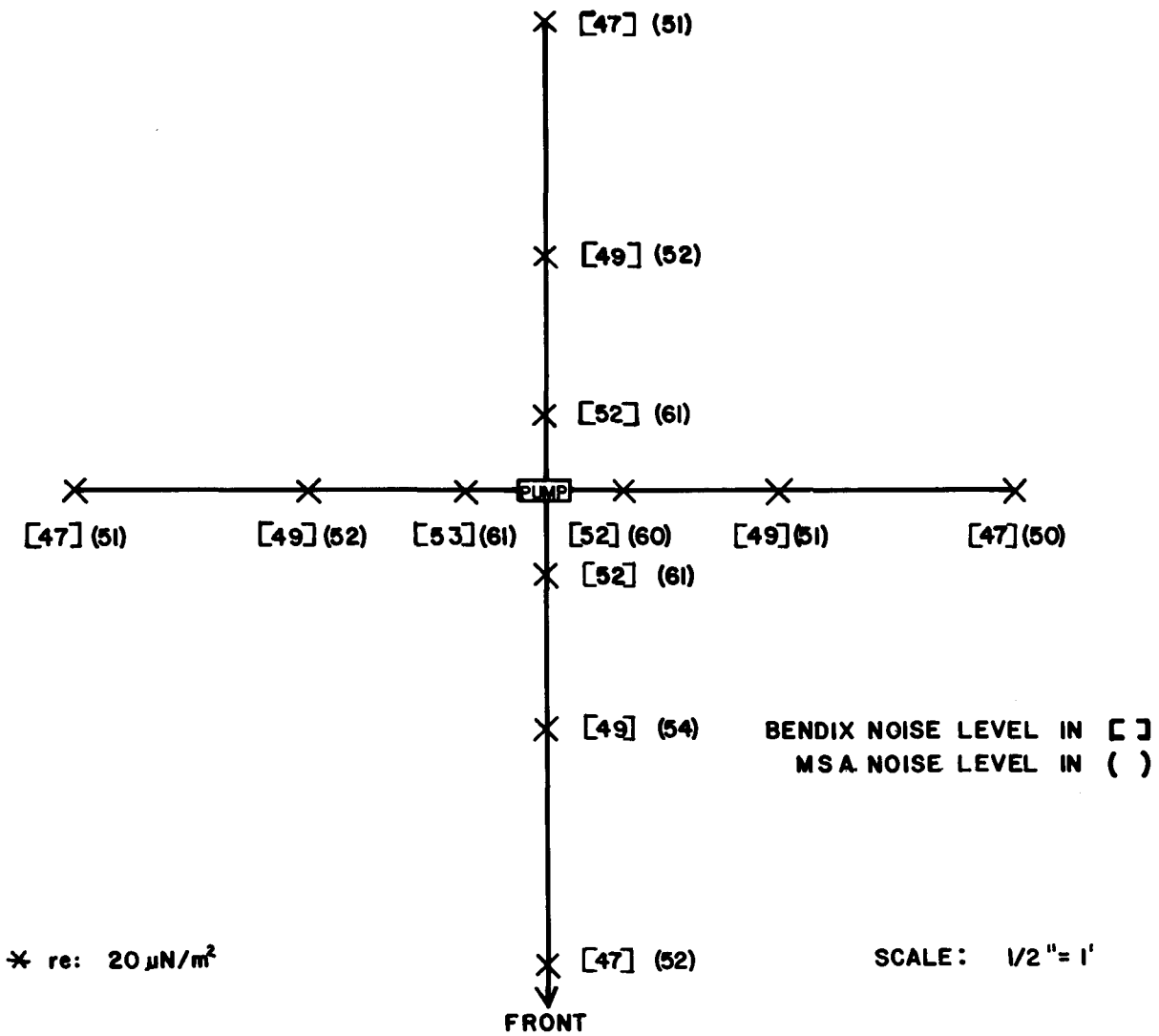

FIGURE 1. - Spatial distribution of dBA noise levels for Bendix and MSA dust samplers.

To determine the average concentration of respirable dust to which miners assigned to a working section are exposed, regulations in Title 30, Code of Federal Regulations, Part 70, Section 70.240 require personal dust samplers to be worn by those individuals or mounted within 36 inches of their normal work position. An examination of current practice shows that most dust samplers used in a working section for determining compliance are machine mounted. Since this is the prevalent configuration, an arbitrary distance of 3 feet was chosen as the typical distance between the dust sampler and the underground worker. Thus, for the purpose of this study, the space averaged noise energy,[3] as emitted by the dust sampler at a distance of 3 feet, is used for investigating possible interference effects.

Typical octave band spectra of the dust sampler noise are shown in figure 2. The major difference in the noise spectrum radiated by the devices occurs in the 250 to 2,000 Hz octave band frequency range with the MSA unit having more noise energy output in these bands.

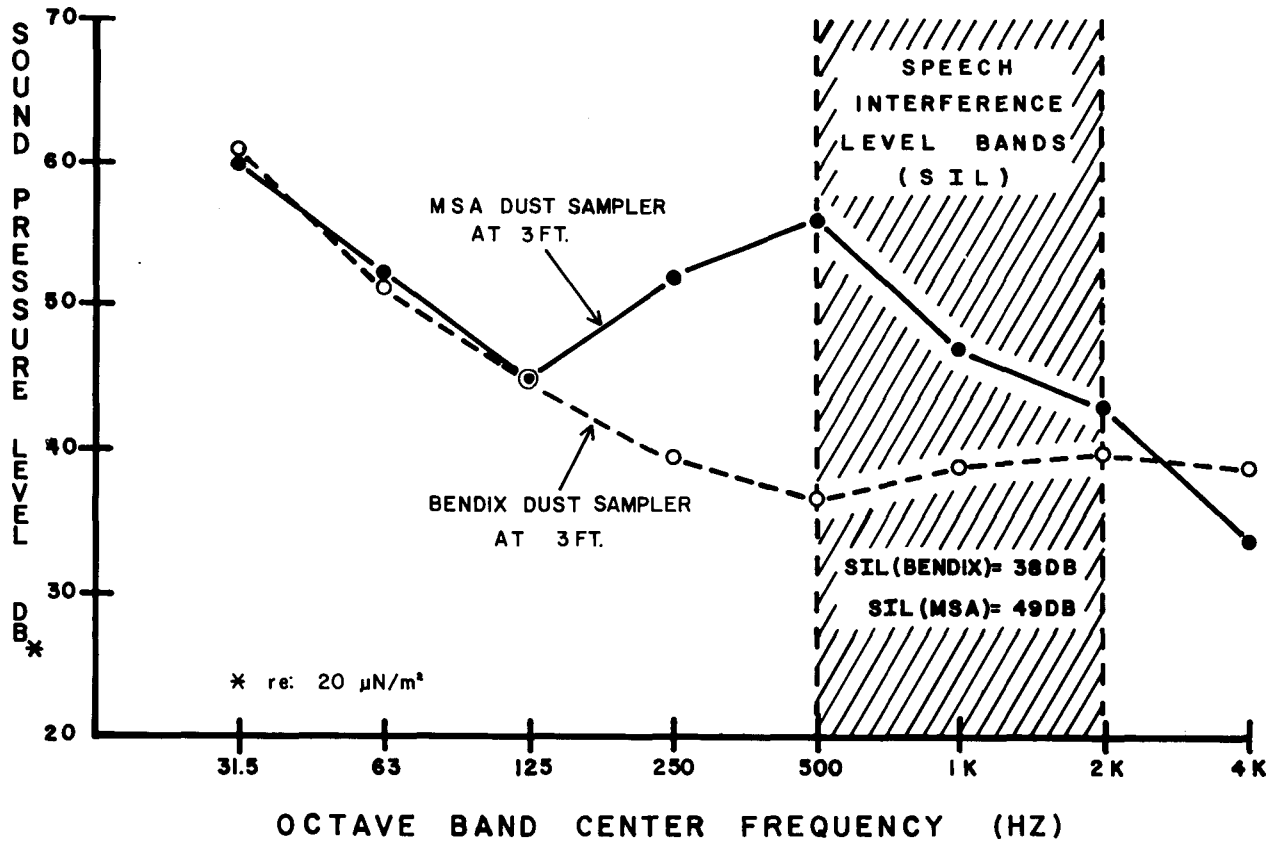

FIGURE 2. - Octave band spectra and speech interference levels of dust sampler noise.

[3] Space averaged noise energy implies an averaging process whereby the dBA levels, as measured at a fixed distance around the noise source, are arithmetically averaged.

INTERFERENCE EFFECTS

Communication Interference

Communication interference between workers vocally addressing each other in the presence of an ambient noise level has been thoroughly documented by several investigators.[4] [5] They have shown that the critical bands for speech communications are the 500, 1,000, and 2,000 Hz octave bands. As the ambient noise level increases in these bands, speech communications become more and more difficult.

Criteria for speech communication in the presence of noise is based on the Speech Interference Levels (SIL), given in dB, where the SIL is defined as the arithmetic average of the noise levels in the 500, 1,000, and 2,000 Hz octave bands. According to accepted criteria,[6] [7] the SIL should be less than the values given in table 2 in order to have reliable conversation at the distances and voice levels shown. From figure 2 it can be seen that the SIL for the MSA and Bendix dust samplers at 3 feet are:

SIL (MSA) = 49 dB
SIL (Bendix) = 38 dB

Comparing these SIL's to table 2 indicates that communication interference because of dust sampler noise, for all practical purposes, is not a problem. It also should be noted that the maximum allowable SIL for satisfactory telephone use is 65 dB. Again, dust sampler noise should not be a problem with respect to telephone use.

TABLE 2. - Permissible speech interference levels (SIL)

Description of voice level	Permissible SIL (in dB) for various distances between speakers			
	1 foot	3 feet	6 feet	12 feet
Normal.....	70	60	54	48
Raised.....	76	66	60	54
Very loud.....	82	72	66	60
Shouting.....	88	78	72	66

Interference With Roof Warning Signals

"Roof talk" is a vernacular term that describes any audible emanations from a coal mine roof. These sounds are presumed to be symptomatic of stress or cracks from stress developing in the roof. Miners use roof talk signals as warnings that a roof fall may be imminent. Because of this, they consider their ability to hear these signals as being of paramount importance.

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[4] Webster, J. C. J. Acoustical Soc. America, v. 37, No. 4, April 1965, pp. 692-699.

[5] Peterson, A. P., and E. E. Gross. Jr. Handbook of Noise Measurement. General Radio Company, 1971, pp. 558-560.

[6] Beranek, L. L. Noise and Vibration Control. McGraw-Hill Book Co., 1971, pp. 558-560.

[7] ASHRAE Guide and Data Book. Fundamentals and Equipment, 1965-66, Chapter 14.

To investigate the possible interference effects of dust sampler noise with respect to roof talk signals, the acoustic character of roof talk signals was determined. This determination was based on the data presented in a report published by J. H. Prout, et al.[8] The report detailed a study which involved the on-site recording of roof talk signals. The average roof talk spectrum shown in figure 3 was derived from this report and represents the average of 28 samples taken from four different mines. The shaded region gives the range of 95 percent of the samples used (approximately two standard deviations). A comparison of the roof talk and dust sampler spectra from figure 3 shows that interference effects of the dust sampler noise should be minimal for hearing roof talk signals.

Interference With Emergency Warning Signals

Dust sampler noise interference with emergency warning signals such as fire alarms should not be a problem. These alarm devices are designed to compete with machine noise which is 25 to 35 dBA higher than dust sampler noise. Therefore, interference effects are highly improbable. A comparison of the noise levels of various warning signals and dust sampler noise is shown in table 3.

TABLE 3. - Noise levels of various warning signals and dust samplers

Average noise level (dBA) 3 feet from dust sampler		Noise level (dBA) of various warning signals at worker's normal locations	
MSA Model G	Bendix Model 300	Emergency alarms	Roof talk signals
52.3	49.0	80-95	82.9

[8] Prout, J. H., P. L. Michael, and L. W. Saperstein. A Study of Roof Warning Signals and the Use of Personal Hearing Protection in Underground Coal Mines. Pennsylvania State University (U.S. Bureau of Mines Contract Final Report - G0133026), December 1973.

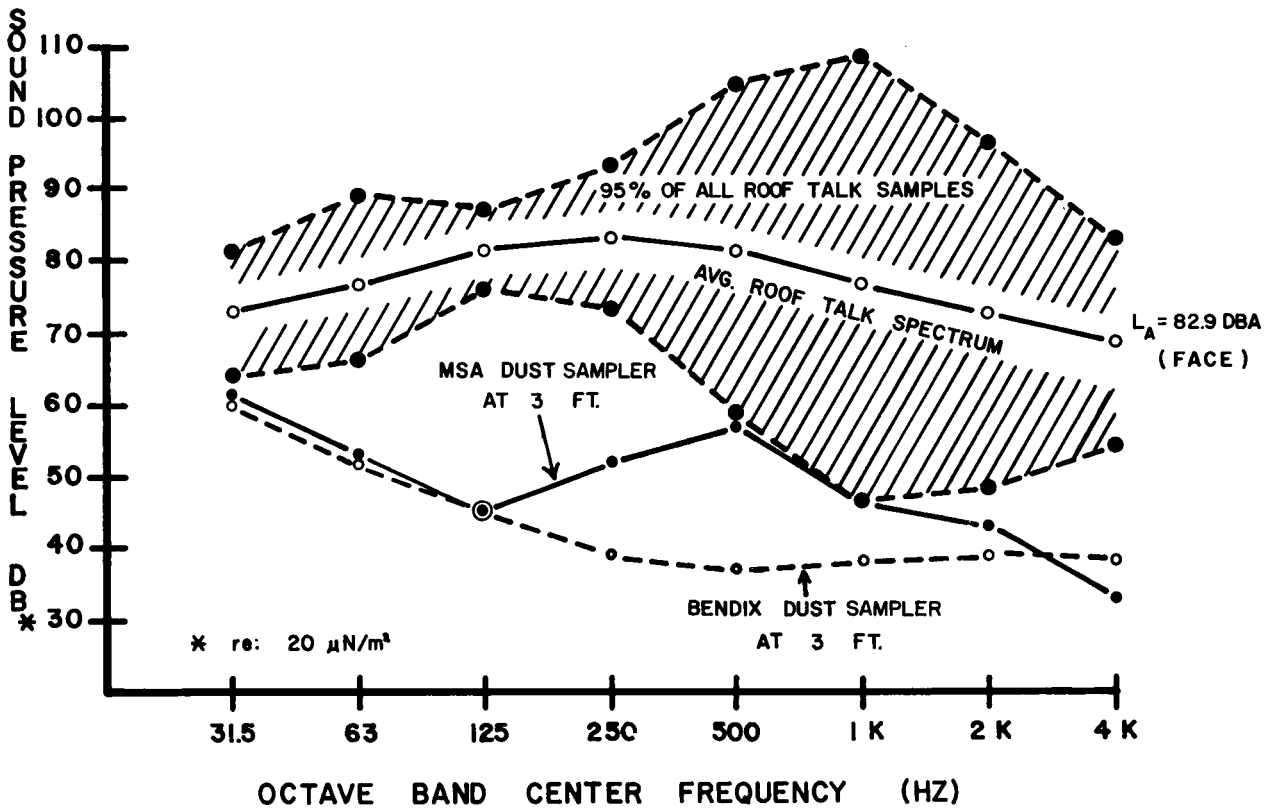

FIGURE 3. - Comparison of dust sampler noise and roof talk spectra.

HEALTH HAZARD EFFECTS

The maximum permissible noise levels in coal mines, as specified in Title 30, Code of Federal Regulations, Subchapter O, Part 70, Subpart F, are shown in table 4. The noise emissions from the MSA or Bendix dust samplers are significantly below any of the maximum permissible noise levels shown in this table. Thus, these samplers do not pose a health hazard with respect to impairing the hearing of the miner.

TABLE 4. - Permissible noise exposures

Duration per day (hours)	Noise level (dBA)
8	90
6	92
4	95
3	97
2	100
1-1/2	102
1	105
3/4	107
1/2	110
1/4 or less	115

CONCLUSIONS

From the data presented in this report, it can be concluded that the noise emissions from either the MSA Model G or the Bendix Model 3900 dust samplers:

1. Will not, for all practical purposes, significantly interfere with face to face verbal communications between individuals at the face of an underground coal mine;

2. Will not significantly interfere with telephone communications as conducted in an underground coal mine;

3. Will not significantly interfere with the miner's ability to hear "roof talk" acoustic signals;

4. Will not significantly interfere with the miner's ability to hear warning signals such as emergency alarms as used in an underground coal mine;

5. Will not be a health hazard to miners--that is, prolonged or extended exposure will not cause hearing loss.

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