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AREA NOISE MONITORING AUDITS

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There are various methods employed by industrial hygienists and others to monitor the industrial noise sphere in which a worker functions. One of the better methods, for cost of survey and accuracy of results, is the area survey and workplace noise profile[1,2] using the Type 1 sound level meter. The area-monitoring concept has been accepted by the United States Occupational Safety and Health Administration (US OSHA)[3] as one method by which the employer can estimate employee industrial noise exposure and subsequent inclusion in a hearing-conservation program. The Agency believes that personal monitoring with a dosimeter is the most accurate method of estimating employee noise exposure. A method should be initiated to audit the completeness and effectiveness of area-monitoring programs.

This paper describes audit results developed by the author. Industrial workplace noise level audits were conducted at each facility at least on an annual basis, in most cases using the B & K Model 2232 Type 1 sound level meter (SLM) with the B & K Model 2306 level recorder. The SLM surveys were conducted using the method of Hess et al.[4] Workplace positions to be audited were randomly selected from among the original total sampling positions, and 10 to 15 minutes of data were randomly taken per position. At least 20 percent of the original sampling positions were tested, and when major differences between the audit data and original data became apparent, additional sampling was done for verification. Area sampling, as defined by the author, included the workplace profile and, in many cases, was identical to personal sampling techniques employed; i.e., the sampling instrumentation was within two feet of the worker's head.

The audits fine-tuned the area-monitoring plans, confirmed the original survey, were easy to accomplish, and were cost effective. The SLMs also offered a degree of reliability not found in dosimeters. By

recording the worker's time of entrance into and exit from the noise sphere, usually through the worker's time card, TWA's and DND's were accurately estimated. US OSHA has mandated that the employee's most recent noise exposure measurement, as DND and/or 8-hour TWA, be included with the employee's audiometer test records.

MATERIALS AND METHODS

The following instrumentation was used by the author during the audits and sampling periods (Table 1). The author does not endorse any of the equipment. The instruments were calibrated and operated in accordance with the manufacturers' manuals. All of the equipment used met or exceeded the specifications mandated by US OSHA.

Table 1. Instrumentation used in the audits and sampling periods

4 GenRad Type 1954-9710 noise exposure monitors
5 DuPont Mark I dosimeters
1 GenRad Type 1954 indicator
1 B & K Type 2306 level recorder
2 B & K Type 2232 precision sound level meters
1 B & K Type 2225 sound level meter
1 GenRad omnical sound level calibrator
1 Texas Instruments Model TI-55 calculator

A confectionery production line, consisting of moulding, cooling, knock-out, wrapping, and boxing processes, was selected to conduct a study to compare noise levels as measured by the GenRad and DuPont dosimeters to the identical noise levels measured with the B & K SLMs. The dosimeters were positioned on cushioned sites with the microphones located within the two-feet zone of the worker. The SLMs were hand-held and the SLM response was recorded on the recorder or entered into the TI-55 calculator for immediate data generation. All data were recorded as daily noise dose (DND) and time-weighted average (TWA). A series of 10 one-hour runs was conducted, the time of sampling randomly selected during the eight-hour manufacturing cycle.

The data generated above were compared to data generated through previous studies by the consulting firm of Bolt Beranek & Newman, the manufacturing plant's engineering personnel, and the corporate safety engineering group.

RESULTS AND DISCUSSION

The results of the 10 one-hour studies and other studies are shown in Table 2. A review of the data suggests that the area monitoring, conducted on a typical manufacturing line, using commercially available Type 1 sound level meters and acceptable statistical methods for data evaluation, is certainly acceptable and compares favorably with the data generated either by the use of dosimeters or SLMs with tape recordings and laboratory analyses. In the application of the workplace eight-hour noise levels to the actual employee eight-hour exposure,

Table 2. Comparison of DND's and TWA's in five (5) workplaces

Position		1983 (A) DND % DOS	1983 (A) TWA dB DOS	1983 (B) DND % SLM	1983 (B) TWA dB SLM	1976 (C) BBN DND % SLM	1976 (C) BBN TWA dB SLM	1982 (D) Plant DND % SLM	1982 (D) Plant TWA dB SLM	1982 (E) Corporate DND % SLM	1982 (E) Corporate TWA dB SLM
Station 2	$\bar{x}$ (G)	92	89	74	88	66	87	100	90	100	90
	$\bar{x}$ (D)	80	88								
	σ (G)	2.91		8.67							
	σ (D)	10.52									
Station 4	$\bar{x}$ (G)			52	85	50	85	57	86	54	86
	$\bar{x}$ (D)	56	86								
	σ (G)										
	σ (D)	4.5									
Station 7	$\bar{x}$ (G)	75	88	50	85	50	85	66	87	67	87
	$\bar{x}$ (D)	55	86								
	σ (G)	9.3		5.04							
	σ (D)	8.75									
Station 12	$\bar{x}$ (G)	124	92	75	88	57	86	57	86	61	86
	$\bar{x}$ (D)	100	90								
	σ (G)	22.4		9.8							
	σ (D)	17.3									
Station 14	$\bar{x}$ (G)	114	91	67	87	57	86	66	87	67	87
	$\bar{x}$ (D)	83	89								
	σ (G)	18.0		6.58							
	σ (D)	13.7									

(G) - GenRad Model 1954-9710 dosimeter; (D) DuPont Mark I dosimeter; SLM, sound level meter
Columns "A" through "E" are data from five separate surveys of the same workplace.

(A) Mean and standard deviation for percent daily noise dose and time-weighted average of 10 one-hour randomly selected sampling periods using GenRad and DuPont audiodosimeters. March, 1983.

(B) Mean and standard deviation for percent daily noise dose and time-weighted average of 10 one-hour randomly selected sampling periods using the B & K 2232 Type 1 sound level meter, using the method of Hess et al. March, 1983.

(C) Mean time-weighted average reading obtained during a plant survey by Bolt Beranek & Newman, Inc. Tape recordings made during the plant survey were analyzed and reduced in the laboratory, using the B & K 2203 SLM, Nagra III-B tape recorder, B & K 4420 statistical distribution analyzer, and the GenRad 1921 real time analyzer. July, 1976.

(D) Mean time-weighted average reading obtained during a plant survey by plant personnel using the B & K 2232 SLM and the method of Hess et al. Jan.-Feb., 1982.

(E) Mean time-weighted average reading obtained during a plant audit by corporate group using the B & K 2232 and 2225 SLMs and the method of Hess et al. June, 1982.

the eight-hour workplace DND's [column "B" Table 2] were multiplied by .9 to compensate for the time the employees are on lunch break and relief break, where the noise levels are held below 80 dBA.

Table 3. The corrected DND's and TWA's for the employee's location.

Surveyed					Corrected	
Location	DND %				DND %	TWA dB
Position 2	74	x	.9	=	67	87
Position 4	52	x	.9	=	47	84
Position 7	50	x	.9	=	45	84
Position 12	75	x	.9	=	68	87
Position 14	67	x	.9	=	60	86

The corrected DND's and TWA's for the employees' locations were then recorded onto the employees' audiograms.

The author believes that the area noise-monitoring program, as described, has broad application in many industries as a least-cost technique. The monitoring meets or exceeds the US OSHA requirements. The method should not be used where circumstances such as high worker mobility, significant variations in sound level, or a significant component of impulse noise make area monitoring generally inappropriate. In those cases, the employer should use representative personal sampling to comply with the monitoring requirements of US OSHA.[3]

REFERENCE

[1] T. H. Rockwell, "Contour Mapping Applied to OSHA Noise Problems." Noise Control Engineering. July-August, 1976.

[2] P. W. Hess and C. R. Reed, "Instruments and Sampling." Proceedings of Inter-Noise '82, J. G. Seebold, Ed. Institute of Noise Control Engineering, Poughkeepsie, N. Y. 1982. pp. 659-662.

[3] Department of Labor. Occupational Safety and Health Administration. 29 CFR 1910. Occupational Noise Exposure; Hearing Conservation Amendment. Federal Register/Vol. 48, No. 46/Tuesday, March 8, 1983/Rules and Regulations, pp. 9738-9785. Washington, D. C.

[4] P. W. Hess, C. R. Reed, P. Jensen, C. R. Jokel, "Method for Determining Complex Operator Noise Exposures." American Industrial Hygiene Association Journal. 39, 717(1978).