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NOISE EXPOSURE OF ENGINE ROOM PERSONNEL

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INTRODUCTION

The daily noise exposure, in terms of the A-weighted equivalent continuous sound level L(EX), of engine room personnel has been determined aboard a freighter, equipped with a large-bore, slow running diesel engine (hereafter called ship A) and aboard a sea-going passenger and car-ferry aboard which medium speed diesel engines have been installed (ship B). The measurements were performed during ordinary trade voyages for several operating conditions of the ships by means of two methods. In the first method use has been made of personal sound exposure meters (dosimeters). In the second method the sound levels were measured in the engine rooms at a great number of positions and the actual exposure times of the engineers involved were measured to enable calculation.
The aim of the investigations was

1. to determine the relationship between the results of the two methods
2. to examine if simple rules can be used to predict L(EX,8).

MEASUREMENTS USING DOSIMETERS

For the measurements the GenRad type 1944 dosimeters were used which have an exchange rate of 3 dB(A) when doubling the exposure time. Before and after the measurements aboard each ship the meters were tested in the laboratory in a diffuse sound field. Aboard the ships the function of the dosimeters was checked by using the calibration provision built into the indicator of the dosimeter. Afterwards the results were tested statistically. From the latter it appeared that one dosimeter used many times aboard ship B showed a defect which was not discovered by the calibration checks. For this reason the measurements aboard ship B were repeated and those aboard ship A re-evaluated. The dosimeters were carried in the breast pockets.

SOUND LEVEL MEASUREMENTS

In the engine rooms sound levels were determined at many positions (ship A: 174, ship B: 104). The positions were chosen at places at which engineers spent a large part of their time and at places along the routes which have to be taken when the watch keeping engineer makes his inspection round through the engine room. The floor and platform decks were divided into rectangular sections with dimensions of 1.5 x 1.5 m^2. The measuring positions were chosen at 1.65 m perpendicular above the centre of these sections.

CALCULATION OF L(Aeq)

From the dosimeter readings $L(Aeq,T_m)$ were obtained (table 1).
During the inspection rounds aboard ship B the observer following the engineer was also wearing a dosimeter. The L(Aeq) experienced by an engineer appeared to be 0.6 up to 1.1 dB(A) higher than measured by the dosimeter of the observer. The observer followed a path through the positions where the sound levels were measured, the engineers took slightly different paths while doing their job. From table 2 it appears that the agreement between both types of observations is largely increased when 1 dB is added to $L(Aeq,T_m)$ obtained by the observer. After correction of the data of lines 3 and 4 of table 1 with 1 dB the agreement between the measured $L(Aeq,T_m)$ by using dosimeters and the calculated ones using either L_A at every 1.5 x 1.5 m^2 or $L_{\overline{A}}$ per deck or compartment appeared to be satisfactory (table 2, lines 3 and 4). The far more laboursome calculation using the routes of the engineers during the rounds (about 10^4 readings per ship) do not give a significant improvement in accuracy with respect to the method using space averaged levels $L_{\overline{A}}$.

CALCULATED VERSUS MEASURED L(EX,8)

The daily noise exposure levels L(EX,8) for each type of watch are given in table 3. For the inspection rounds agreement exists between the calculated and measured levels even if the calculation is simplified by using $L(EX,8) = L(Aeq,T) - 27 + 10\ lg(T/T_o)$
L(Aeq,T) being obtained from table 1, T_o = 1 min.
For the other types of watches this equation appears to give good results when L(Aeq) is obtained considering all working areas or all engine rooms (ship B), including pump rooms, separator rooms, workshops etc. It is interesting to observe that L(EX,8) of the inspection watch at ship B is higher than the level during maintenance work.
The levels measured for the inspection watches are much higher than might be expected from the exposure during the rounds. Work outside the control room apart from the rounds through the engine rooms causes these levels.

During harbour conditions L(EX,8) aboard ship B is 3 dB(A) lower than aboard ship A though L(Aeq) is 2 dB(A) higher. It is probable that the separate engine rooms aboard ship B cause this favourable difference.

Table 1. Average values of measured and calculated $L(Aeq,T_m)$ for inspection rounds at both ships (T_m = measuring period); the standard deviations are placed within brackets.

ship	A	B (4 main engines)	B (2 main engines)
number of rounds	18	26	9
obtained by integration by means of:			
1. dosimeters carried by engineers	100.3 (1.4)	105.2 (1.1)	103.2 (1.6)
2. dosimeters carried by observer	-	104.6 (1.1)	102.1 (2.1)
3. calculation using L_A at every 1.5 x 1.5 m^2	99.0 (1.1)	104.3 (1.0)	101.5 (2.5)
4. calculation using $\overline{L_A}$ per deck or per compartment	98.9 (0.4)	103.8 (1.2)	100.8 (2.1)

Table 2. Cumulative percentages of differences between observations

	number of inspection rounds	differences less than 1	2	3	4	dB(A)
1. Ship B: differences between measured $L(Aeq, T_m)$ for engineers versus for accompanying observer						
- 4 main engines in operation:	24	54	96	100	-	%
- 2 main engines in operation:	9	44	78	100	-	%
2. as 1 but 1 dB added to L(Aeq) of observer						
- 4 main engines in operation:	24	75	92	100	-	%
- 2 main engines in operation:	9	67	100	-	-	%
3. measured versus calculated L(Aeq) using routes of engineers, the latter + 1 dB						
- ship A	18	72	89	100	-	%
- ship B	54	65	82	94	98	%
4. measured versus calculated L(Aeq) using space average levels, the latter + 1 dB						
- ship A	18	72	89	100	-	%
- ship B	54	63	82	91	98	%

Table 3. L(EX,8) for the several types of watches

type of watch	averaged value of exposure time (min.)	calculated using routes	calculated using spaces	measured by dosimeters
Ship A				
1. inspection rounds	42	88	88	88
2. inspection watch (including rounds)	212	--	--	95
3. maintenance watch, sailing	211	--	95	95
4. maintenance watch, in harbour	228	--	92	92
Ship B				
1. inspection rounds	41	94	94	94
2. rounds by observer	42	93	93	94
3. inspection watch (including rounds)	279	--	--	98
4. maintenance watch, sailing	248	--	98	96
5. maintenance watch, in harbour	158	--	89	89

The noise exposure of the engineers probably depends only slightly on the types of watches. However aboard ship B much more time is spent in harbour than aboard ship A. This influences the average value of L(Aeq,8) per watch which was aboard ship B 92 dB(A); calculation using data of table 3 gives 93 dB(A).

CONCLUSIONS

1. From measurements aboard two ships it appeared that L(EX) per watch may be obtained either by using dosimeters or by static measurements; the methods appeared to give equal results.
2. The average value of the daily noise exposure level aboard may be predicted by using measured (or predicted) L(Aeq) per engine room compartment, the exposure time and the workshift schedules.

ACKNOWLEDGEMENT

The author expresses gratitude to the ship owners and crews, to the Gemeenschappelijk Administratie Kantoor and her observers who carried out the noise dose surveys and to the former Netherlands Maritime Institute and the Stichting Coördinatie Maritiem Onderzoek for their financial support.