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SEVERAL SPECIFIC AND NONSPECIFIC RESPONSES OF THE  
HUMAN AND ANIMAL BODY TO SHIP NOISE

S.S. Markaryan, A.A. Volkov and A.B. Sysoyev

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ABS: The effect of noise on cargo boats on a long voyage differs considerably from the effect of noise in factories and in service industries. The peculiarities of the effect of round-the-clock noises at sea at 55 to 85 decibels, typical for cargo boats, were studied in white rats in the laboratory and aboard ship (each of the experiments lasted three months) and in young naval cadets and experienced seamen on voyages lasting one.

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SEVERAL SPECIFIC AND NONSPECIFIC RESPONSES OF THE  
HUMAN AND ANIMAL BODY TO SHIP NOISE

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The many-month around-the-clock effect of ship noise and vibration with a wide range of levels hygienically are important features of ship noise, while traveling, affecting the human organism. The works of Ye. Ts. Andreyeva-Galinina and coauthors (1972), V. Ye. Ostapkovich (1982), G.A. Suvorov and coauthors (1981), I.L. Karagodina (1979) and others has convincingly shown that noise which has a general biological effect results in a change not only in the hearing organ but also in other organs and systems of the organism. It has also been established that noise with a level lower than 80 db does not cause organic breakdowns in the auditory analyzer for a working shift of operators of computers but is apparent in functional disorders of the nervous and cardiovascular system (L.M. Marmysheva, 1979). However, a long-term noise effect at a level of 60--65 to 85 db and higher was accompanied by changes in practically all systems of the human organism and at all functional levels (S.A. Soldatkina, 1973; I.L. Karagodina and V.A. Tokarev, 1976). Specific changes are apparent only in the area where the noise stimulus is applied, that is, in the auditory analyzer which shows itself in the increase in auditory thresholds (V. Ye. Ostapkovich, 1982, et al.). As to the reactions of nonauditory systems, the effect of noise can be accompanied by a change in arterial pressure, the rate of sensomotor reactions, etc. An analysis of the bibliographical data indicates that depending on the selected indices (psychometric, physiological, biochemical, auditory or nonauditory) the changes in the organism are detected with noise at a level of 35 db and higher. For

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\*Numbers in the margin indicate pagination in the foreign text.

instance, sleep is the most sensitive to the effect of noise; its breakdown occurs with a noise level of 35 db (A.P. Shitskova, 1981).

Our task was to study the acoustic circumstances on maritime cargo ships, a determination of the range of levels of noise affecting sailors at sea, the study of the effect of noise with these levels on the organism and determination of the noise level whose effect in ship conditions, with a definite probability, would not cause change in the human organism.

The research made it possible to establish that a proven interval of average levels of noise in the rooms of maritime cargo ships is from 52 to 107 db. The average equivalent levels of noise to which the sailors were subjected while in the maritime service varies from 55 to 70 db and for personnel in the machine compartment it is from 85 to 100 db.

In laboratory conditions, two series of experiments were conducted on white male rats to study the biological reactions to a round-the-clock effects for a period of 3 months of broadband noise with a level of 85 and 55 db. Over a period of 3 months at sea the effect of ship noise was studied on the animals in two series of experiments with equivalent levels of 86 and 56 db. The animals were studied for excitability of the central nervous system, the biochemical index characterized in the reaction of metabolism of amino acids, lipids and carbohydrates in the internal organs (heart, testicles, brain, liver), blood serum, the functional state of the spermatozoids and the resistance of the animals to acute hypoxia. Besides laboratory studies, noise with an equivalent level of 84 and 64 db was studied on a contingent of young naval cadets for a period of 3 months at sea taking into consideration the vibration effect during relaxation in the living quarters. Also the watch and cruise shifts in the indices for sailors who had served 3-5 years were studied; they were receiving an equivalent of 89 or 60 db of ship noise while sailing. A method of subjective evaluation of noise was used, the rate of

free association was determined for word-stimuli of various thought groups and the speed of motor reactions to light and sound; pulse and tonometry, tonal audiometry and certain subthreshold tests (differential in the strength of the threshold for sound, time of the auditory post stimulus adaptation and the threshold of intelligibility of speech) were all carried out; 8 biochemical indices in the blood serum were determined: the content of total protein, cholesterol, glucose, the activity of lactate dehydrogenase alkaline phosphatase, creatinphosphokinase, alanine and asparagine transaminase. Data obtained in the first days of sailing were used for the background indices.

The results of laboratory research made it possible to establish that prolonged around-the-clock effect of intense (85 db) or average (55 db) noise causes a set of reactions in the animal /10 organism which are characterized both by an increase and by a decrease in physiological and biochemical indices. This was apparent in the phase changes in excitability of the central nervous system, acceleration in the reactions of total paths of catabolism using products of decay of fatty acids and amino acids, a decrease in level of aerobic and an increase in anaerobic oxidation of pyrogacemic acid, the change in content of basic biochemical substrata in the blood serum and internal organs. Worsening of the functional state of spermatozoids was established in the animals and at the end of the experiment--a decrease in resistance to acute hypoxia. Manifestation of the indicated set of changes in the organism of the experimental animals depended on the intensity of the noise effect and was evaluated according to the quantity of proven changes in the indices studied for the entire research period.

While sailing for 3 months, the around-the-clock effect of ship noise with equivalent noises of 86 or 56 db caused, in the organism of the animals, twice as large a quantity of proven changes in comparison with the equivalent noise effect in the laboratory conditions. This circumstance was related to the

additional effect of the low-frequency component of ship noise and vibration.

The conduct of experimental research on animals made it possible to establish that the closest connection to the intensity of long-term noise effect in a range of levels 55--85 db was the quantity of proven changes in the research indices whereas an unambiguous relationship was not noted for the value of the shifts. The results obtained in the experiments were the basis for utilization of this index when evaluating the effect of ship noise on the human organism in sailing conditions.

It was established in the study on the ship that the effect of noise with equivalent level 84 db causes in young naval cadets after 1½--3 months of sailing, an increase in levels of tonal hearing by 2--12 db (Figure 1), an increase in differential thresholds of hearing, a change in the rate of free associations and biochemical indices of the blood serum. The effect of ship noise in these same conditions with the equivalent level 64 db was accompanied by an increase in the auditory thresholds only in the low-frequency range of the tonal scale below 1000 Hz at 3--10 db and also nonspecific indices showed marked changes to the least degree.

The effect, during relaxation in the living areas, of the vibration whose level exceeded the allowable health standard in the 8 Hz band by 7--1 db of acceleration caused in the personnel, with other conditions being equal, more pronounced changes both in the auditory thresholds (see Figure 1) and in the nonspecific indices.

Examination of apprentice sailors at sea showed that the long-term effect of ship noise for a period of 3--5 years with a range of equivalent levels from 60 to 89 db causes an increase in the auditory thresholds (Figure 2) and a change in nonspecific indices (rate of associate reactions, subthreshold

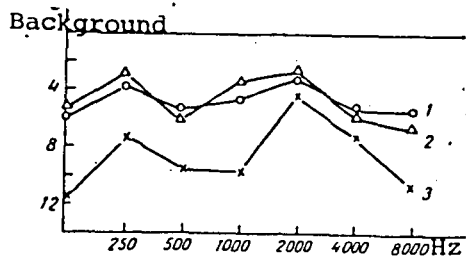


Figure 1. Average thresholds of auditory sensitivity of young naval cadets subjected for 1½ and 3 months to the effect of ship noise with the equivalent level 84 db (in comparison with background values).

1--duration of sailing 1½ months, vibration in the living areas does not exceed allowable levels;  
 2--duration of sailing 3 months, vibration in the living areas does not exceed the allowable levels;  
 3--duration of sailing 1½ months, vibration in the living areas exceeds the allowable in the octave band 8 Hz by 7--11 db of acceleration in 3 mutually perpendicular directions. Here and in Figure 2 along the axis of the abscissa is the frequency of sound (in Hz), on the ordinate axis--a decrease in hearing (in db).

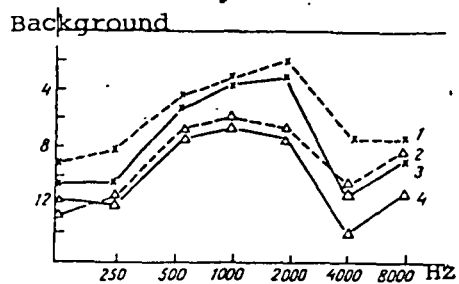


Figure 2. Average thresholds of auditory sensitivity of sailors (service 3--5 years), subjected to 3 months of sailing to ship noise with an equivalent level of 89 db (in comparison with background values).

1--auditory thresholds before duty at the beginning of the voyage;  
 2--auditory thresholds after duty at the beginning of the voyage;  
 3--auditory thresholds before duty at the end of the voyage;  
 4--auditory thresholds after duty at the end of the voyage. The level of noise operative during duty was 94 db.

auditory sensitivity, functional state of the central nervous and cardiovascular systems) which are retained after rest on shore between cruises. The study of logbook changes in the apprentice sailors made it possible to establish that an increase in the levels of hearing occurred only with the effect of noise at a level of



94 db whereas noise at a level of 64 db during a watch did not cause changes in tonal hearing but was accompanied by shifts in the nonspecific indices.

In this way, on the basis of the study made it was established that the noise level which guarantees an absence of change in the human organism in sailing conditions does not exceed 40 db. This makes it possible to recommend it as a hygienic standard in the living areas of the maritime cargo ships.

The results of the set of studies were used for developing health standards for noise on maritime ships.

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