

reactions to noise, because it is known that the accumulative effects of prolonged exposure are physiologically dangerous, through loss of sensitivity to tones, through deterioration of the hearing function of the inner ear, and eventually through permanent audiometric damage. Psychological factors are also involved.

Certainly, noise serves to distract and reduce the effectiveness of a worker and decrease his output. Intermittent noise is the most obnoxious, particularly during any period of adjustment to a new task or in new surroundings. Evidence indicates that, if a worker remains in a noisy situation which distracts him initially, he may eventually adapt to it, and regain his original loss of output. While this may be so, the fact is often wrongly interpreted to mean that, in the long run, continued exposure to noise does not have any adverse effects. Such a generalization is definitely unjustified.

Some investigators have found that the effect of noise on work output depends upon the nature of the work; a long term job requiring constant vigilance is especially susceptible. The effect of noise is more likely to be a higher rate of errors and accidents rather than an actual reduction in total output. The attention of the worker wanders from the job in hand more often as the noise level increases. Further, noise is more likely to lead to increased errors and accidents if its value exceeds 90 db., and high frequency audible noise is more harmful in this respect than low frequency noise.

Noise and its effects have given rise to much controversy in industry. How dangerous can it be? Has it a deleterious effect upon worker performance? Does it effect certain types of work more than others? Has it a detrimental effect upon worker adjustment?

The intensity noise level is probably the most important single factor in determining the severity of exposure, but the duration of exposure is also important. The threshold level of noise that the ear can withstand for some time without audiometric damage is of the order of 90 db. Since the average pneumatic percussive rock drill produces some 120-130 db., the problem is not one to be brushed aside lightly.

The underground mining environment has become progressively so noisy that speech communication in a confined area is difficult if not impossible and, for this reason, speech

interference levels are evaluations of importance. The consonants contain most of the informative values in speech but unfortunately they are more readily masked than vowels because the consonant sounds are weaker. Noise may therefore mask certain speech sounds and not others. The energy of the various speech sounds is distributed over the frequency range of below 100 to above 10,000 c.p.s. The "s" in speech has an energy range of from 4,000-8,000 c.p.s.; in contrast, most of the "ee" in speech is distributed below 4000 c.p.s. Such variations in sound frequencies account for failure of speech communication in noisy environments.

Insofar as industrial noise is generally unpleasant, it may be assumed that its correction will lead to better worker morale for the same reason that any consideration for the welfare of employees tends to produce a favorable reaction. Intermittent, high pitch, and high intensity noises are the most disturbing so far as emotional reactions are concerned. Some individuals are hypersensitive to noise and cannot make effective adjustment.

Ear defenders will invariably serve a useful purpose, but it is difficult always to "sell" the principle. Personalized ear plugs, cast for individual ears, are probably more readily acceptable. The use of mufflers and machine enclosures have proved partially effective in reducing noise levels in practice, but the noise surrounding even the muffled rock drill is still dangerously high. The greatest advantage in relation to rock drill noise abatement will probably be made through improved design of the equipment and the application of human factors engineering.

In every mine, some staff member should be responsible for the noise hazard. He should be equipped with noise and peak level meters, an octave band analyzer, and other standard equipment and he should be trained in their use and in interpreting their data. Periodical noise surveys should be carried out and steps taken to mitigate this nuisance to personnel, impediment to production and menace to health. In many cases, simple remedial steps are effective; others present topics for research. Of particular interest, and something we know little about, is the influence of reverberation upon noise levels from machines and at the operator's ear; this is of importance in development ends, rises and other headings.