Some general reactions to Kryter's paper "Impairment to hearing from exposure to noise"

Alexander Cohen

Some general reactions to Kryter's paper "Impairment to hearing from exposure to noise"

Alexander Cohen

National Institute for Occupational Safety and Health, Cincinnati, Ohio 45202

(Received 26 July 1972)

Reactions offered here (a) urge rethinking on the adequacy of a widely used criterion for defining hearing handicap in view of data referenced in the subject report, (b) criticize the author's evaluations basic to estimating hearing loss risk from known levels of noise exposure and recommending safe limits for hearing, and (c) question the use of proposed complex schemes for rating noise hazards to hearing as derived from presumed relationships between temporary and permanent noise-induced threshold shifts in hearing.

Subject Classification: 7.2; 4.4, 4.4.5.

The subject paper by K. D. Kryter is an important document which deserves special attention by those concerned with aspects of noise control and hearing conservation. Using updated evaluations and extrapolations from assorted data in acoustic literature, the author calls into question and offers major revisions to a number of concepts and practices basic to setting noise limits for hearing protection. For example, Dr. Kryter (a) proposes a stricter criterion for defining hearing impairment than is currently used, (b) suggests far greater hearing loss risk in populations exposed to known levels of noise than have been previously estimated, and, in this regard, (c) drafts a set of noise limits for hearing conservation which are much more stringent than those in use or under consideration at the present time. This reviewer's remarks are intended to highlight and provide some general reactions to Dr. Kryter's views on these matters. These reactions may set the stage for other, more specific comments likely to be contained in the statements of other reviewers.

Key to the formulation of noise limits for safeguarding hearing are specifications as to how much of one's hearing is to be protected and the percentage of persons in the exposed population that are to receive such protection. Dr. Kryter agrees with others in this field that preservation of the ability to understand speech should be the major protection goal. Particular issue is taken, however, with the operational definition of this ability as stated by the American Academy of Ophthalmology and Otolaryngology (AAOO). According to AAOO, a hearing handicap for speech reception begins when the average of hearing levels for pure tones of 500, 1000, 2000 Hz exceeds 25 dB (*re* ISO audiometric 0). Further, the degree of hearing impairment, expressed as a percentage, is to be calculated by adding $1\frac{1}{2}\%$ for each decibel that the three frequency average exceeds the 25-dB "fence." Dr. Kryter references data showing losses in speech reception for individual words and sentence materials in listener groups that are far more serious than AAOO ratings of their pure-tone hearing levels would suggest in terms of a hearing handicap. The consequences of impaired hearing in everyday life, as studied through critical listener incidents and social surveys, also indicate greater difficulty than estimated by the AAOO ratings for hearing handicap in the subject groups under test. As such, the author proposes a more stringent criterion for defining hearing handicap for everyday speech, specifying a lower starting point (15-dB average hearing level for 500, 1000, and 2000 Hz) and a sharper growth rate for depicting the severity of the handicap relative to the AAOO scheme.

Supporters of the AAOO guidelines may criticize this reformulation of Dr. Kryter, believing it goes beyond the minimum hearing requirements for understanding familiar speech in quiet which was their premise. On the other hand, it behooves the same AAOO supporters to reevaluate the adequacy of their rating scheme, especially in light of current information.

Dr. Kryter argues that calculations of hearing loss risk from industrial noise exposure are underestimating the hazard due to elevated baseline data taken to represent the incidence of hearing impairment in non-noise-exposed persons. Attempts to remedy this situation, however, suggest errors of overestimation on the part of the author. For example, he elects to use the *better ear data* from the National Health Survey as the baseline values for determinations of risk of hearing loss. These determinations, however, are derived through comparisons with the *right ear hearing data* of persons exposed to high levels of workplace noise. Though mention is made that hearing levels for right ears tend to be better than left ears in industrial surveys, the fact remains that better ear data for worker groups will show more sensitive hearing than either their right or left ears. Thus, the sets of data used by Dr. Kryter in making revised risk calculations are not strictly comparable. Indeed, they can yield inflated values (by an amount equal to the differences in incidence of hearing impairment between the better ears and right ears of the noise-exposed workers).

Also to be noted in this context is the 55-dBA noise limit[1] which the author proposes as providing sufficient hearing protection for effective eight-hour-per-day exposures. Dr. Kryter arrives at this value through extrapolation from survey results which relate 78-dBA and higher-level noise exposures at work to hearing changes in the worker groups. It is important to realize that these referenced hearing data were taken from audiometric tests given during the work day. Hence, the resultant hearing levels can reflect a certain amount of temporary threshold shift (TTS) as well as permanent threshold shift (PTS) due to the subject noise conditions. This too could serve to inflate the estimates of hearing loss incidence observed for workers so exposed. Hence, apart from there being no direct evidence to support the establishment of specific noise limits for conserving hearing below exposure levels of 78 dBA, the extrapolation to such levels is based on values that may be elevated by TTS. This depicts a worse picture than actually exists and suggests much more stringent limits than are needed.

These probable exaggerations of hearing loss risk and noise limits are incorporated in the author's master chart (Table III), which relates measures of speech reception loss to decibel levels and durations of single daily exposures to uninterrupted noise for a 45-year time period. Accepting Dr. Kryter's revised criterion of hearing impairment and the desirability of protecting at least 90% of the exposed population from such harm, the question remains whether the noise-exposure conditions shown in this chart can induce pure-tone hearing losses sufficient to cause the specified amounts of speech impairment. As already noted, the eight-hour exposure limits are taken from survey data which are judged to yield inflated estimates of hearing loss. The limits suggested for shorter daily exposure times have not been substantiated on the basis of permanent threshold shift data. On this latter point, Dr. Kryter leans heavily on the use of noise-induced TTS results to quantify hearing loss risk, especially for intermittent and variable level noise conditions. It is assumed that TTS is proportional to PTS, given the same exposure conditions protracted in time. Such relationships have never been evaluated for noise conditions other than those of a continuous nature; and even here support for TTS–PTS correspondence seems somewhat fortuitous.

Dr. Kryter offers formulas based on growth and decay functions for noise-induced TTS to rate possible hearing hazards from interrupted and/or variable levels of noise exposure. One wonders, however, about the practicality of using such procedures in the workplace or other environments where the noise conditions may vary not only in the course of a given day but from day to day. What, in fact, is the usefulness in employing rather complicated formulae to make judgments about hearing loss risk which rest upon untested TTS–PTS correlational assumptions.

[1] This limit is presumed to protect all but 10% of the exposed population from developing hearing levels exceeding a "fence" of *15* dB as averaged for the three audiometric frequencies 500, 1000, and 2000 Hz. The author also acknowledges a 65 dBA noise limit for eight-hour-per-day exposures which is considered to pose a 10% risk of hearing impairment as defined by a *25* dB "fence," similarly averaged.