ical response cannot be expected to be a linear function of time and concentration. The amplitude and frequency of variation from a defined mean may be very important. Many other chemical, physical, and perhaps even biological agents or factors of environment—even variation in chemical nature or physical form of the same substance—may have a very significant influence on the physiological or pathological response to a specified amount of one agent, and even on another with which it is associated. In some instances the influence may be synergistic and in others antagonistic. Although time does not permit an extended discussion of toxicology, it is pertinent to the question of industrial hygiene standards to mention a few examples of these influences. The minute-volume of air inspired and of blood circulated through the lungs increase rapidly with physical activity. For strenuous work the volume of air may be of the order of 10 or more and blood circulated 5 times that for sedentary activity. The amount of most harmful airborne contaminants that are acquired through the lungs from a particular environment and its transportation into the body may vary in the same general order. For these reasons a "maximum allowable concentration" may readily have a large safety factor for one degree of activity or a large factor of "unsafety" for another. Hot environment also increases respiration and circulation. Increased pressure of atmospheric environment, such as experienced in compressed air work, increases the mass of a harmful gas in unit volume of air and can be generally expected to increase the effectiveness concentration of the environment as compared to the same air-contaminant proportions at "normal" pressures, exceptions being those in which an antagonistic agent is likewise effectively concentrated. Such increase in potency may be expected owing not only to the fact that the mass of agent is directly increased, but owing also to non-linearity of response with concentration. Little is known about the variation in response with particle size of dispersoids—their retention in the lungs, their solubility, and other elements of physical, chemical, and biological behavior that are associated with size and surface. However, enough is known to give a basis for expecting considerable differences. The foregoing pertains to the relation of only a few specific agents and factors. The situation becomes very complex when all factors are considered. It requires that more attention be given to all important agents and factors of industrial environment and occupational activity in the development and use of standards; it supports the necessity of including an ample factor of safety in standards; it suggests the possible usefulness of multiple standards; and it emphasizes an existing inadequacy of knowledge and the need of an expanded program of research. Unfortunately this need greatly exceeds the facilities that are available for supplying it.

Procedures for Solving Problems

A procedure that offers good possibilities for resolving some of the problems arising from limited knowledge is to define industrial hygiene standards for atmospheric agents in terms of an established system of zones; such as (for illustration only) Zone 1, 0-3 ppm; Zone 2, 4-10 ppm; Zone 3, 10-30 ppm, etc. A portrayal and use of the present knowledge in this manner would not only give recognition to the limitations of knowledge but also to the difficulty of accurately assessing the environment to which a standard is to be applied. It would avoid the multitude of individual numbers and hair-line decisions that industrial hygienists must deal with at the present time. A very important feature would be the possibilities for harmonizing differences of opinion on standards for particular substances and obtaining more uniformity among code-making agencies. It is apparent that the development of an acceptable schedule of zones will require considerable study, and that some later modifications may be necessary to meet individual substances and new knowledge. Also that there will be some continuance of differences of opinion relating to zone assignments. However, the inherent good possibilities for mitigating some of the present problems, invites real attention with open-minded considerations. A procedure of this kind was discussed by the American Standards Committee on Allowable Concentrations of Toxic Dusts and Gases, Z37, at its meeting on December 9, 1947, and subsequently published by Drinker and Cook.[6] ASA Committee Z37 is continuing to explore the possibilities with a view to the development of a schedule of zones.

Some of the other comments that are pertinent to many of the lists of limits may be mentioned, briefly. The first of these has been discussed, namely, the labeling of the limits as "maximum allowable" or "maximum permissible," or the like. Another is the mixture of concepts represented by the limits; in some it is that of maximum tolerable, in others it is a mental concept of hygienic standards. A real deficiency is failure to designate whether the definition is related to toxicological effects or to sensory effects—to maintenance of good health or comfort. In many instances the origin of the limit is obscure and validity is difficult to assess. However, notwithstanding their deficiencies and limitations, these limits appear to be gaining in prestige and authority through mere copying and repetition. It should be realized that repetition does not improve validity. Again, this is not a condemnation of the use of such information as guides (even though recognized as being inadequate), if it represents the best information and is used with consideration of its limitations.