One logical objective of lighting is to make various objects and visual tasks as nearly equal in visibility as possible. Therefore, a more important application of the L-M Visibility Meter is to determine the footcandles necessary to provide equality of visibility.[22] That is, the levels of illumination are determined with which various visual tasks can just be seen through a given density of the filters. It is widely used to study the visibility of school, office, and industrial tasks. Since it is portable, the instrument can be taken into an industrial area and the task evaluated where it is being performed and under the actual viewing conditions. Table 1 illustrates a few of the results obtained with the L-M Visibility Meter.

TABLE 1

Results Obtained with the Luckiesh-Moss Visibility Meter

Task	Footcandles for equal visibility
Reading	
Typing on white paper	15
Magazine text	30
Newspaper text	60
Handwriting in pencil	60
Shorthand notes	90
Bookkeeping	120
Drafting	120
Medium grade assembly and inspection	200
Metal buffing	250
Sewing, white thread on white cloth	300
Metal finishing—surface grinding	500
Sewing, black thread on black cloth	over 1000
Precision die making	over 1000

Some of the tasks require what appear to be unreasonably high levels of illumination. For example, drafting requires eight times as much light as reading typing on white paper, and the industrial tasks require still more. When the tasks are analyzed in terms of size, contrast, and time, it is evident that such footcandle levels are required in order for the tasks to be equal in visibility. Furthermore, the values are in agreement with experimental results such as shown in Figures 3 and 4. The footcandle levels should be considered as relative rather than recommended levels of illumination for the performance of these visual tasks. It is obvious that the more difficult, low-contrast tasks require considerably higher footcandle levels than the larger, high-contrast tasks. In the present discussion, the practicability of attaining these higher footcandle levels is not of importance. The interest of the illuminating engineer lies in developing a single standard for lighting practice. It does not seem logical that light for seeing industrial tasks should be recommended on a different basis than for office tasks just because it may be more difficult to obtain. Visibility does provide a uniform basis for evaluating different tasks and for determining the amount of light needed. Many industrial tasks have been studied in this manner and the results used to determine recommended footcandle levels.[23]

[22] M. Luckiesh and A. A. Eastman, Footcandles for critical seeing, *Illum. Eng.*, 41, 823 (1946).

III. Ease of Seeing

Providing light for perception is only part of the over-all problem. The eye is but a single unit of the entire human organism. It is influenced by body fatigue and, also, it influences general body fatigue. Unfortunately, fatigue is difficult to define because of the innumerable factors concerned.[24] It is important to adjust all the environmental factors so that they combine to provide the best possible working conditions. Therefore, in the case of seeing, the footcandle level should be high enough that the worker can perform his job for prolonged periods with minimum expenditure of energy.

Many attempts have been made to detect and appraise visual fatigue by measurements of visual functions, such as visual acuity, speed of perception, and visibility. Even where work periods were long and the workers expressed definite indications of fatigue and discomfort, the decrement in such functions generally has been insignificant. Therefore, it has been necessary to explore the possibilities of other more sensitive criteria that will more adequately evaluate poor seeing conditions.

Some of the results obtained with more sensitive criteria based upon certain involuntary responses are presented in Figure 6 for three levels of illumination.[25] In all of these investigations the visual task of reading a well-printed book was performed by young adult subjects possessing average normal vision. Thus, the results may be considered conservative, since greater differentials certainly could be expected from older subjects or those having subnormal eyesight.

The data summarized in Figure 6 relate directly to ease of seeing as appraised by the integrated physiological effects of visual effort. The close correlation among these criteria indicates that the favorable influences of illumination upon the visual processes and upon ease of seeing extend to levels of illumination at least as high as 100 footcandles. Since the pages in all cases were white, this is equivalent to saying that increased visual benefits are obtained for brightness levels at least as high as 100 footlamberts. Studies of this sort indicate that the broader concept illustrated in Figure 1 is sound. If the task of reading involved a gray surface (such as that used for obtaining curve *a* of Figure 4), several hundred footcandles would be required to produce the same brightness conditions and ease of seeing

[23] American Standard for Industrial Lighting, A11.1-1952. American Standards Association, New York, 1952.

[24] S. H. Bartley and E. Chute, *Fatigue and Impairment in Man*. McGraw-Hill, New York, 1947.

[25] M. Luckiesh and F. K. Moss, *The Science of Seeing*. Van Nostrand, New York, 1937.