light of the different color temperatures. The corresponding total radiation of a blackbody at each point would be markedly different. A method for determining the sensitivity of a given film to different colored illuminants is described in an American standard;[10] the relationship is called the *actinity* of the source. For these reasons, it is especially important in standards for photographic measurements to specify in considerable detail the light sources and the filters used with them.

One of the two manufacturers of meters having red-sensitive cells has found it necessary to assign a higher speed to certain color films than the film manufacturer. It is obvious that the red-sensitivity of the cells causes the meter to read relatively lower in daylight resulting in overexposure. A higher film speed was assigned to compensate for the discrepancy.

The revised standard[1] completely specifies a suitable blue glass filter for converting 2850°K tungsten light to 4700°K light. It also specifies a diffusing sandwich composed of blue glass and diffusing filter which in combination with a 2850°K lamp provides a 4700°K surface source of uniform luminance. These filters and sandwiches are to be made available and calibrated by the National Bureau of Standards for luminous directional transmittance per unit of incident light at 2850°K. Thus, the luminance of the calibration source at 4700°K can be easily computed from the candlepower of the 2850°K lamp, its distance from the sandwich, and the luminous directional transmittance of the sandwich.

The blue-glass conversion filter will probably absorb 75% or more of the light, making it difficult to achieve a large-area source of daylight brightness levels without excessive heating and power consumption. For this reason it is expected that the 4700°K surface source will be used as the primary laboratory reference for luminance and that factory calibration will continue at 2700°K. It is important that the cells used to transfer the luminance calibration from the 4700°K reference source to the 2700°K factory equipment be identical in manufacture, mounting, enclosure, and directional characteristics with those of the products to be tested.

The new standard source of luminance at 4700°K should bring all manufacturers into closer agreement and result in better-satisfied customers.

Spectral Sensitivity

The existence and availability of two standard light sources at 2850°K and 4700°K provides a convenient means for checking the relative spectral response of different meters. A method for determining relative spectral sensitivity by this means may be included in the next revision of the standard. The response to the 4700°K source is between .75 and 1.30 of that to the 2850°K source for most selenium cells. The standard[1] states that the responses to wavelengths over 7000 A or under 3500 A shall

10. American Standard Method for Determining the Actinity or the Relative Photographic Effectiveness of Illuminants, PH2.3-1956.

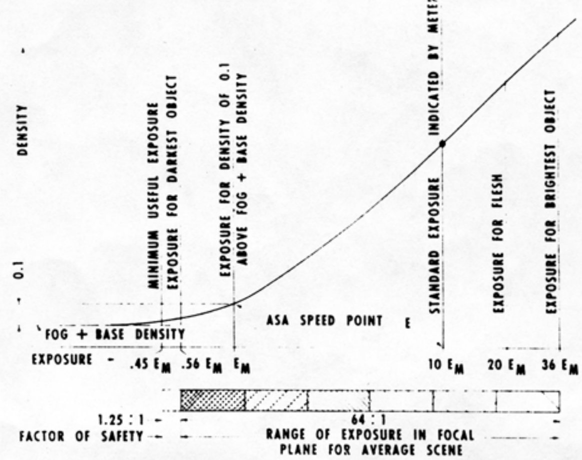

Fig. 4. Characteristic curve of a negative film product showing the relations between exposure meter readings of a typical subject and the ASA speed point of the film.

each be less than 5% of the total response to an equal energy source.

Performance

The standard[1] gives precise instructions for measuring important performance characteristics of exposure meters so that different laboratories can duplicate results. The method of calibration is described in detail and test methods for determining the accuracy of calibration are outlined. It is prescribed that the accuracy shall be within a cube-root-of-two factor in the center angular half of the scale and within a square-root-of-two factor in the end quarters.

The position or balance error is checked in each of three positions, and the total error is limited to 2% of the calibrated scale length.

The directional system is evaluated in terms of the angle from the axis of the receiver, at which the cutoff is 50%. This is called the specific acceptance angle in the observed direction.

Background Theory

In an appendix of the standard[1] a learned discourse is given by C. N. Nelson on the relations between field luminance, lens and camera characteristics, and illuminance in the focal plane. He compares the exposure meter reading with the sensitometric criterion used in determining speeds. This section is an up-to-date revision of important parts of his article,[11] "Safety Factors in Camera Exposures."

The latest standard on sensitometry of films[4] bases the ASA speed on the exposure required to produce a density of the negative of 0.1 above the fog-plus-base densities, provided other stipulations in the sensitometric procedure are followed. Thus,

11. C. N. Nelson, *Phot. Sci. Eng.*, **4:** 48 (1960).

in Fig. 4, the designated ASA speed point corresponds to an exposure E_m. An exposure meter designed in accordance with PH2.12–1961[1] will indicate the standard meter exposure[12] E, which for average conditions is equal to $10E_m$. Using Jones and Condit's data for image illuminance,[13] the brightest object in the average scene will produce a film exposure of 36 E_m, and the darkest object, 0.56 E_m. This provides a safety factor[4] of approximately 1.25 compared with 2.5 used prior to 1960.[3] The smaller safety factor is desirable today because the widespread use of exposure meters and the uniformity of commercial processing has largely eliminated a source of uncertainty in the computation of camera exposure. The lesser exposures permit higher shutter speeds or smaller apertures, or better pictures in darker surroundings, and result in more printable negatives of lower graininess.

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12. Allen Stimson, Chap. 8, *Photography, Its Materials and Processes*, 6th ed. C. B. Neblette, ed., Van Nostrand, New York, 1962.
13. L. A. Jones and H. R. Condit, *J. Opt. Soc. Am.*, **31**: 651 (1941).