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TECHNICAL NOTE

SENSITOMETRIC DATA FOR EARTH RESOURCES FILM

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(NASA-CR-141555) SENSITOMETRIC DATA FOR EARTH RESOURCES FILM (Technicolor, Inc., Houston, Tex.) 7 p HC $3.25 CSCL 14E

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by

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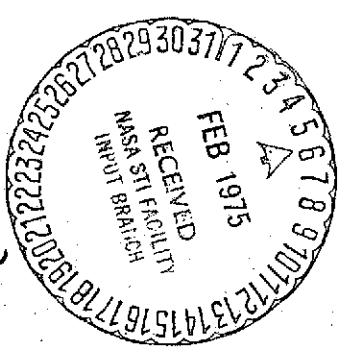

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SENSITOMETRIC DATA FOR EARTH RESOURCES FILM

Sensitometry is applied to all photographic Earth Resources mission film processed by the Photographic Technology Division. The exposure is made using an intensity-modulated sensitometer with a 2850°K source filtered to produce a 5500°K spectral distribution. In addition, any filters used on the sensor are included in the sensitometer filter pack in order to accurately simulate the exposure conditions.

The modulator consists of a continuous carbon wedge and a 20-step carbon step tablet. The densities of the step tablet are given in Table 1. Table 2 gives the density of the continuous wedge as a function of distance.

PROCEDURES

I. Absolute Log Exposure Values

Absolute log-E values can be expressed in four ways:

1. Unfiltered - Photometric - in log meter-candle seconds
2. Unfiltered - Radiometric - in log ergs/cm^2
3. Filtered - Photometric - in log meter-candle-seconds
4. Filtered - Radiometric - in log ergs/cm^2

(All logarithms are base 10.)

The absolute log exposure values supplied for both the continuous wedge and the step tablet are exact for Step 11 (or for the line on the wedge) when they are increased by 1.50.

Filtered photometric log exposure values are computed by the formula

$$\text{Log } E = \log_{10} \left[t \int_{\lambda_1}^{\lambda_2} P(\lambda) \cdot T_f(\lambda) \cdot L(\lambda) \cdot d\lambda \right]$$

where $P(\lambda)$ = unfiltered spectral irradiance at the film plane (watts/$m^2/\Delta\lambda$)

$T_f(\lambda)$ = filter spectral transmission

$L(\lambda)$ = eye luminosity functions (lumens/watt) = spectral sensitivity of the eye

t = exposure time (seconds)

λ_1, λ_2 = wavelength limits of integration

The integration is carried out with a $\Delta\lambda$ of 10 nanometers, and limits of 300 to 720 nanometers for panchromatic materials and 300 to 920 nanometers for infrared-sensitive materials.

The calculation of filtered radiometric log-E values is identical to the above, except for the elimination of the eye luminosity function.

An absolute log exposure given for the original film also applies to the duplicate, since the wedge and tablet are printed through during duplication. Thus, a density in the duplicate can be directly related to the exposure at the camera focal plane. Any attempt to relate this exposure to brightness or reflectance on the ground, however, must take into account such factors as the non-image forming light introduced by the camera lens (flare) and the atmosphere (haze due to scattering). This can be accomplished if there is some ground truth data available, e.g. panels of known reflectance photographed under the same conditions.

II. Reading the Step Tablet

In order to relate a density in the duplicate to camera exposure, it is necessary to read the step tablet printed on the duplicate and plot the densities versus the corresponding sensi-

tometer log exposures. It is especially important that the same densitometer be used to read both the step tablet and the imagery. Otherwise, it is necessary to cross-calibrate between two instruments. If a microdensitometer is used, the duplicate step tablet should be scanned with the same configuration used to scan the imagery, and the average density of each step plotted against its sensitometer log exposure. Thus, no cross-calibration is necessary.

TABLE I

STEP TABLET DENSITIES
Tablet #M887-117-6

STEP	DENSITY
1	0.21
2	0.36
3	0.52
4	0.66
5	0.81
6	0.96
7	1.12
8	1.26
9	1.42
10	1.58
11	1.74
12	1.89
13	2.05
14	2.21
15	2.37
16	2.52
17	2.68
18	2.84
19	2.98
20	3.14

TABLE II

CONTINUOUS WEDGE DENSITIES
Wedge #M887-117-6

DISTANCE (cm)	DENSITY
1	3.06
2	2.91
3	2.76
4	2.60
5	2.45
6	2.30
7	2.16
8	2.01
9	1.87
10	1.73
11	1.59
12	1.45
13	1.30
14	1.15
15	1.01
16	0.86
17	0.70
18	0.56
19	0.42
20	0.28
21	0.13