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TECHNICAL NOTE

S-190 EXPOSURE VERIFICATION FLIGHT TEST

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INTRODUCTION

A flight test was conducted in order to determine the optimum exposures for the Skylab S-190A experiment. Aircraft Multispectral Photographic System (AMPS), Serial Number 001, which is installed in the NASA Earth Resources aircraft NP3A was used to simulate the S-190A system.

The same film emulsions to be used for S-190A were used in the flight test. These rolls were on factory-loaded spools for use in the AMPS camera system. Some variation is to be expected between these rolls and the S-190A flight loads, particularly for film type 2443.

DISCUSSION

Preflight sensitometric calibration exposures, both broadband and spectral, were applied to all rolls. Table I lists the camera configuration used in the flight test.

TABLE I
Camera Configuration for AMPS S/N 001

Station	Film	Filter	Reseau No.
1	2424	= CC	49
2	2424	DD	37
3	2443	EE	50
4	SO-356	FF	48
5	SO-022	BB	43
6	SO-022	AA	47

The following exposure series was established in order to fully bracket the predicted exposures.

Run	Frames	Exposure (Station 1-3)	Exposure (Station 4-6)
1	1-20	f/9.5 @ 2.5 msec	f/4.8 @ 2.5 msec
1	21-44	f/9.5 @ 5 msec	f/4.8 @ 5 msec
1	45-60	f/9.5 @ 10 msec	f/4.8 @ 10 msec
2	62-78	f/5.6 @ 10 msec	f/2.8 @ 10 msec
2	79-96	f/5.6 @ 5 msec	f/2.8 @ 5 msec
2	97-114	f/5.6 @ 2.5 msec	f/2.8 @ 2.5 msec
3	116-137	f/16 @ 2.5 msec	f/8 @ 2.5 msec
3	139-159	f/16 @ 5 msec	f/8 @ 5 msec
3	161-184	f/16 @ 10 msec	f/8 @ 10 msec

There appear to be exposure discrepancies on the two color bands (stations 3 and 4). For station 3 (2443) the series appears to run as follows:

Run	Frames	Exposure
1	1-20	f/9.5 @ 2.5 msec
1	21-44	f/9.5 @ 5 msec
1	45-60	f/9.5 @ 10 msec
2	62-78	f/9.5 @ 10 msec
2	79-96	f/9.5 @ 5 msec
2	97-114	f/9.5 @ 2.5 msec
3	116-137	f/5.6 @ 2.5 msec
3	139-159	f/5.6 @ 5 msec
3	161-184	f/5.6 @ 10 msec

For station 4 (SO-356) the precise exposure series could not be determined. A visual examination of the roll showed no exposure intermediate between the first two exposures settings of run 1. This may, however, have been due to a variation in terrain reflectance in different areas of the flight line.

The test was flown on 24 April 1973, between Fort Stockton and San Angelo, Texas. The three runs of the exposure test were conducted between 1754 and 1850 GMT corresponding to a sun elevation angle of approximately 70°.

Based on a densitometric analysis of imagery from all six stations (Figures 1-4), the following exposures were considered optimum for the test site flown. (Table II). These exposures are valid only for the test area flown, and, in the case of the black-and-white films, only for S190A flight-type processing.

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TABLE II

OPTIMUM EXPOSURES FOR TEST AREA

Station	Film	Filter	Exposure
1	2424	CC	f/9.5 @ 2.5 msec
2	2424	DD	f/9.5 @ 2.5 msec
3	2443	EE	f/9.5 @ 2.5 msec
4	SO-356	FF	f/4 @ 2.5 msec
5	SO-022	BB	f/5.6 @ 2.5 msec
6	SO-022	AA	f/5.6 @ 2.5 msec

Exposures for other sites will have to be determined based on terrain reflectance. It is highly desirable to correlate the results of this test with ground reflectance measurements taken at the test site.

CONFORMANCE TO FLIGHT PROCESSING CONTROLS

The emulsions used for this test are sensitometrically identical to the Skylab S-190A emulsions, with the exception of the color infrared film, type 2443. This film, though the same emulsion number as the Skylab film, has less infrared sensitivity (Figures 5 and 6). However, as a result of tests performed by this office, it appears that the Skylab emulsion will have essentially the same sensitometry as the AMPS emulsion after storage at the ambient conditions of the OWS for the duration of SL/2.

EXPOSURE COMPENSATION FOR FILM SENSITIVITY CHANGES

Due to pre-exposure sensitivity loss (aging) and latent image decay, it may be necessary to make adjustments to the exposures determined in this test.

1. Film type 2424 - tests showed a speed loss of approximately 1/4 stop (0.07 log exposure) over a one-month period. This difference is too small to be a factor in exposure calculations, since it would be lost in the "noise" of other exposure variables.
2. Film type SO-022 - tests showed a 1/3 stop speed loss (0.10 log exposure) over a one-month period due to latent image decay. It is recommended that exposures for the first 14 days of the mission be increased 1/2 stop, but normal exposure used for the last 14 days.
3. Film type 2443 - as mentioned above, 2443 loses infrared sensitivity with time. One month's aging will result in an IR speed loss of 0.15 in log exposure for emulsion 116-2. In addition, there is a slight reduction in green Dmax, about 0.10. There is no evidence of any significant latent image failure over a one-month period.

As a result of this IR sensitivity loss, vegetation will appear less red than normal and low reflectance areas may become slightly green. It appears from our tests, however, that the Skylab emulsion will not be degraded significantly more than the AMPS emulsion.

4. Film type SO-356 - test results are incomplete, but it appears that SO-356 loses sensitivity in the blue layer. This will tend to make the imagery more yellow than normal.

This film type is the most susceptible to radiation fogging of the S-190A films. The effect of radiation is to reduce the blue Dmax and lower contrast in the blue layer.

Due to the above effects, it is desirable to give SO-356 1/2 stop more exposure than the results of the flight test indicate.

It may also be necessary to expose the film without filter FF in order to reduce the yellow appearance of the imagery.

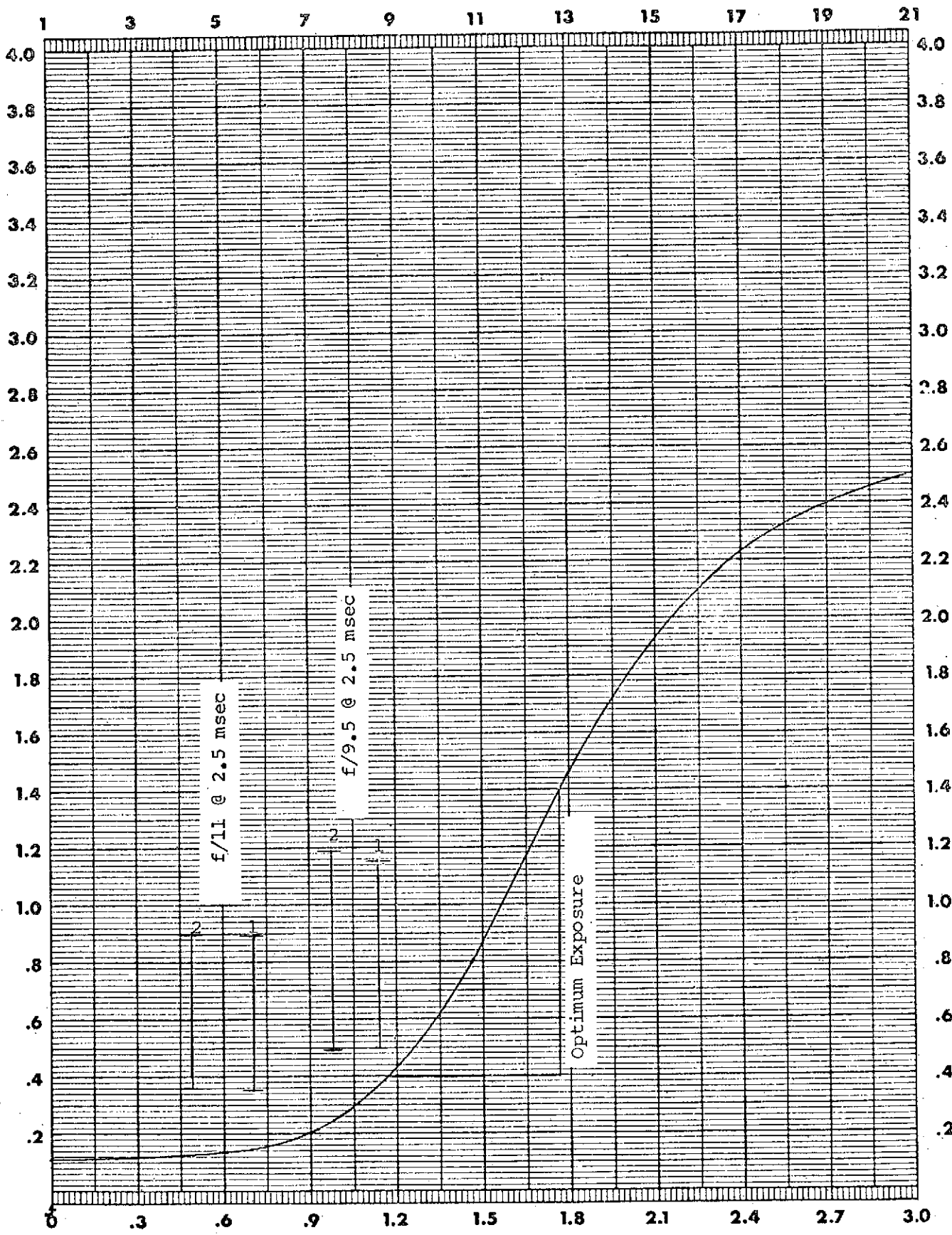


FIGURE 1. Film Type 2424 Exposure Test

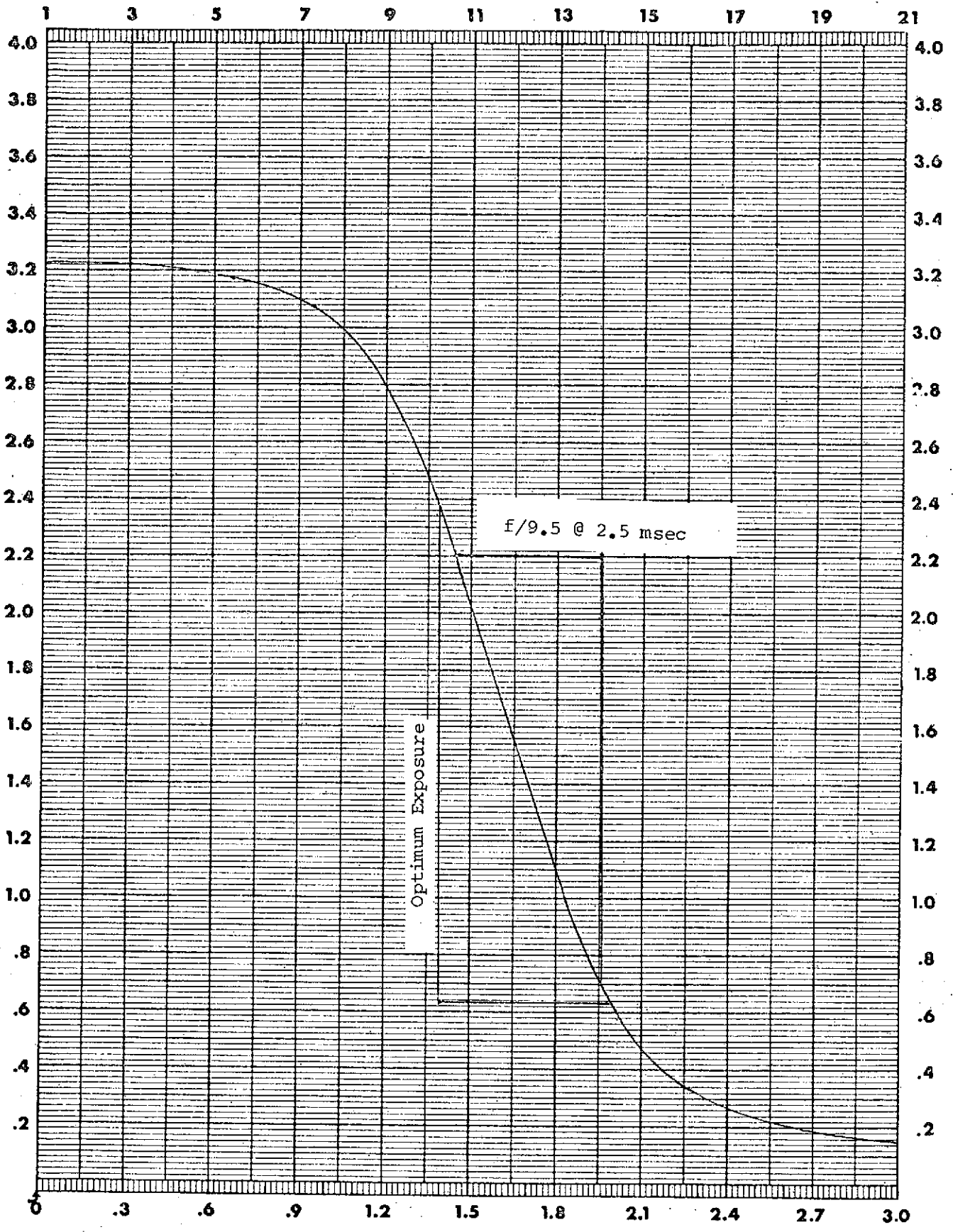


FIGURE 2. Film type 2443 Exposure Test

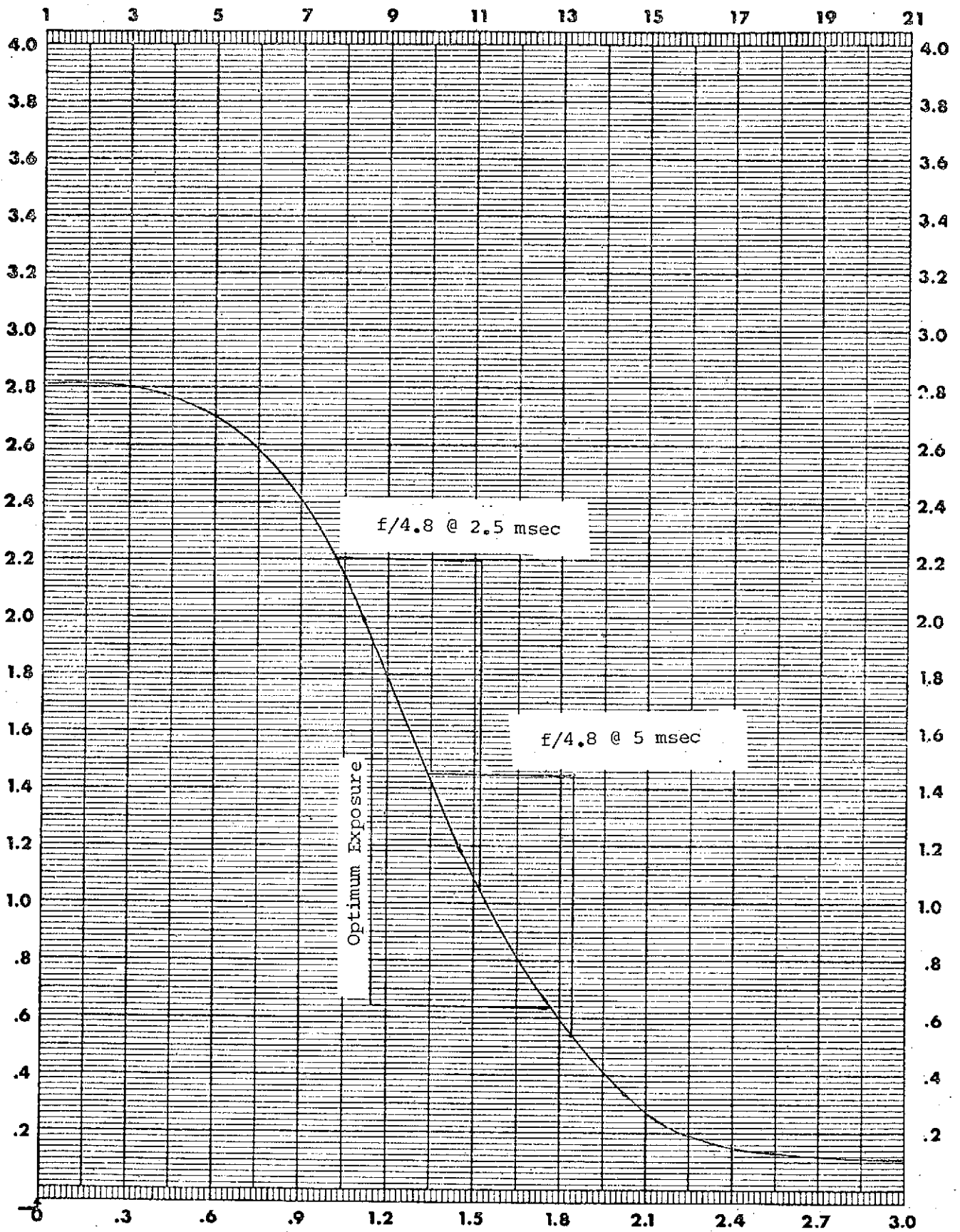


FIGURE 3. Film Type SO-356 Exposure Test

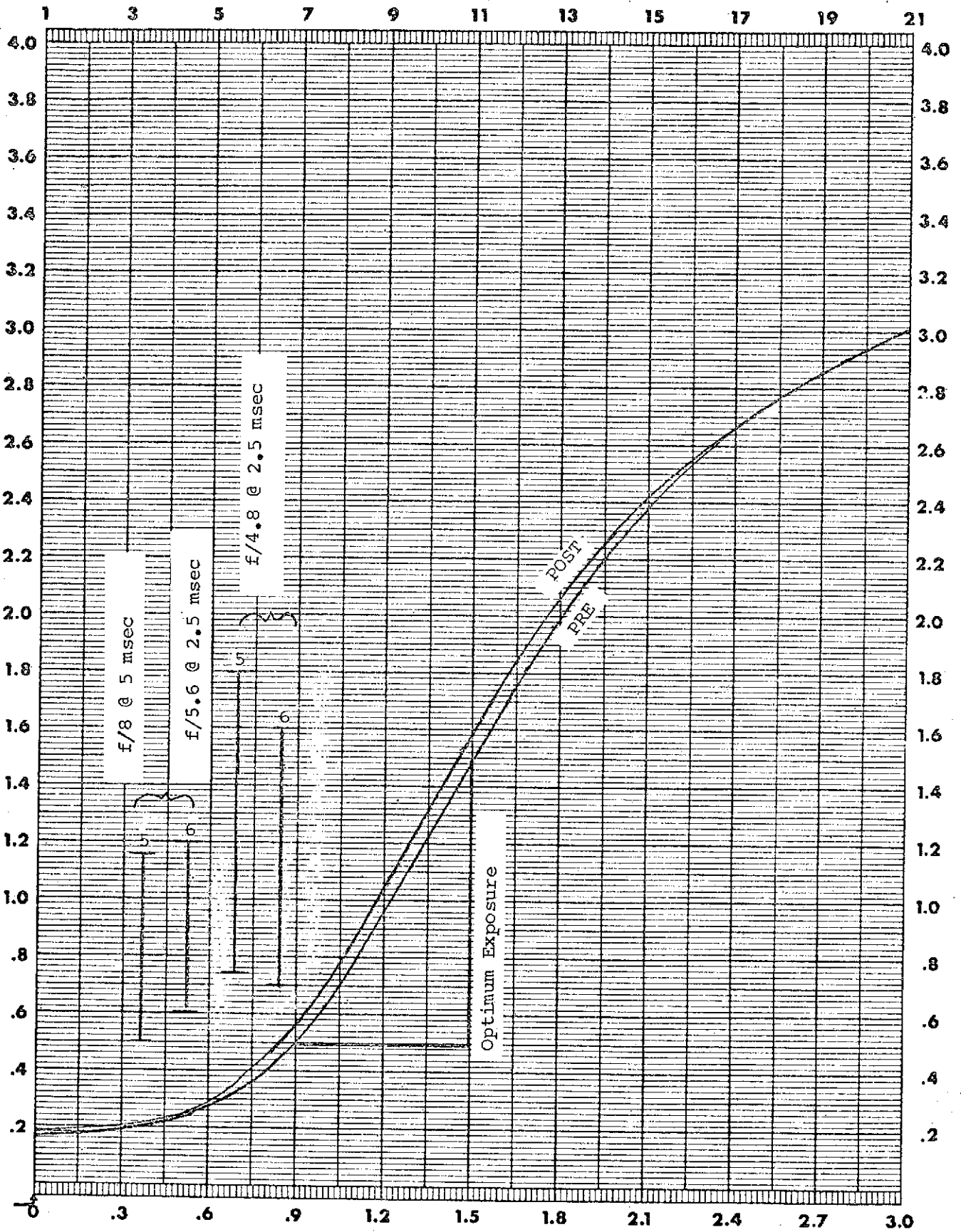


FIGURE 4. Film Type SO-022 Exposure Test; Wratten 25 Filtration.

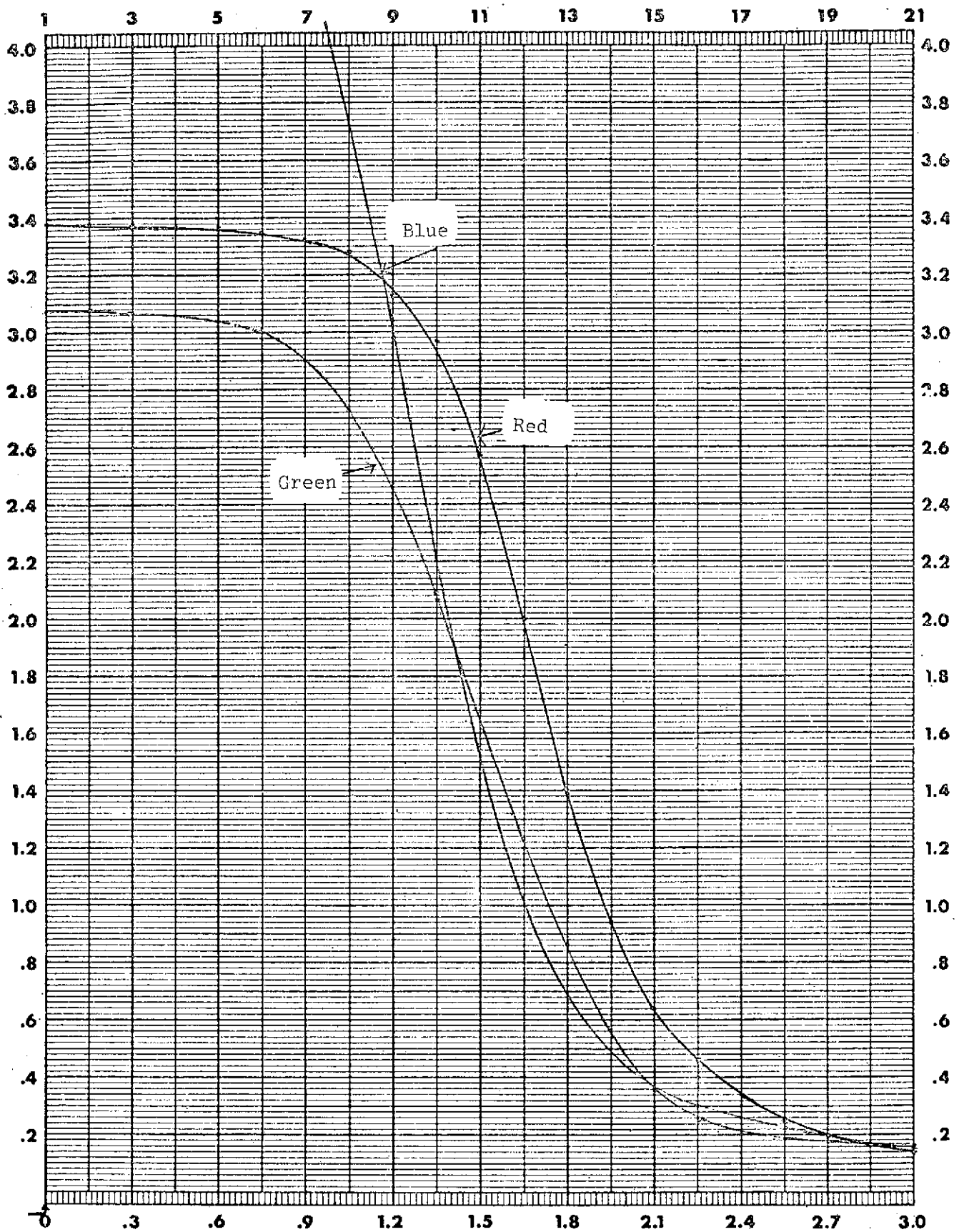


FIGURE 5. Pre-emption Sensitometry for AMPS Film Type 2443, Station 3.

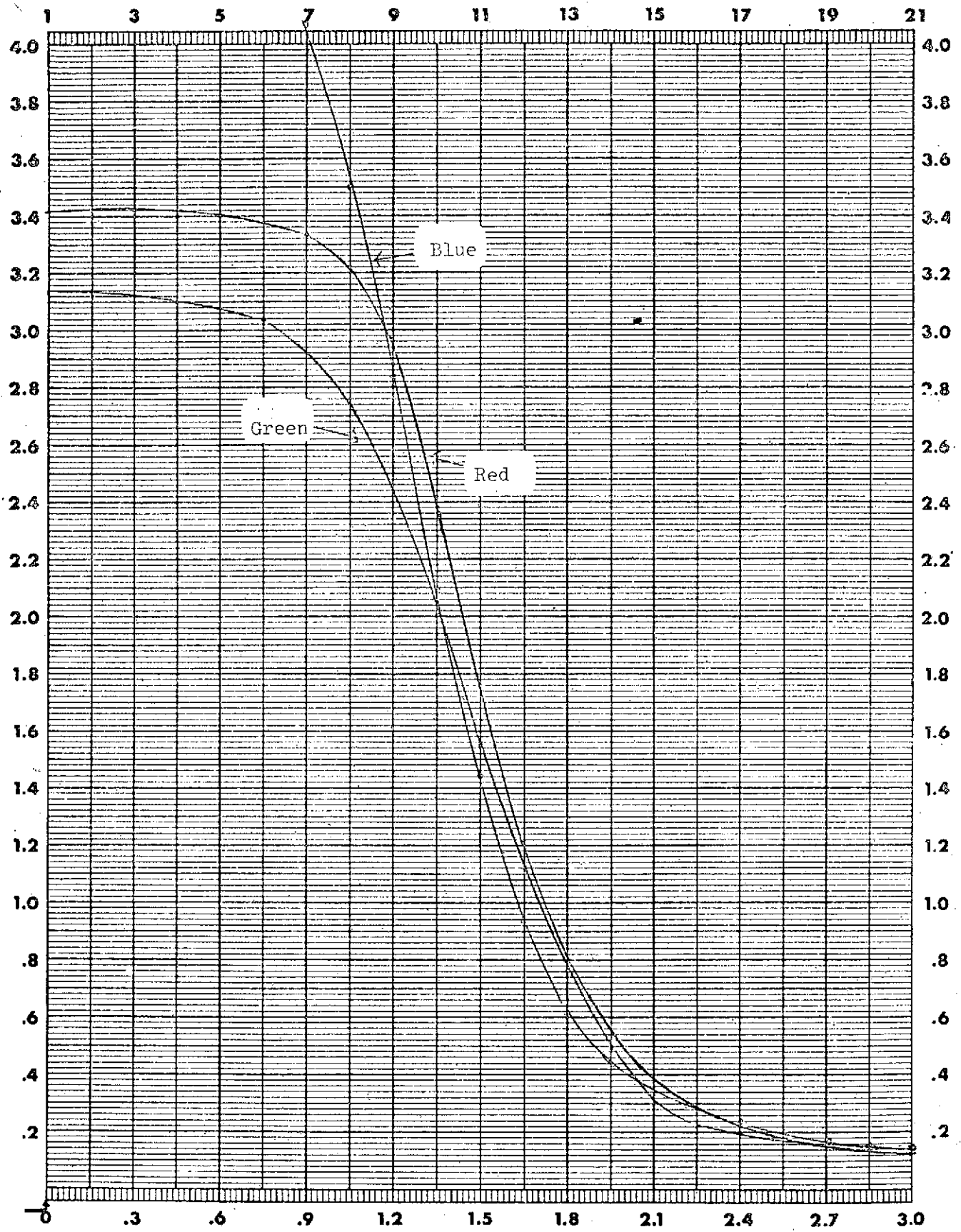


FIGURE 6. Process Control Curve for Skylab S-190 Film Type 2443.