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# THE CALIBRATION OF PHOTOGRAPHIC AND SPECTROGRAPHIC FILMS

Mr. Ernest C. Hammond, Jr.
Morgan State College

## ABSTRACT

The object of this investigative research problem is to develop and evaluate certain techniques and procedures for the ascertainment of the relative Spectral-Photometric characteristics of standard and special spectroscopic films and plates in the visible and UV regions. These films are used in ground based and rocket launched instruments by the Laboratory for Optical Astronomy. Two photographic Spectral Sensitometers have been developed by the Laboratory for Optical Astronomy. One instrument is a vacuum sensitometer covering a range of 1000 to 3000 Angstroms and the other sensitometer is the device this investigator used to study its spectral responses in the visible region of the spectrum through the utilization of a computer microdensitometric and photometric plot and contour routines.

## INTRODUCTION

Photography and its applications to Astronomy are very well known and well documented in many publications of the discipline. The best record of any solar, planetary, and/or stellar phenomena has been the photograph. There is a real necessity to know more about the film and plate responses to certain photographic optical parameters in an accurate scientific manner. The film manufacturer can generally qualitively list and describe the film and plate spectral-photometric characteristics for certain types of films and plates. But for the Astronomer or other photographically oriented researchers who deal with a wide range of light intensities and spectroscopic distributions, there is a requirement for a device and procedure to further quantify the calibration procedures of a film or spectral plate of a particular class and type assuming that one or more of the optical parameters that influence the final photographic result are considered i.e. temperature, developing, Stop bath, and fixing procedure, time of film exposure, spectral distribution, and pressure.

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## DESCRIPTION OF THE SPECTRAL SENSITOMETER

The spectral sensitometer as designed by Dennis Evans is a device consisting of a tungsten light bulb that permits light to pass through a shutter and an assortment of filters if necessary (See Diagram of Spectral Sensitometer). Next to the tungsten light bulb there is placed intantum a small mercury vapour lamp used to produce the necessary Hg spectral reference lines. The light then enters an adjusting diaphragm which further collimates the light into a pencil point beam that is reflected off of a first surface mirror whose normal is at 45 degree angle to incident and reflected beams of light. This reflected beam is then incident on a 600 line/mm grating whose normal makes a 33 degree angle with the incident light beam from the mirror after it passes through a second slit. The first order diffraction pattern is then observable by film, plate or eye. The spectral sensitometer is constructed of an odized Aluminum plate suitable for rocket or ground based applications (Figures 1 and 2).

The most important optical component of the Spectral Sensitometer is the Chromium/Quartz Step Wedge. These step wedges consist of ten different layers of chromium metal vapor deposited in a vacuum so that its transmission characteristic is equal to one stellar magnitude for every two steps. The total transmission factor over the entire step wedge is approximately 100 or 5 stellar magnitudes. A microdensitometric/calcomp examination indicated that the deposition of Chromium was very evenly distributed for each step. There is some evidence of instrumental noise and a small amount excess Chromium as seen in Figure 3 in the lower lefthand corner. The tall spiked tracings to the extreme right represent a portion of the mounting. The step wedge is reasonably rugged for a metallic disposition but care must be taken to avoid abrasions. The wedges can operate at room or lower temperatures. The wedge dimensions are 1" ×3" × 1/4".

Further, microdensitometric/calcomp examination of a Trix 135-36 exposed film to the first order image from the grating with the step wedge interposed indicated certain classic edge effects as shown Figure 4 caused during the development process.* A contour plot further substantiates the effect as shown in Figure 5.

Experimental calibration pictures were taken with Plus X, Tri X, Panatomic X II AO, and 103 AO UV film in the Spectral Photometer. Figures 6, 7, and 8 indicate the position of a particular step on the wedge versus the photometric

*As illustrated in the "Kodak Plates and Films for Science and Industry" page 9, 2nd. edition, 1962.

intensity measured with a Autoranging Digital Photometer. These results show a dependence between film types, similar to those expected based on the manufacturers general description. This procedure may be further modified into a simple calibration procedure for all types of films and plates. The spectroscopic film produced Figures 9 and 10 showing a step wedge position versus a photometric intensity dependency for two exposures of 125 seconds and 625 seconds.

A patent application has been submitted to the U.S. Patent Office on the Spectral Photometer.

Many thanks to Mr. Curtis McCracken, Mr. Alfred Stober and Mr. Dennis Evans for their tireless, unwavering and patient assistance to me on this problem.

Many thanks to Dr. Dan Klinglesmith for his assistance on the operation of the Microdensitometer Digital Encoder System.

Figure 1. A Top View of the Spectral Photometer

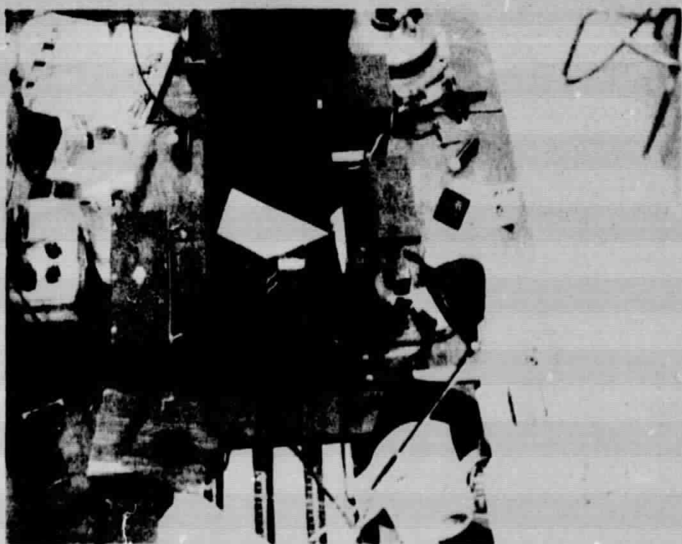

Figure 2. A Side View of the Spectral Photometer

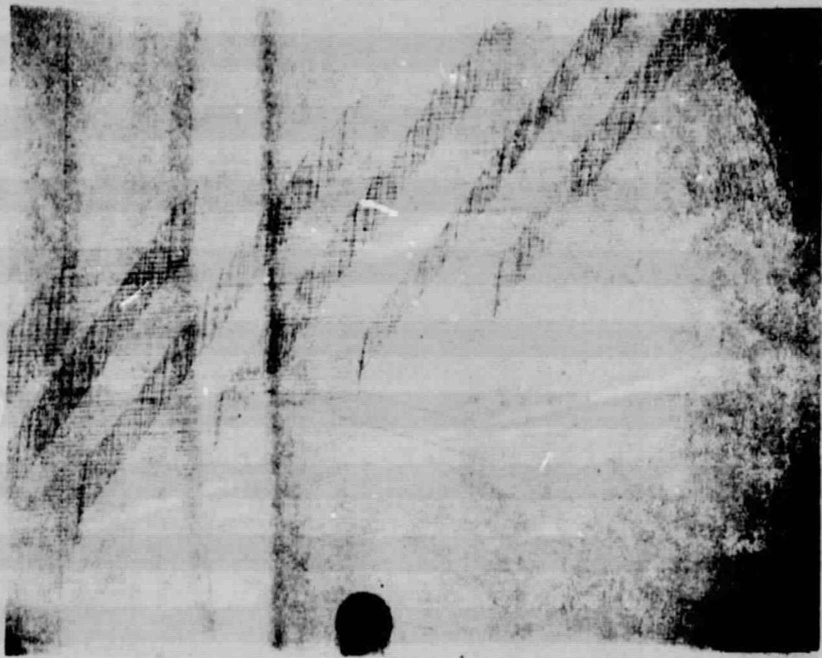

Figure 3. Microdensitometric/Computer View of the Step-Wedge Surface

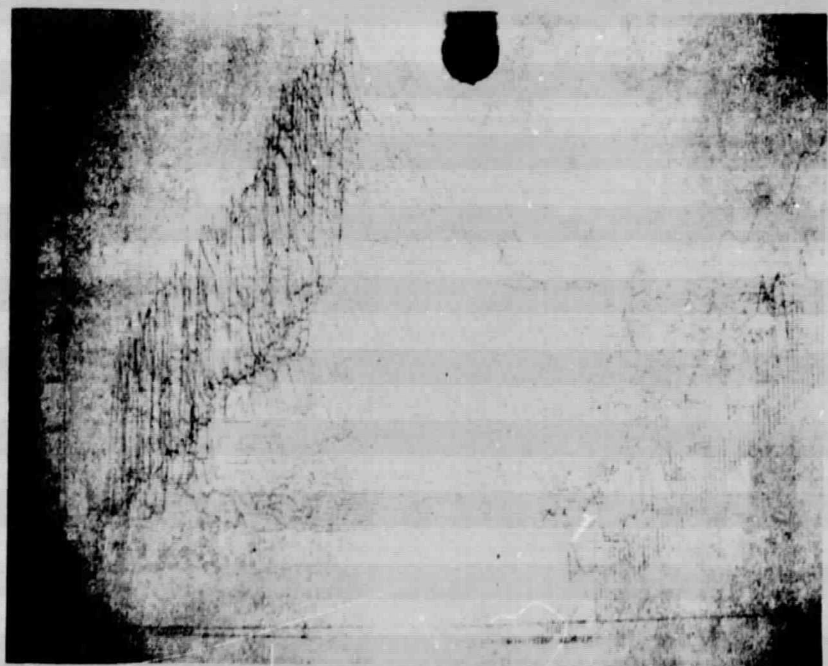

Figure 4. Microdensitometric/Calcomp Examination of a Tri-X Exposed Film Taken with the Spectral Sensitometer

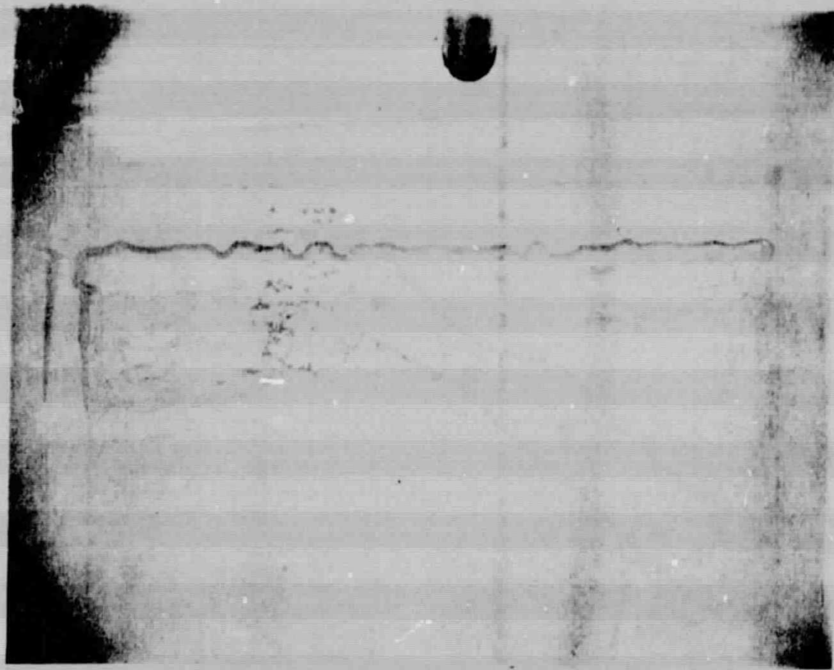

Figure 5. A Contour Plot of the Exposed Tri-X Film

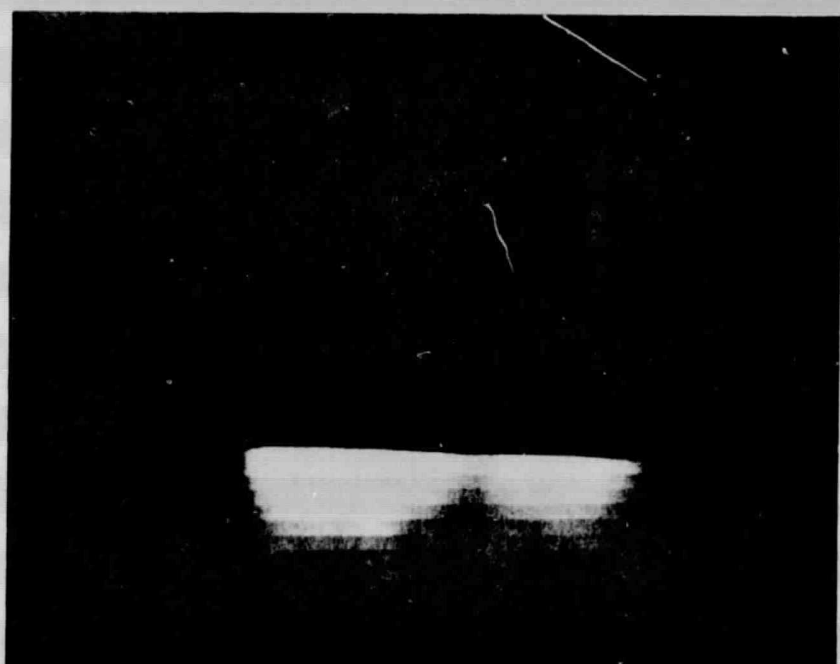

Figure 6. The Spectrum as Viewed Through the Quartz/Chromium Step Wedge

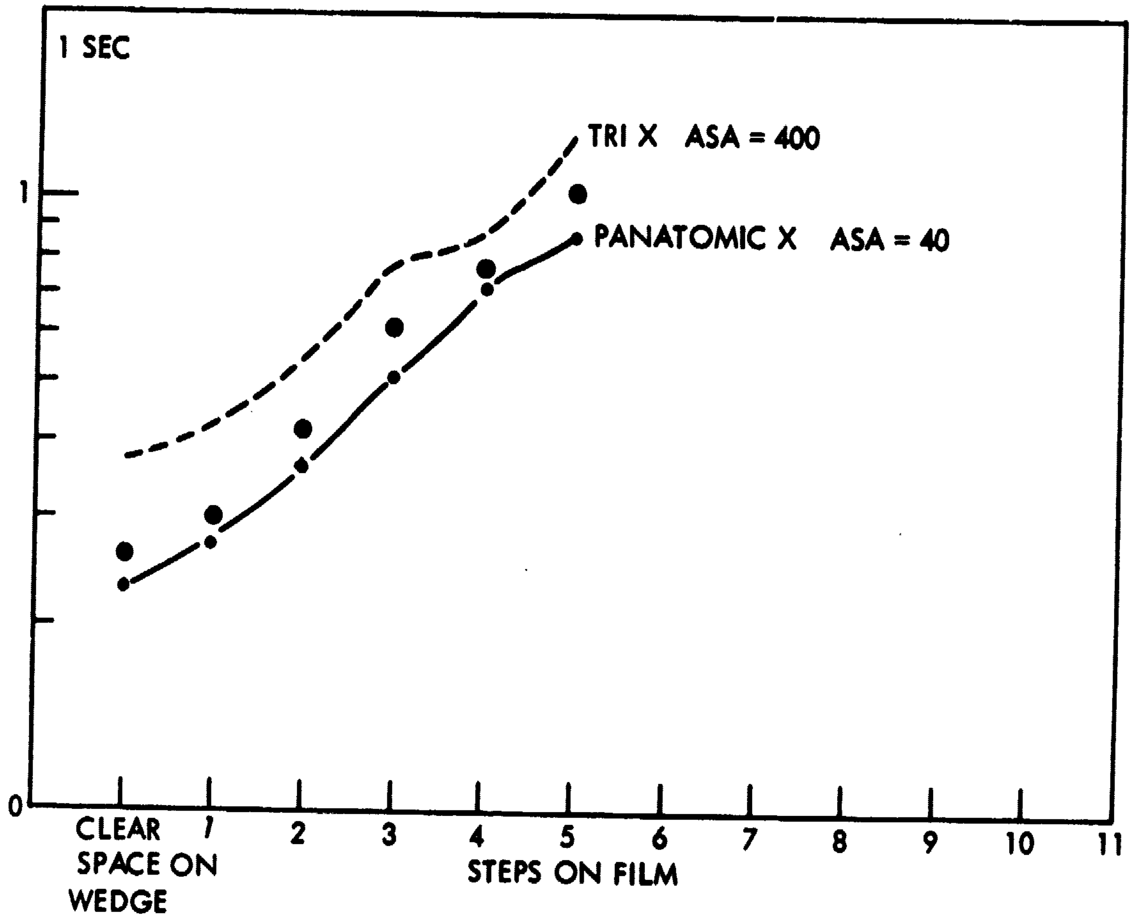
1 SEC
TRI X ASA = 400
PANATOMIC X ASA = 40
1
0
CLEAR SPACE ON WEDGE
1
2
3
4
5
6
7
8
9
10
11
STEPS ON FILM

Figure 6

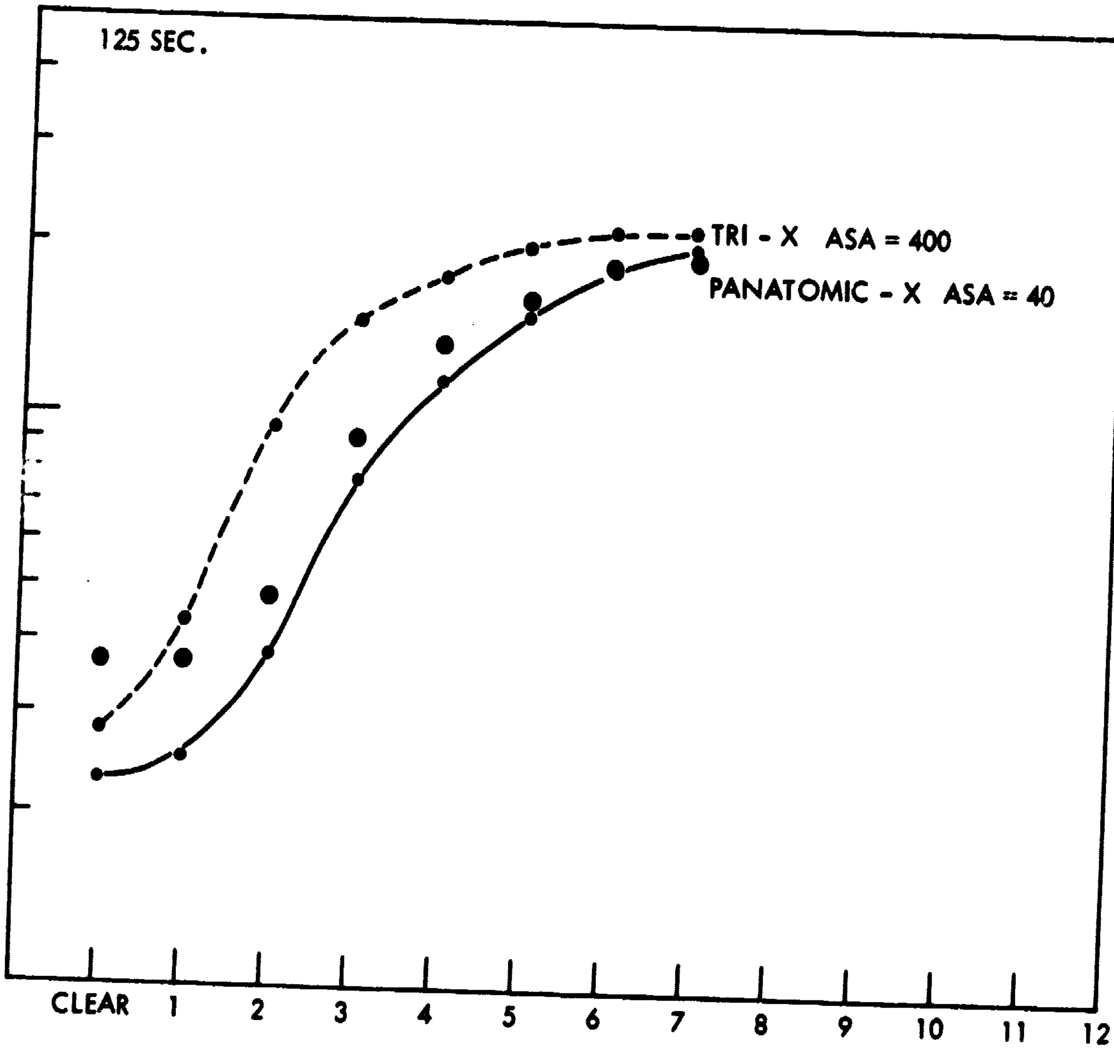
125 SEC.
TRI - X ASA = 400
PANATOMIC - X ASA = 40
CLEAR
1
2
3
4
5
6
7
8
9
10
11
12

Figure 7

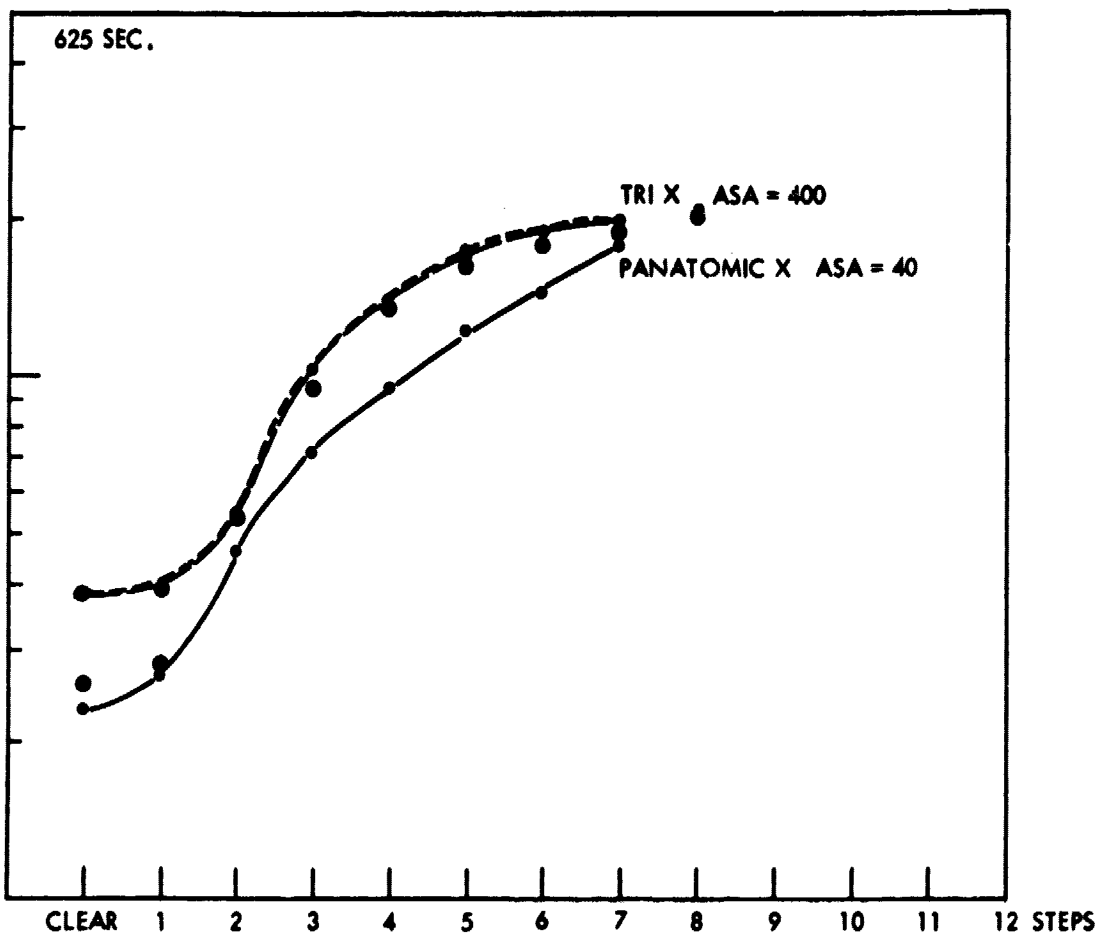
625 SEC.
TRI X ASA = 400
PANATOMIC X ASA = 40
CLEAR
1
2
3
4
5
6
7
8
9
10
11
12 STEPS

Figure 8

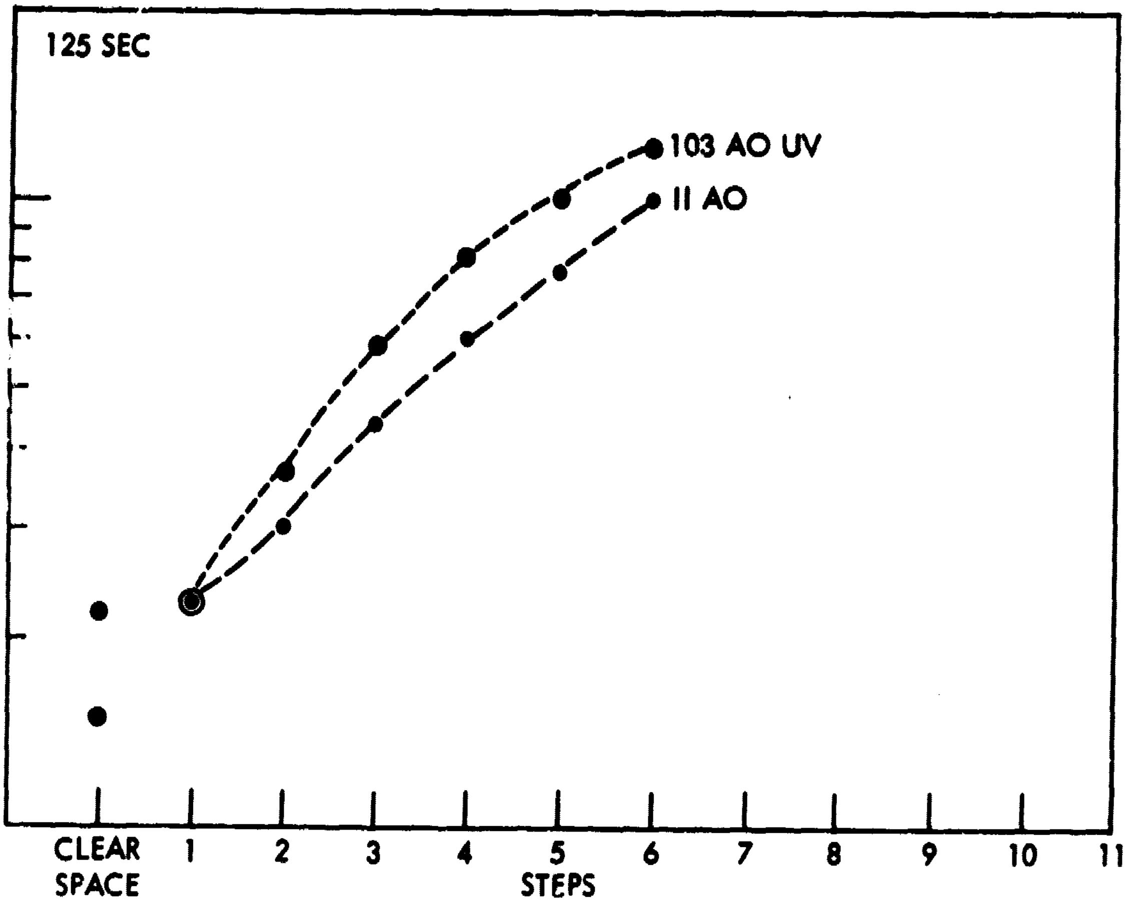


Figure 9

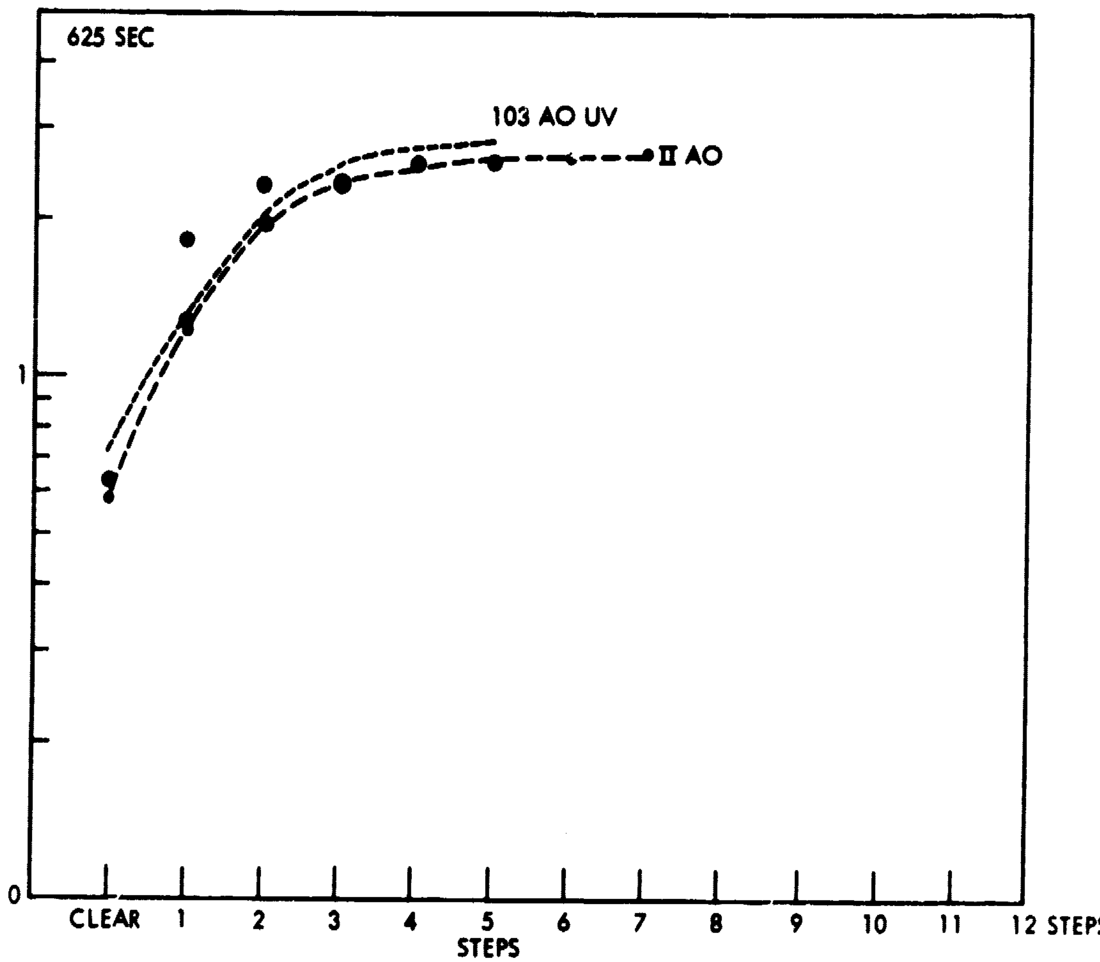


Figure 10