A PROPOSAL FOR THREE ADVANCED PHOTO-INTERPRETATION LIGHT TABLES

24 April 1964

TABLE OF CONTENTS

Approved For Release 2002/06/17 : CIA-RDP78B04747A001400040003-0

I. INTRODUCTION

The basic tool used in the interpretation and viewing of aerial photographic films is a light table. Most of the light tables presently being utilized are simple light boxes in which conventional fluorescent tubes provide the illumination. A few of the more recent light tables incorporate methods for varying the intensity of the lamps but these often flicker at the low illumination levels. The human engineering considerations and the requirements of the photo interpretation personnel have been either secondary considerations or compromised by the low cost of products assembled from readily available components and fabricated by local machine shops.

The purpose of the proposed light tables, as we interpret the technical exhibit, is to consider the engineering design requirements of film viewers which will meet the following criteria:

1. Provide the P.I. with a tool that satisfies his ease of viewing requirements which are: high illumination, an easy loading mechanism, and a simple transport system.

2. Reduce the physiological strains associated with the human visual system, control location, and equipment dimensions. Incorporate into the design, features which are selected according to optimum human performance.

3. Provide a precision microscope carriage assembly for accurate measurement of target dimensions.

The three light tables that are described in the following sections of this proposal represent a significant improvement over the tools presently employed by photo interpretation personnel. The following features are emphasized in the design which we believe will result in a superior product:

1. Ease of viewing and use - by a stylized, human engineered package.

Approved For Release 2002/06/17 : CIA-RDP78B04747A001400040003-0

2. Increased package illumination and a light level control by utilizing a special high quality fluorescent lamp and a high frequency excitation.

3. Elimination of stroboscopic or flicker effect - by using high frequency pulse duration modulation.

4. A simple but rugged mechanical design.

5. An easy loading system having positive support and eliminating the adapters previously required to handle various types of spools.

6. A superior mechanical film drive - with magnetic clutches for directional control and maintenance of the film tension.

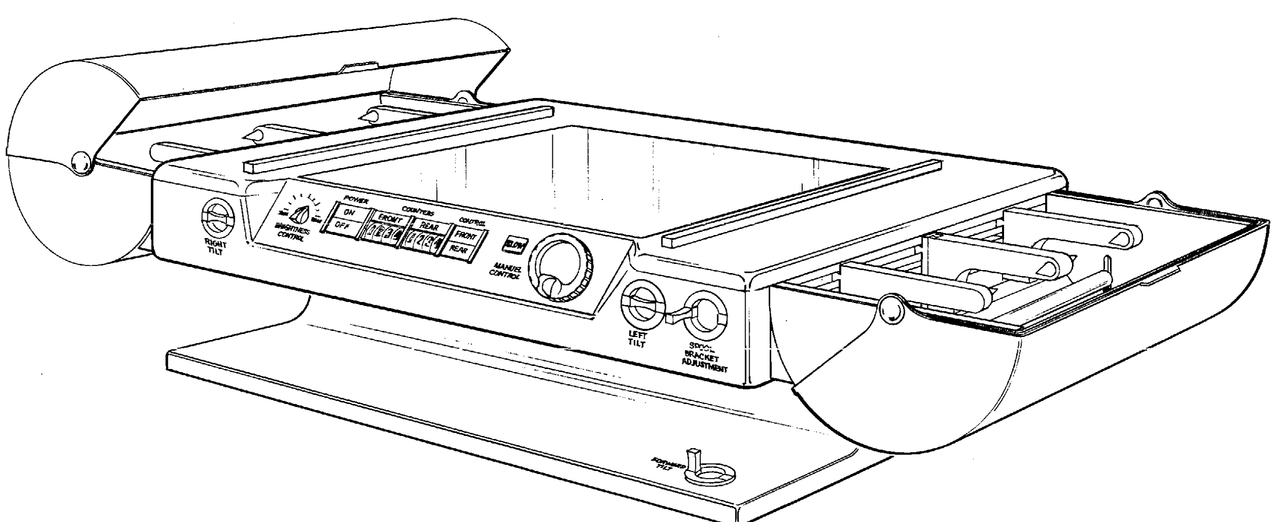
7. Elimination of film scratching by clamping the film against the table only when not in motion - the film being transferred directly from roll to roll when it is in motion.

8. Automatic masking of the light in the unused portion of the table to reduce eye strain.

The proposal which follows has been divided into three sections with each describing the design of one of the light tables. The first section which follows discusses our proposed design of an advanced tilt top light table. This discussion covers the film drive, loading, and illumination techniques which will be common or similar for all three light tables. Thus the sections which follow are devoted to the description of the precision microscope carriages and tracking high intensity light sources.

We estimate that the design and fabrication of a single light table will require five months. If the design of the three tables is sequenced in the order of Items I, II, and III, described in this proposal, Item I can be delivered in five months, Item II in six months, and Item III in seven months from receipt of a contract.

The work will be administrated and accomplished in the Development Department [redacted] which is responsible for the development of [redacted] rapid film processing equipments as well as data collection and evaluation programs. Assistance will be provided as required by the Human Factors and Industrial Design personnel located in other departments.



ADVANCED TILT TOP
LIGHT TABLE *figure no. D*

STATINTL

II. AN ADVANCED TILT TOP LIGHT TABLE (ITEM I)

A. MECHANICAL CONFIGURATION

The light table will be of rugged mechanical construction using the best materials available. It has been determined that the overall size of the table can be maintained as specified in the technical exhibit and yet permit the required adjustments to be made. Although weight will be given due consideration, one design goal will be not to sacrifice ruggedness for a decrease in weight in any of the members or mechanisms involved. All tolerances and allowances will be commensurate with good design practice. Finish will be decorative and protective. It is requested that the customer specify the desired finish. Preliminary layouts have indicated that all mechanisms required to perform the specified functions can be of basic "tried and true" design. Ruggedness, reliability, and simplicity of operation will be cardinal in each design feature of the light table.

1. Overall Size

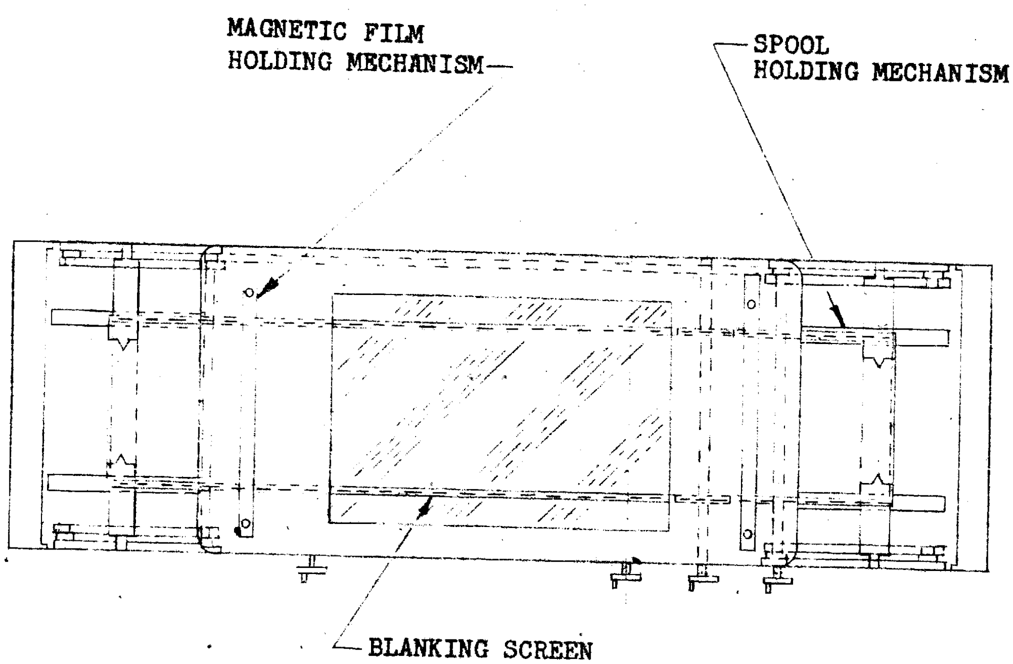
Preliminary layouts have disclosed that the specified size of the light table can be maintained and yet permit all necessary adjustments to be made. The external configuration will be no larger than 32" long x 16" wide x 9" high less film transport mechanism. Handwheels will be recessed to fit into the light table case.

2. Spool Loading and Holding Mechanism

The spool loading and holding mechanism will be so designed to accept single spools of 9-1/2", 5", and 70mm film or dual rolls of either 5" or 70mm film of 500 foot capacity. The holding mechanism will be designed to operate from one hand crank driving right hand and left hand screws (see Sketch B). Single rolls of film will be inserted into the holder and supported on adjustable rollers. By simply turning one crank, the operator can fit the film spool and take-up spool simultaneously into the film transport system. To eliminate the need for various adapters to drive different film spools, the spools will be initially centered on axis with a cone shaped pin and

STATINTL

Approved For Release 2002/06/17 : CIA-RDP78B04747A001400040003-0



TOP VIEW - ADVANCED LIGHT TABLE

Sketch - B

[redacted]

held stationary by friction discs. This method will provide an extremely simple and rapid film loading system. The film spools will be held rigidly during the entire operation of the system; therefore, no danger of dropping the spools will occur at any table elevation. The film spools are released by simply cracking the crank on the holding mechanism. Center posts will be provided for handling dual film rolls. These posts will slide into dove-tailed slots in the track supporting the holding mechanism. Provision will be made for storage of the center posts with the system.

3. Film Transport

The film transport system shall permit bi-directional film motion controllable from either end. It will permit both winding and unwinding with one crank located at the right hand side of the light table. The proposed system will be electromechanical using a scheme of magnetic clutches actuated from pushbutton switches located on the light table control console. Both ends (supply and take-up) will be mechanically connected through a chain drive. Power will be manual (hand control) through a two-speed transmission to a splined shaft carrying two sprockets to drive the chain. A magnetic clutch arrangement will be used on the splined shaft to engage the sprockets as required to obtain the desired film motion. This scheme will allow the simultaneous transport of both reels or allow each reel to be translated separately in either direction. A small two-speed gear box will be used to provide a slew mode for rapid transport and a fine control for viewing. Gear ratios will be changed manually at the transmission. The transmission will employ anti-backlash gears. The handwheel will be balanced for smooth operation and elimination of drift in the system when the handwheel is released and the film is being viewed. Gear ratios will be carefully chosen to provide optimum transport in the slew mode and to give the operator a fine control of the film during viewing. A friction brake will be incorporated on the power output shaft so that the transport system can be adjusted to the "feel" of each operator using the equipment under different load conditions. Inertial damping will be used where necessary to provide a smooth drive system.

STATINTL

Not it 15° from the vertical

4. Tilt Mechanism

A tilt mechanism will be provided to allow the table to be tilted 15° to the right or left (see Sketch A). The 15° tilt mechanism will employ telescoping screw jacks driven by a gear and pinion from handwheels and locked by a friction device. The jacks will be located at each end of the long axis of the table. Once the table is tilted and locked, this position will be maintained no matter how film is shifted and will support a load of 75 pounds without changing position. The contractor will design the tilt mechanism to be as rugged as possible. This design will enable the operator to adjust the table in the right and left (15°) position while the table is in any forward and aft position (45°) or visa versa.

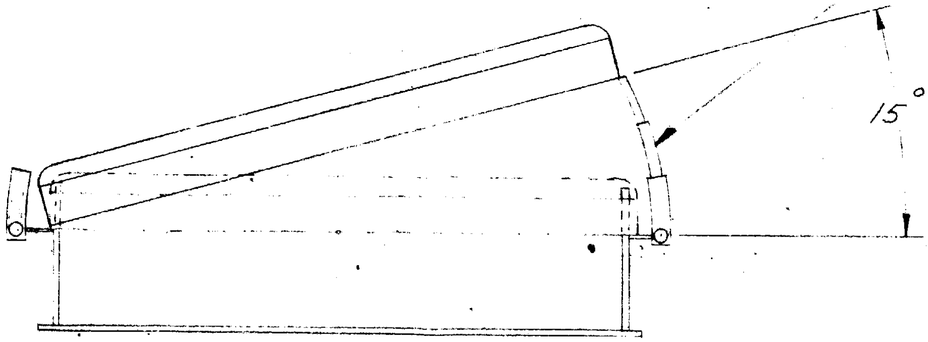
5. Film Hold-Down Mechanism

To prevent damage to the film during transport, it is desirable to have the film travel an obstruction-free path from spool to spool. Yet for proper reading, the film must be placed securely on the viewing surface. The contractor will accomplish this action by using spring loaded hold-down bars (see Sketch C) actuated by solenoids. A plunger actuated by first motion of the hand crank (inertial device) will trigger a microswitch which will in turn close a circuit applying power to solenoids to lift two felt lined bars used to hold the film flat on the viewing surface. The film will pass freely between the bars and top surface of the light table during transport. When motion stops the solenoids will be de-energized allowing spring action to pull the bars and film tightly against the viewing surface. An electrical override will be provided to release the bars to facilitate film loading.

6. Light Shades

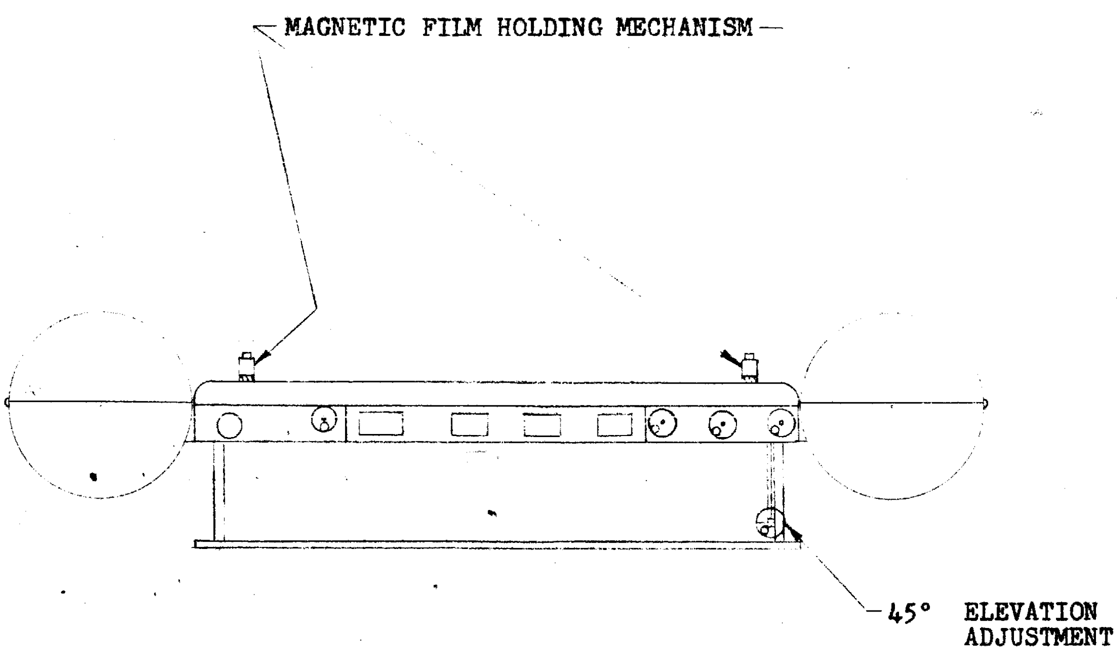
Light shades will be provided to shield all areas of the lighted surfaces not covered by film. The light shades will be roller mounted, spring loaded and located on the bottom surface of the illuminated viewing area. The shades will be automatically adjusted to the appropriate width by connecting the leading edge of the shade to the film holding mechanism (see Sketch B). As the holding mechanism is moved in or out to accept the required film spool or spools, the light shades will be automatically adjusted to blank out the unused viewing area.

STATINTL



15° TILT MECHANISM

Sketch - A



FRONT VIEW - ADVANCED LIGHT TABLE

Sketch - C

STATINTL

In the case of viewing dual spools, an insert will be provided to slip into a track thus blanking out the area between film. A storage space will be provided for the insert. By careful design of the center post, it is anticipated that the distance between any two film strips will not exceed 1".

7. Controls and Accessories

In addition to the aforementioned controls for manual film drive and tilt adjustment, the unit will contain the following electrical controls:

a. Power switch and indicator light
b. Brightness control
c. Film rotation direction controls
d. Hold down bar override switch

In addition to the above controls, the light table will be equipped with a scale at one end graduated in centimeters and inches. This will always be available to the operator as a ready source of measurement. Two counters will be supplied to provide the operator with an index to frame location. The counters will be driven from the film transport drive chain.

8. Overall Configuration

The light table will be of smooth construction using presently accepted industrial design standards. All mechanisms and film rolls will be covered to present a streamlined appearance and added protection. This design philosophy will not be practiced where streamlining will interfere with ruggedness or ease of operation and maintenance. Placement of controls will be for optimum operator ease. Human engineering will be given every consideration in the design of the unit.

B. LIGHTING AND ELECTRICAL FEATURES

The illumination system shall be composed of a cold cathode fluorescent lamp and a diffusing plate. The lamp will be especially constructed in an encapsulated mount 12-1/2" x 19-1/2" x 1-1/2". The illumination system shall provide 1800 feet Lamberts maximum light output and also a dimmer control to gradually reduce this to 15% of the original value by means of a high frequency, solid state power supply.

STATINTL

Approved For Release 2002/06/17 : CIA-RDP78B04747A001400040003-0

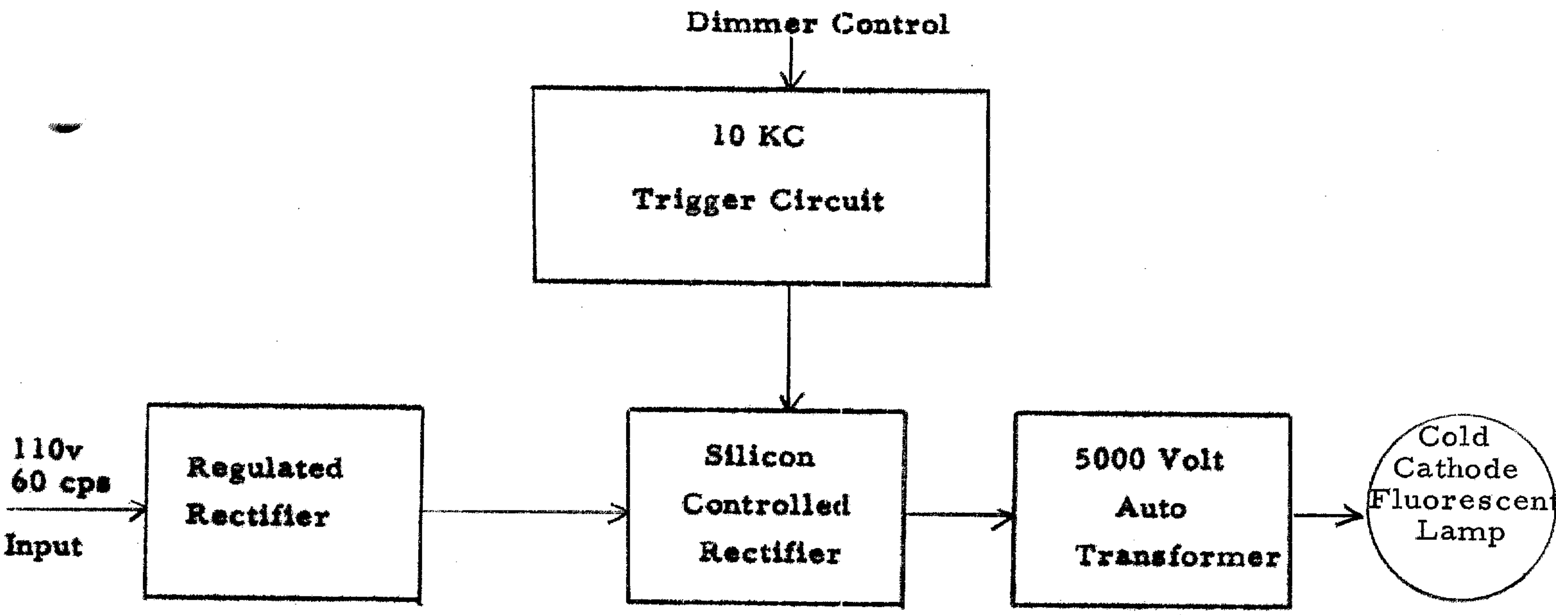


Figure E. Fluorescent Lamp Dimmer Control Flow Diagram

Approved For Release 2002/06/17 : CIA-RDP78B04747A001400040003-0

Cold cathode lamps producing an illumination of 2300 foot lamberts have been utilized in a photographic film viewer and reported by Howard S. Glick[1]. Thus there appears to be no difficulty in meeting or exceeding the illumination level specified in the technical exhibit.

1. Lamp Type

A single special cold cathode fluorescent lamp of special configuration will be utilized. The required brightness level will be obtained by using a single small diameter (12mm) bulb, folded or spiraled and encapsulated to provide a replaceable panel 12-1/2" x 19-1/2" x 1-1/2". The special lamp will result in increased efficiency and more uniform illumination. Standard fluorescent lamps cannot approach the required brightness simply because of their geometry. They cannot be arranged to fit the box area.

We propose to procure several lamp configurations and their associated components to compare their brightness, light uniformity, and dimming control.

2. Dimmer Control

The design shown in the flow diagram in Figure E illustrates an electronic control which regulates the amount of current and the time during which the current will flow through the lamps. The dimming control determines the voltage applied to the silicon controlled rectifiers and adjusts the point in the cycle at which the tube begins to conduct.

The advantage of utilizing high frequency modulation is that:

a. Stroboscopic effects are eliminated
b. The lamp efficiency is increased about 6%
c. The transformers are 1/2 the size, 1/3 the weight, and result in 1/5 the heat compared to 60 cps transformers
d. The component hum frequency can be made beyond the human audible range. (The audible frequency due to lamination hum is twice the chosen electrical frequency.)
e. Capacitors can be used instead of ballasts at high frequency.

[1] Glick, Howard S., "Inspecting Photographic Film," Illuminating Engineering, January 1964, 59:22-23

Approved For Release 2002/06/17 : CIA-RDP78B04747A001400040003-0

STATINTL

f. A dimmer control can be provided for a range of 100:1 instead of the 6.7:1 range requested in the technical exhibit.

3. Heating

The distribution of energy in a 40-watt fluorescent lamp is approximately as follows:

60% is converted to ultra-violet energy

38% appears as lamp heat

2% is converted to the visible spectrum in the mercury lines of 4047 and 4358 angstroms.

Of the 60% which is converted to ultraviolet energy, only about 23.5% is transformed by the fluorescent materials into visible light. Thus the final distribution of the energy placed into the lamp is:

a. Light 16.5%

b. Radiated heat 37.5% (follows the light)

c. Convection and Conduction 46% (dissipated by heating the surrounding air and conduction to fixture parts)

Using the above approximate factors, the proposed 500 watt lamp will produce 230 watts of convected or conducted heat and 187 watts of radiated heat. The transformer and electronics will result in another heat loss of about 250 watts. Thus the overall heating effect will be 2270 BTU/hour at the rate of 3414 BTU/KW hour.

We believe the above heat can be transferred to the case and cooled sufficiently by convection if ventilation holes are appropriately positioned along the sides and lower surface of the housing.

4. Flicker and Stroboscopic Effects

Every lamp burned on alternating current has a nonuniform light output due to the cyclic variation of the current. However, these variations in light are associated primarily with low frequency 60 cycle power. The stroboscopic effect will be virtually eliminated by the use of the proposed high frequency supply since the persistence of the phosphor glow or phosphorescence will eliminate any noticeable light variations at high frequencies.

STATINTL

Another method of reducing the variation in light, is to employ two lamps, one operated with a leading power factor and the second with a lagging power factor. This is accomplished by adding a series capacitor to one lamp circuit. Thus the light from one lamp is at maximum, the other will be about 120° out of phase. While this is effective in reducing the flicker at 60 cps, we do not believe it will be required when a high frequency power supply is utilized.

Flicker can also be caused by failure to start and could be a problem in dimming controls in which the voltage is reduced to lower the lamp current or brightness. Cold cathode lamps do not exhibit as much stroboscopic effect as hot cathode lamps probably because of the higher arc voltage. Flicker due to low starting voltage will not be a problem in the proposed design because dimming will be accomplished by adjusting the time duration or period of the cycle when the lamp is turned on--not by reducing the starting voltage.

5. <u>Weight and Size</u>

The weight and size of the high frequency control circuitry will be substantially reduced compared with 60 cycle transformer and ballast components. As previously mentioned, these components will be reduced by at least 1/2 in size and 1/3 in weight of comparable 60 cycle components.

Since cold cathode lamps have been selected, low voltage cathode heater transformers are not required. Employment of high frequencies also makes it possible to utilize capacitors to replace ballasts.

6. <u>Lamp Life</u>

Still another reason for selecting a cold cathode over a hot cathode fluorescent lamp is that an increase in lamp life is obtained. The life of a lamp is lengthened when the burning period per start is increased. The lamp life for a hot cathode lamp based on a burning time of 3 hours is 7,500 hours. The cold cathode lamps on the other hand have corresponding rated lives of 12,500 and 25,000 hours depending upon the pressure and lamp current. Their life is not effected by off-on cycling as are hot cathode lamps. However, light output decreases throughout their life and thus it is usually economical to replace them prior to actual failure. One manufacturer of cold cathode lamps

Approved For Release 2002/06/17 : CIA-RDP78B04747A001400040003-0

STATINTL

indicates their lamps decrease 10% in 100 hours and 10% the following 1000 hours of operation. Thus for photographic interpretation it may be advantageous to replace the lamps at 6 month intervals for cold cathode lamps and much more frequently in light tables employing hot cathode fluorescent lamps.

STATINTL

Approved For Release 2002/06/17 : CIA-RDP78B04747A001400040003-0

C. SPECTRAL QUALITY OF FLUORESCENT LIGHTS AND HUMAN REACTIONS

In general, light sources that provide warm, soft illumination, as opposed to cold, harsh illumination are preferred by most people. Such light sourses generally have least effect on neutral colors.

There is no particular frequency range that has been proven easier on the eyes than any other. Maximum visibility (i.e., sensitivity of the retina) is realised at 5550 angstroms in the greenish yellow part of the spectrum. Ease of viewing is determined more by such factors as contrast, glare, and the nature of the material being viewed by the spectral quality of the light.

There are two types of contrast which affect ease of viewing:

1. Contrast between the various portions of the material being viewed - This should be maximized if optimum visual acuity is to be obtained. (Relation reaches asymptote at about 85% contrast.)

2. Contrast between the illumination on the material being viewed and the ambient illumination - Visual efficiency is sacrificed when the ambient illumination is less than 1/10 as bright as the material being viewed.

D. OTHER HUMAN ENGINEERING CONSIDERATIONS

1. The users' line-of-site should ideally be perpendicular to the material being viewed. Deviations of $\pm 45^{\circ}$ are acceptable if the perpendicular criterion cannot be met.

2. Information available as a result of anthropometric (the science of measuring human body dimensions) studies should also be utilized if equipment is to be designed for optimum human performance. The problem in designing work areas for human body dimensions is essentially one in which efforts should be made to accomodate as large a portion of the population of potential users as possible. Proper application of anthropometric data will contribute significantly to the solution of this problem.

III. AN ADVANCED FILM-VIEWING LIGHT TABLE WITH A TRANSLATING MICROSCOPE CARRIAGE (Item II)

The features proposed in the basic light table will be incorporated in the advanced Film Viewing Light Table with a Translating Microscope Carriage in addition to the following features:

A. TRANSLATING MICROSCOPE CARRIAGE

The contractor will provide a carriage for translating a stereo microscope or microstereoscope in both X & Y directions over the illuminated format. The optical center of the microscope shall scan an area of 10" x 35". The carriage will be so designed to permit complete scanning of the area and shall commerce one-half inch from the right hand edge of the illuminated area as defined in the technical exhibit. The carriage motion shall be smooth, positive, low friction motion which is free of vibration. The contractor proposes to drive the carriage in both X & Y directions by use of ball bearing screws and handwheels. This method will give positive motion with no vibration. By using this method of carriage transport, a consistent motion with no position of lesser or greater resistance will be realized. Friction locking devices will be used to lock the carriage in X & Y at any position of travel. A design goal will be to so mount the carriage and microscope mount to facilitate easy removal and replacement of the entire assembly from the light table should the operator desire to use the table simply as a viewing surface. Vee ways will be used to support the microscope in both the X & Y axes thus giving optimum stability and precision of motion. The ways will be so designed and of such precision as to permit less than .002" of motion at the longest possible lever arm when a 5 pound force is applied.

B. MICROSCOPE MOUNTING

A rigid mounting bracket will be provided to mount the three microscopes specified in the technical exhibit. Adapters will be equipped with captive screws for easy removal or installation of any adapter. The mounting base will be guided by vees circular in construction to permit 180° rotation of the base. Spring loading will be used to secure the base

[redacted]

IV. AN ADVANCED FILM-VIEWING LIGHT TABLE WITH A TRANSLATING MICROSCOPE CARRIAGE AND HIGH INTENSITY TRACKING LIGHT SOURCES (Item III)

In addition to the features proposed in the Advanced Film Viewing Light Table with a Translating Microscope Carriage, the contractor will supply two high intensity collimated light sources. The light sources and a lens system will provide a collimated beam of high intensity light that will be directed to a 45° reflecting surface that is located beneath the viewing surface and above the general illumination surface. The light beams will then be focused on the objectives of the stereomicroscope. The light sources and lens systems will be packaged in one unit and mounted external to the light table proper to eliminate the cooling problem. The light sources will be connected by a mechanical linkage to the microscope carriage for transport along the X & Y axes of the light table. Mirrors will be connected by a system of belts and pullies to the microscope transport. Motion imparted to the microscope carriage will translate the mirrors and light sources in synchronism with the microscope.

A. INDEPENDENT ADJUSTMENT CONTROL

Mechanical adjustments will be provided to allow independent positioning and alignment of each light source and mirror. This adjustment will be external to the light table proper and so located to provide adjustment with ease. A lock mechanism will be provided to lock the reflectors in synchronism with the microscope carriage. The reflectors will be so mounted that they can be positioned on the separate objectives of a microscope or beneath the single objective of a stereomicroscope. By using mirrors, a separation of 50mm from center can be maintained. The light sources and reflectors will track through the total scan range of 10" x 35".

[redacted]

to the guide block.

C. FINE MICROMETER MOTION

The microscope mounting plate will be so designed to allow for ± 2cm of micrometer adjustment in the X & Y directions. This motion shall be a precision auxiliary motion accomplished after the main translational carriages have been locked in position. Micrometers will be selected to produce the most accurate adjustment with the least reading effort required. The contractor is proposing a [redacted] mount and vernier adjustment system, or equivalent, to meet the accuracies specified, in the technical exhibit.

Next 5 Page(s) In Document Exempt