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# NGA STANDARDIZATION DOCUMENT

## Softcopy Exploitation Facility Standard

(2019-09-05)

Version 2.2

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NATIONAL CENTER FOR GEOSPATIAL INTELLIGENCE STANDARDS

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**UNCLASSIFIED GOVERNMENT REFERENCES**

Display Performance Standard v4.0 01 Nov 2017
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# Introduction

This document provides lighting specifications for softcopy **exploitation** facilities. These specifications must be met to the greatest extent possible to avoid significant impact on the **interpretability** of displayed imagery. Specifications provided in this document include lighting in the workstation environment during image **exploitation**, light measurement instrumentation, and surface material properties. Recommendations are also provided for nonexploitation task lighting and ergonomics.

Specifications provided in this standard are to optimize the exploitation environment. National, state, and local Occupational Health and Safety or Workplace Safety requirements shall take precedence in the event of conflicting specifications.

# Facility Standards

Softcopy Exploitation Facility Standard includes workstation lighting, light measurement instrumentation, and surface material properties.

## 2.1 Lighting Standards

Tables 2.1 and 2.2 summarize the lighting standard for an imagery exploitation facility. The user can refer to the Ambient Light Measurement Procedure and Visual Assessment documents found in the Appendices in Section 5.

**Table 2.1:** Exploitation-Critical Lighting Standards

Measurement	Illumination Type	Description	Justification	Procedural Step	Acceptable Illumination
2.1.2	Diffuse light normal to the softcopy display	Measure illuminance from center of display—Fig. 2.1b	Exploitation accuracy (Shadow detail)	Step M:14 <sup>1</sup>	$\leq 2.0$ foot-candle (fc)
2.1.4	Glare on display	Examine unpowered monitor for glare	Glare impedes visibility of imagery details	Step V:2-3 <sup>2</sup>	No glare evident
2.1.5	Window light	Examine windows visible from workstation location	Dark adaptation is compromised by window light	Step V:6-7	No uncovered windows in workstation line of sight
2.1.7	Color Temperature	Check Manufacturer's Specifications	Color perception is affected by mismatches between lighting and display	N/A	6500 K and CRI $\geq 80$

<sup>1</sup>Step numbers with an "M" prefix refer to the Ambient Light Measurement Procedure document found in Section 5.1.

<sup>2</sup>Step numbers with a "V" prefix refer to the Ambient Light Visual Assessment document found in Section 5.2.

**Table 2.2: Ergonomic-Critical Lighting Standards**

Measurement	Illumination Type	Description	Justification	Procedural Step	Acceptable Illumination
2.1.1	Diffuse light normal to keyboard	Measure illuminance from center of keyboard—Fig. 2.1a	Ergonomic/Eye Strain	Step M:10	$\geq 0.5$ fc, $\leq 2.0$ fc
2.1.3	Diffuse light normal to the background	Measure illuminance normal to background at the display—Fig. 2.1c	Eye Strain	Step M:6	$\geq 0.5$ fc, $\leq 6.7$ fc
2.1.3	Diffuse light normal to the background	Measure illuminance on surface behind display	Eye Strain	Step M:6	$\geq 0.5$ fc, $\leq 6.7$ fc
2.1.5	Window light	Examine windows visible from workstation location	Dark adaptation	Step V:6-7	No light visible
2.1.6	Task lighting	Illuminance Meter on the work surface underneath task lighting fixture—Fig. 2.1d	Eye Strain	Not Applicable (N/A)	$\leq 30$ fc

### 2.1.1 Measurement 1: Diffuse Light Normal to the Keyboard

The amount of light measured **normal** to the keyboard affects the analyst's light **adaptation** level and is also a source of **veiling glare**. **Diffuse light** falling on the keyboard shall be  $\geq 0.5$  fc and  $\leq 2.0$  fc, as shown in Figure 2.1a.

### 2.1.2 Measurement 2: Diffuse Light Normal to the Display

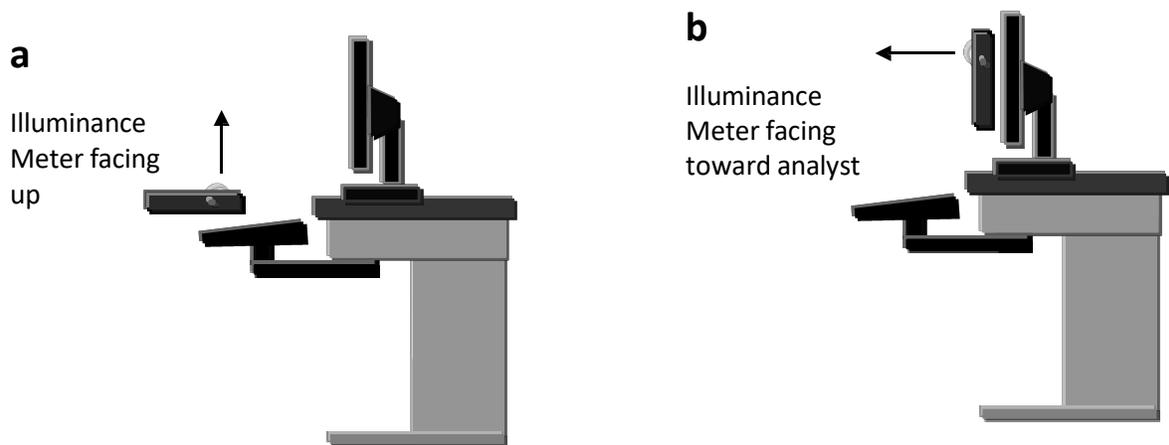
Significant **diffuse light** illuminating the display surface will lower the dynamic range of the display and thus reduce image contrast. **Diffuse light** falling on the face of the display shall be  $\leq 2.0$  fc, as shown in Figure 2.1b.

### 2.1.3 Measurement 3: Diffuse Light Normal to the Background

Surfaces within the analyst's field of view outside the display affect the analyst's light **adaptation** level. This in turn affects the ability to discriminate image contrast.

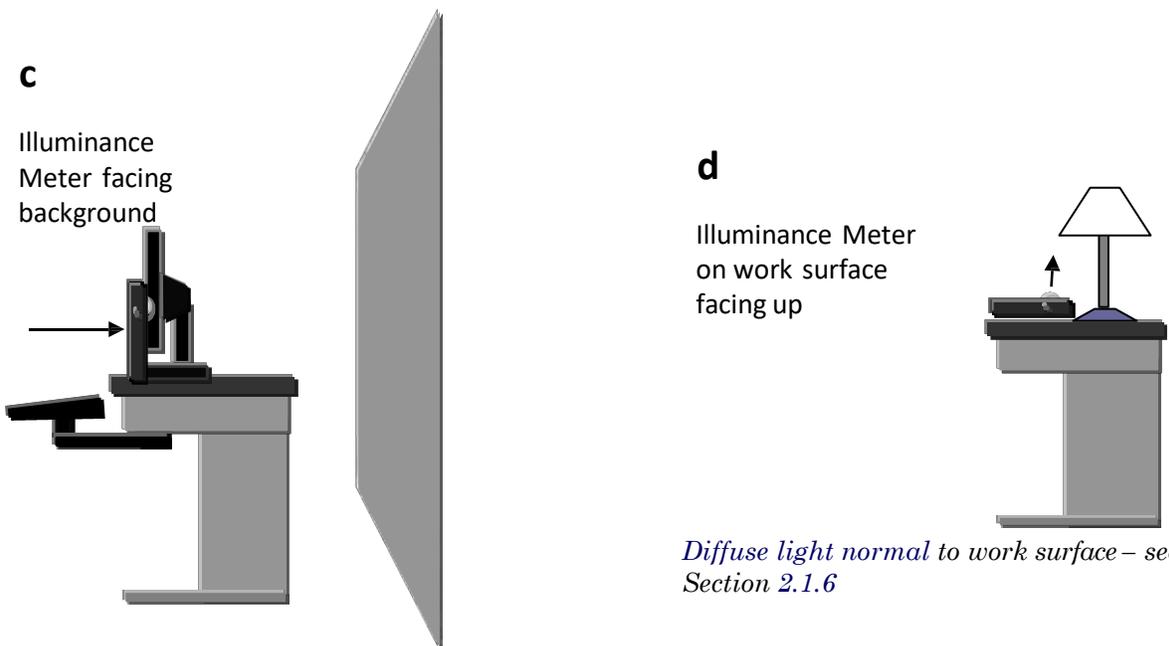
Office cubicle environments generally do not allow for uniform **illuminance**, and measurements are affected by the lighting nonuniformity. Measurements made following the procedures of the Ambient Light Measurement Procedure, as shown in Figure 2.1c, shall be between 0.5 and 6.7 fc.

For environments in which wall wash lighting is feasible, the vertical surface behind the display(s) shall have a uniform **illuminance** level between 0.5 and 6.7 fc, as measured in accordance with Ambient Light Measurement Procedures.



*Diffuse light normal to the keyboard – see Section 2.1.1*

*Diffuse light normal to the display – see Section 2.1.2*



*Diffuse light normal to the background – see Section 2.1.3*

*Diffuse light normal to work surface – see Section 2.1.6*

**Figure 2.1:** Illumination Measurements

### 2.1.4 Glare on Display

Glare from bright surfaces or light sources located behind the analyst can reflect off the display surface. These reflections will degrade the image in that local area. To check for glare, the analyst should be seated at the exploitation workstation.

With the display turned off and all operational light sources turned on, there shall be no **glare** sources evident on the face of the monitor. Alternatively, the **luminance** at any point of an unpowered display shall not exceed a value equal to 50% of the minimum **luminance** value to which the powered display is calibrated (e.g., 0.075 **foot-Lambert [fL]** for a 0.15 – 40 **fL** calibration).

### 2.1.5 Window Light

Window lighting is a source of **glare**, changing light level, and changing color temperature. For this reason, no window lighting is permissible. Any windows within the workstation area shall be covered totally with opaque drapes or paint.

### 2.1.6 Task Lighting

Activities related to printed matter and other nonsoftcopy-display-related tasks require a work area that is sufficiently well illuminated to support visual examination without ambient light-induced distortion on the softcopy display itself. Lighting for these sorts of tasks should not exceed 30 **fc** as measured on the work surface underneath the task lighting fixture, as shown in Figure 2.1d. The source of the ancillary task lighting (the bulb) should not be visible to the workstation operator.

### 2.1.7 Color Temperature

For color (multi-spectral) imagery or reference materials, the analyst's perception of color is influenced by the ambient environment as well as the imagery displayed. If there is a mismatch between the display and lighting color temperatures, color perception will be affected. The color temperature of the ambient lighting should be visually consistent with the chosen color temperature of the monitors as deemed through visual observation. There is no need to perform color temperature measurements. Many available LED light systems allow for the continuous adjustment of color temperature. Matching the color temperature of the room environment to the displays is not as essential for monochromic imagery.

## 2.2 Illuminance Meter

All measurements shall be made with an **illuminance** meter having a range of 0.01 – 200 **fc** and an accuracy of  $\pm 5$  percent. Measurements shall be made in accordance with the procedures defined in the Ambient Light Measurement Procedure in the appendix. Specifications apply at all times during operational **exploitation**, including when doors to nonexploitation areas are opened.

## **2.3 Surface Material Properties**

Surfaces within the workstation area affect lighting in the workstation area by reflecting ambient light. Glossy surfaces are a potential source of glare and colored surfaces affect color adaptation. Bright surfaces make it difficult to control ambient light to the desired low levels.

### **2.3.1 Diffuse Reflecting Surfaces**

Surfaces visible to the workstation operator (walls, furniture/equipment, floor) shall be diffuse reflectors. This is accomplished using neutral-colored flat (matte) or textured finishes instead of glossy finishes. Floor carpeting is recommended (but not specified) for both light control and sound-reducing properties.

# Recommendations

Recommendations for the design of a softcopy **exploitation** facility include ancillary task lighting, passage and maintenance lighting, emergency lighting, and ergonomics.

## 3.1 Lighting Recommendations

Table 3.1 covers lighting recommendations. These recommendations refer to the **exploitation** area in general; a specific measurement location or procedure is not as critical for lighting specifications.

**Table 3.1:** Lighting Recommendations

Lighting Type	Description	Acceptable Illumination
Cleaning/housekeeping lighting	Measure light falling on area surrounding workstation from above	10 – 25 fc
Workstation maintenance lighting	Measure light available at boards and connectors (from above or directable)	50 – 100 fc
Passage lighting within workstation area	Measure light directed at passage area on floor	0.5 – 10 fc, Tables 2.1 and 2.2 values must not be violated
Passage lighting outside workstation area	Measure light directed at passage area on floor	20 – 30 fc
Emergency lighting	Measure light directed at passage area on floor	≥ 20 fc

### 3.1.1 Lighting for Other Considerations

In addition to workstation and ancillary task lighting, lighting is needed for safe passage, maintenance and cleaning, and emergency egress. Lighting for cleaning and housekeeping activities should be in the range of 10 – 25 *fc* and should be directed downward from above the workstation. Lighting for workstation maintenance activities should be in the range of 50 – 100 *fc*. Such lighting should be directed downward from above the workstation or should be movable at the discretion of the maintenance operator. Lighting for cleaning, housekeeping, and maintenance should not be on during operational *exploitation* activities, since it would violate the specifications of Section 2.1.

Passage lighting within the workstation area should be in the range of 0.5 – 10 *fc* and should not violate provisions of Section 2.1. Such lighting may be directed downward from the ceiling level or upward from floor level. Passage lighting outside the workstation area should be in the range of 20 – 30 *fc*. Emergency lighting should be 20 *fc* or greater. Emergency lighting fixtures should not be placed on the wall behind a workstation, since they will interfere with uniform wall wash lighting.

## 3.2 Ergonomic Recommendations

Ergonomic recommendations include workstation furniture design and layout as well as noise, temperature, and airflow control. Proper ergonomic design maximizes analyst efficiency and reduces the potential for such things as repetitive strain injury.

# Glossary and Acronyms

## 4.1 Glossary

**adaptation** process by which the eyes adjust to varying levels of illumination or changes in color temperature.

**attenuation** gradual loss of intensity or amplitude.

**brightness** *colorimetric* term corresponding to an attribute of a visual sensation according to which an area appears to exhibit more or less light.

**candela** unit of luminous intensity in the *Commission Internationale de l'Éclairage (CIE)* photometric system;  $\frac{1}{60}$  of the luminous intensity of  $1 \text{ cm}^2$  of a black-body radiator at the temperature of solidification of platinum.

**chromatic** exhibiting hue as distinct from white, gray, neutral, or colorless.

**color** (1) sensory or perceptual component of visual experience, characterized by the attributes of *hue*, *saturation*, and *brightness*, and usually arising in response to stimulation of the *retina* by radiation of wavelengths between 380 and 760nm; related to the terms *hue*, *tint*, or *shade*; (2) stimulus or a visual object that evokes a *chromatic* response.

**color temperature** temperature of a black body radiator for an illuminant that is not a blackbody radiator; the *correlated color temperature* is the temperature of a blackbody radiator that yields the same chromaticity.

**colorimetric** relating to measurement of color.

**cones** photoreceptors in the human eye that are responsible for color vision, active during both *mesopic* and *photopic* vision.

**correlated color temperature** temperature in degrees *Kelvin (K)* of the Planckian radiator whose perceived color most closely resembles that of a given stimulus seen at the same *brightness* and under specified viewing conditions.

**diffuse light** light that is scattered and spread out as opposed to specular light; diffuse light is softer than direct light, with shadows that are less sharply-defined (lower contrast).

**distribution amplifier** device that amplifies and transmits a video signal over a distance using shielded coaxial cable.

**exploitation** extracting intelligence information from an image.

**foot-candle** unit of **illuminance** measurement; 1 foot-candle = 1 lumen per square foot.

**foot-Lambert** unit of **luminance** measurement; describes the **luminance** of a surface that emits or reflects one lumen per square foot; also the **luminance** of a **Lambertian** surface under an illumination of one **foot-candle**; 1 foot-Lambert = 3.4263 **candela** per square meter.

**ghosting** replication of the transmitted image, offset in position, that is superimposed on top of the main image.

**glare** direct or reflected light within workstation field of view that is sufficiently bright enough to cause reduction in image contrast.

**hue** degree to which a color stimulus can be described as similar to or different from stimuli that are described as red, green, blue, and yellow.

**illuminance** light intensity per unit area arriving at a surface, expressed in lumens per unit area; commonly measured in **foot-candles**.

**impedance** total passive electrical resistance, including resistance, inductive reactance, and capacitive reactance; opposition to the flow of electric current; measured in ohms; used to rate input and output characteristics of components so that a proper “match” can be made when connecting two or more electronic devices.

**interpretability** ability to derive intelligence value from an image.

**Lambertian** uniform radiance distribution.

**luminance** photometric measure of the amount of luminous intensity in a given direction; measured in **foot-Lamberts**.

**mesopic** state of vision in which both **rod** and **cone** photoreceptors are active.

**normal** perpendicular.

**perception** physical sensation interpreted in the light of experience of, relating to, or involving perception especially in relation to immediate sensory experience.

**photopic** state of vision in which only the **cone** photoreceptors are active.

**repeater** device that amplifies a signal before transmitting it again.

**retina** part of the eye containing photoreceptor cells, called **rods** and **cones**.

**rods** photoreceptor cells in the **retina** of the eye that function at lower light levels; located more in the periphery of the eye, and are more sensitive to movement; about 130 million rod cells exist in a human **retina**.

**saturation** quality of visual perception that permits a judgment of different purities of any one dominant wavelength; degree to which a **chromatic** color differs from gray at the same **brightness**.

**veiling glare** **diffuse light** scattered in the line of sight, masking image-forming light from a display.

## 4.2 Abbreviations/Acronyms

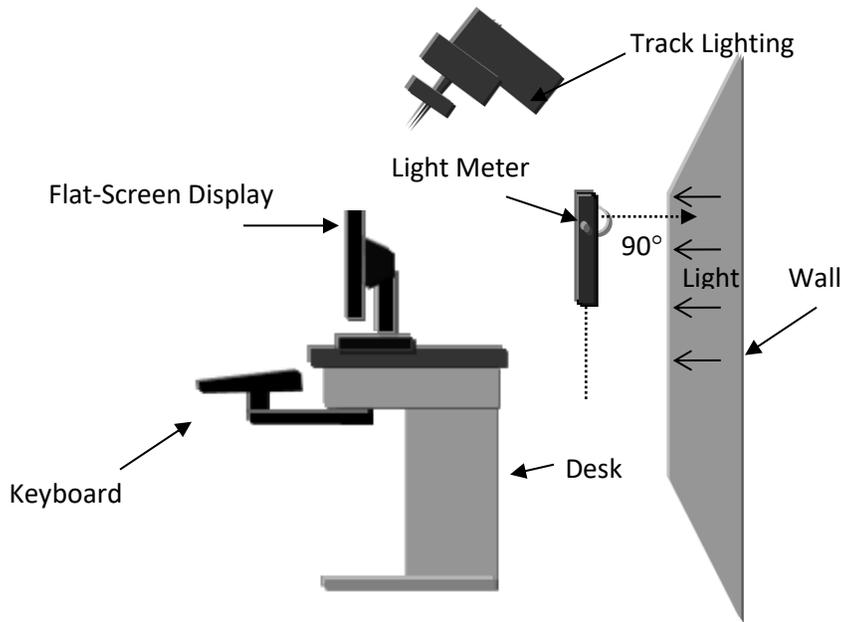
CIE	Commission Internationale de l'Éclairage.
CRI	Color Rendering Index.
fc	foot-candle.
fL	foot-Lambert.
K	Kelvin.
N/A	Not Applicable.
NGA	National Geospatial-Intelligence Agency.
NIQU	NGA/TACQ Image Quality & Utility.

# Appendix

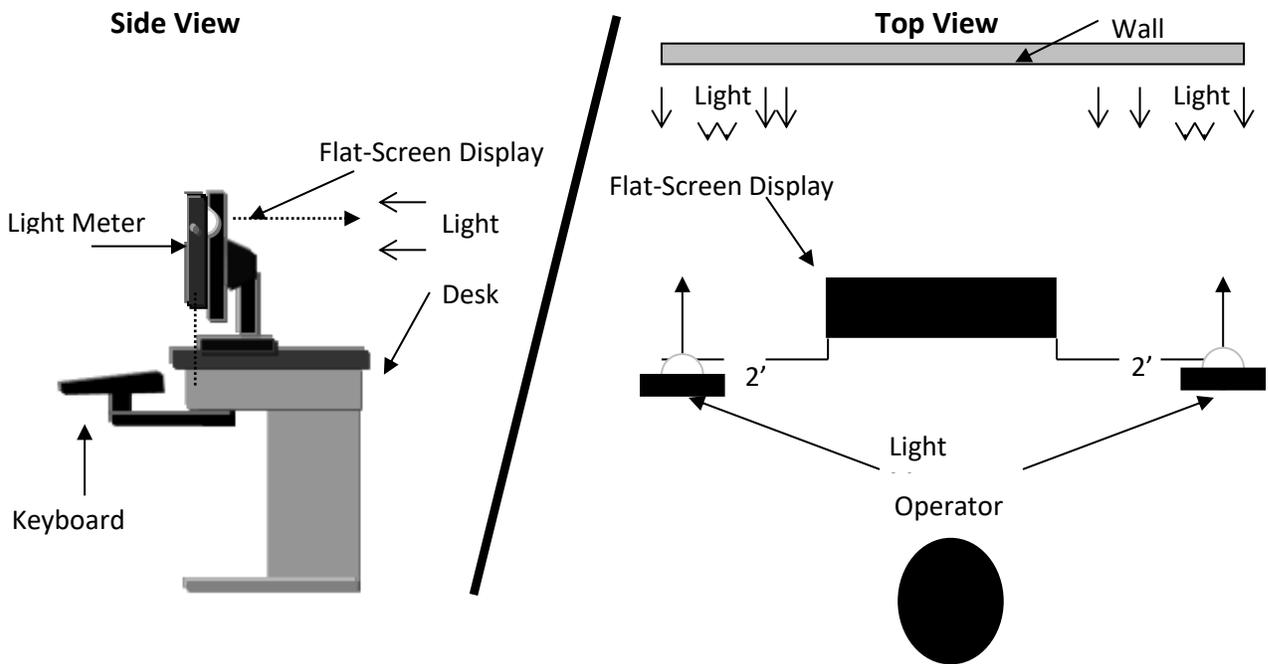
## 5.1 Ambient Light Measurement Procedure

Step #	Action	Check/Comments
1.	Check the calibration expiration date on your illuminance meter. If the illuminance meter has passed its calibration expiration date, continue with the procedure and submit for recalibration when complete.	
2.	Power on the illuminance meter.	
3.	Adjust the following settings on the illuminance meter: Units: foot-candles (fc or fcd) Illuminance: match lamp type <b>NOTE: 10.76 lux = 1 fc</b>	
4.	If required, zero-adjust the illuminance meter.	
5.	<b>(WALL WASH EXPLOITATION ENVIROMENTS ONLY)</b> Perform a <b>Normal to Background measurement</b> by positioning the illuminance meter approximately 2 ft from the uniformly lit wall, at the monitor's height, with its sensor facing normal to the wall. Wait a few seconds and then press the hold button to record an illuminance reading. <b>Refer to Figure 1.</b>	
6.	<b>(CUBICLE EXPLOITATION ENVIROMENT ONLY)</b> Perform a <b>Normal to Background measurement</b> by positioning the illuminance meter approximately 2 ft from the side of the display, with its sensor facing normal to the cubicle wall. Wait a few seconds and press the hold button to record an illuminance reading. <b>Refer to Figure 2.</b>	
7.	If the reading is between 0.5 and 6.7 foot-candles, proceed to the next step. Otherwise, adjust any possible light sources until you achieve a reading between 0.5 and 6.7 foot-candles. <b>NOTE: Some environments may have trouble reaching appropriate ambient light measurement values for the Normal to Background measurement.</b>	

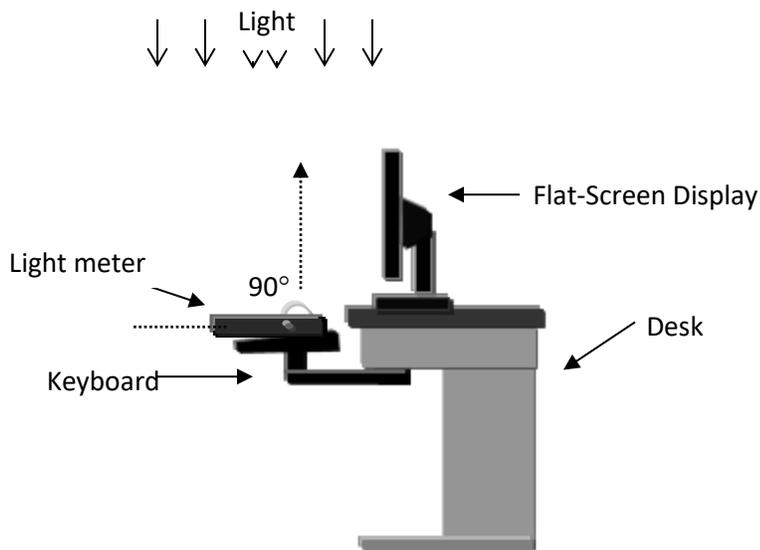
Step #	Action	Check/Comments
8.	Perform a <b>Normal to Keyboard</b> measurement by holding the illuminance meter 6 inches directly above the keyboard, with its sensor facing the ceiling. Wait a few seconds and then press the hold button to record an illuminance reading. <b>Refer to Figure 3.</b>	
9.	If the reading is between 0.5 and 2.0 foot-candles, proceed to the next step. Otherwise adjust any overhead light source until you achieve a reading between 0.5 and 2.0 foot-candles, and then proceed to the next step.	
10.	Perform a <b>Normal to Softcopy Display</b> measurement by holding the illuminance meter flat against the center of the display, with its sensor facing away from the screen. Wait a few seconds and then press the hold button to record an illuminance reading. <b>Refer to Figure 4.</b>	
11.	If the reading is less than or equal to 2 foot-candles, proceed to the next step. Otherwise, lower any possible light sources until you achieve a reading that is less than or equal to 2 foot-candles.	



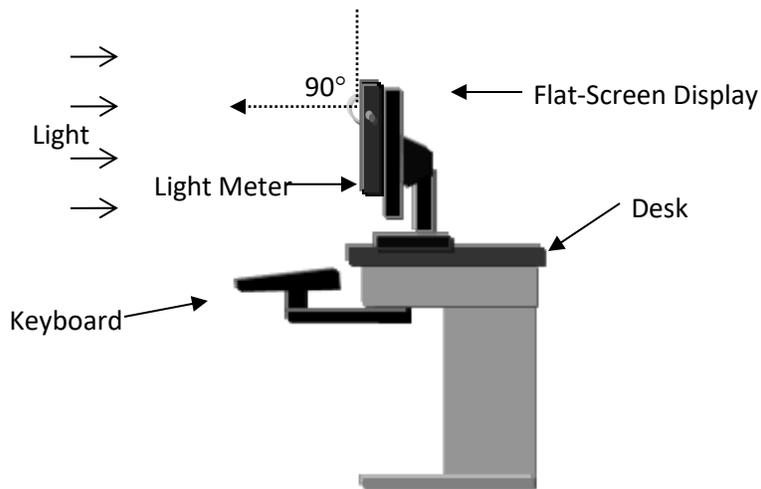
**Figure 1: Normal to Background Measurement (Wall Wash Exploitation Environment)**



**Figure 2: Normal to Background Measurement (Cubicle Exploitation Environment)**



**Figure 3: Normal to Keyboard**



**Figure 4: Normal to Softcopy Display**

## 5.2 Ambient Light Visual Assessment

Step #	Action	Check/Comments
1.	If the monitor is on, turn it off.	
2.	Sit in front of the workstation and view the softcopy display screen.	
3.	Move your head several inches left to right and up and down while looking for glare reflections on the screen.	
4.	In your notes, record whether or not you have found any glare.	
5.	If you did find glare, identify the light source causing the glare, reposition the light source to remove the glare from the softcopy display, and record your corrective actions in your notes. <b>CAUTION: When repositioning a light source, be careful not to aim it directly at another exploitation workstation.</b>	
6.	Turn off all room lights.	
7.	Visually inspect any windows to determine if any light is visible. If there is light leaking into the room, make an attempt to block the light coming through the window. Repeat observation to verify no window light is entering the exploitation area. Record corrective actions in your notes.	
8.	If there is no visible light leakage from the window, then the Ambient Light visual assessment is complete.	