American Railway Engineering and Maintenance of Way Association
Letter Ballot

1. **Committee and Subcommittee: Committee 33 – Electrification – No subcommittee**
2. **Letter Ballot Number: 33-22-01**
3. **Assignment: 33-02**
4. **Ballot Item: Revise Part 10 – Revisions to 10.4 and 10.5 – Illumination**
5. **Rationale: Text updates to section 10.4 and 10.5**

Part 10

Illumination

— ~~2018~~ 2022 —

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

SECTION 10.0 CHANGES FROM 2005 EDITION (2018)

Section 10.3 dealing with lighting for Transit and Railroad Storage and Maintenance Yards has been added, but is still under development together with its associated table of recommended illumination levels (Table 33-10-7). In addition, the previous Table 33-10-1 has been split into six tables directly associated with the relevant text sections. As in prior versions, Illumination Levels are quoted in Foot Candles but a soft conversion to Lux values, which are shown in parentheses, has been added.

SECTION 10.1 GENERAL (2018)

This section details recommended practices for the application of lighting and illumination in railway applications. It should be understood that lighting designs for railway applications should be performed by a qualified lighting professional.

The majority of the information contained in earlier versions of Part 10 of this Chapter has been expanded, updated or reprinted in the Illumination Engineering Society of North America (IESNA), "Lighting Handbook" including the engineering and maintenance recommendations, which should be used as the basis for any railway lighting system. This section covers items that may be specific to railway applications and are generally not covered under the IESNA guidelines.

SECTION 10.2 OUTDOOR AREA LIGHTING IN RAILROAD YARDS AND TERMINALS (2018)

10.2.1 GENERAL

a. Adequate lighting of railroad yards, work tasks and areas, storage areas and platforms is essential to promote safety of personnel, expedite operations, and to reduce vandalism.

b. The purpose of this section is to present recommended illumination levels applicable to the varied tasks encountered on railroad properties and to guide the lighting designer in the proper application of the lighting

luminaires to assure satisfactory visibility. Included are descriptions of visual tasks encountered on railroad properties, design data, and graphic illustrations or select technical items.

c. Recommended levels of illumination included herein were determined by scientific evaluation of the seeing tasks, and the material presented was a joint effort of the Illuminating Engineering Society, Outdoor Productive Areas subcommittee of the Industrial Lighting Committee, together with personnel from the former AAR Lighting Committee and former AREA Committee 18, prior to the formation of Committee 33.

d. Railroad properties can be divided into general areas which have different seeing tasks within them. By considering each type of property separately, and further breaking down each type into areas involving specialized seeing tasks, specific levels of illumination can be recommended that cover most variations among individual railroads. Refer to the relevant table for recommended illumination levels. Different levels may be required if closed circuit television is utilized to aid in operations.

e. Railroad regulations should be observed with respect to the location of any lighting equipment above or adjacent to tracks.

f. Effective lighting requires more than just selecting the “recommended illumination level”. Optimum “lighting application efficacy” for a specific task is determined by selecting the appropriate illumination level, then analyzing the characteristics of the surrounding environment ambient luminance and light source placement and luminance to verify that extraneous light will not create adverse effects, such as glare. Glare can seriously degrade visual performance at the task site and elsewhere, and can create “light pollution” on adjacent properties or facilities.

g. The Recommended Illumination Levels shown in the following tables are general in nature. The direction of the lighting or luminaire type may require different levels from those quoted for specific installations. All foot-candle values are assumed to be in the horizontal plane and measured at top of rail unless otherwise specified

10.2.3 RETARDER CLASSIFICATION YARDS.

The large and often highly automated retarder classification yard, with its supporting yards and servicing facilities, presents a number of different seeing tasks that are considered under the following locations (See Figure 33-10-1 and

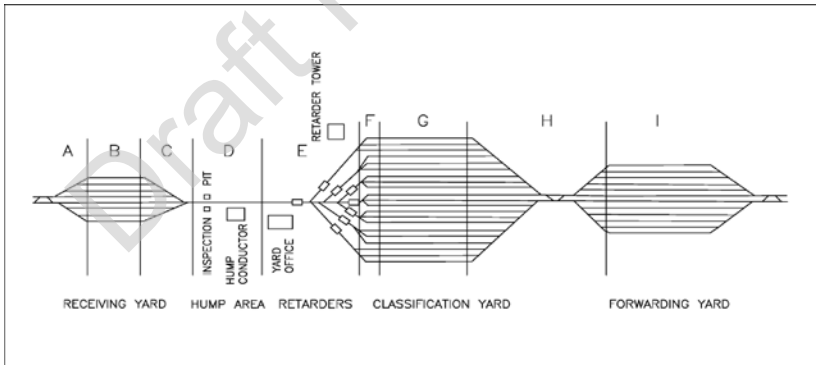

Table 33-).

Figure 33-10-1. Retarder Classification Yard

10.2.3.1 Receiving Yard

a. Inbound freight trains generally pull into a receiving yard where road locomotives and freight cars are uncoupled and moved to servicing or storage tracks. Air lines between cars may be disconnected, cars may be inspected, axles tested, etc. A locomotive then pushes the cars to the hump for classification.

b. Seeing tasks throughout the area consist of walking between cars, bleeding air systems, and observing air hoses, safety appliances, etc.

10.2.3.2 Hump Area

a. The hump area includes those facilities between the leaving end of the receiving yard and the entering end of the main retarder. Located in this area are the hump conductor, scale operator, and the car uncoupler. Special facilities in this area may include a car inspection pit, broken wheel flange detector, and a facility to insert disposable wedges into couplers to verify that they are held open for coupling to other cars in the yard. In some yards, a hump conductor operates remotely controlled power switches to route the car onto the proper track in the classification yard.

b. Seeing tasks in the hump area are diversified. The scale operator is usually required to visually check each car number to confirm that the weight is recorded against the proper car. The hump conductor also should confirm the car number against his list and confirm that the car is sent to the proper yard track. The car inspectors must have a high level of light on the underneath surfaces of the car and on the running gear to permit ready and precise inspection of a car that is in motion. The car uncoupler should be able to see the uncoupling mechanism in order to safely reach it while the car is in motion. The operator of the wedge inserter, if one is used, must be able to accurately see the coupler in order to apply the wedge, again with the car in motion.

c. The hump conductor, car inspector, car uncoupler and wedge operator should have supplemental lighting, in addition to general lighting in the hump area as indicated in Table 33-.

10.2.3.3 Control Tower and Retarder Area

a. Many retarder classification yards are equipped with various methods for determining car speed, "rollability," track occupancy, etc. These devices automatically set retarders to permit a car to roll from the hump to its proper position in the yard without action by the control tower operator. Other less automated yards may require the operator to visually check the extent of track occupancy in the yard, gauge the speed of the car coming from the hump and manually set the amount of retardation to be applied to the car. Even in the automated yard, the operator may also be required to do this manually in the event of failure of one or more of the automatic features. In many yards, the control tower operator is expected to check the car number against a switching list and see that the car goes to the correct track. Accordingly, it is essential that the operator quickly and accurately identify the moving car.

b. Under clear atmospheric conditions, it is important that there be no direct light projected toward the operator, and this covers a considerable angle. However, under adverse atmospheric conditions of dense fog, for example, it is general practice to utilize auxiliary lighting equipment on the far side of the tracks opposite the retarder control tower which will reveal the outlines of cars in silhouette.

10.2.3.4 Head End of Classification Yard

After a car is classified and leaves the retarders, it rolls along one of several "lead" tracks with various switches branching off each lead track into the classification yard tracks. The operator should be able to see that the car actually clears switch points and clearance points so that following cars will not be impeded or perhaps damaged. If a car does not clear, a locomotive enters the yard to move the car, and if for some reason a car is sent down the wrong yard track, the locomotive must pull it back. Some highly-automated yards have indicating systems to show locations of all cars and track occupancy conditions on the classification tracks. Again, if automated features fail, it is as important for the operator to be able to see yard conditions as accurately in the automated yard as in the less automated one.

10.2.3.5 Body of Classification Yard

A relatively large number of parallel tracks form the body of the classification yard. Cars having a common initial destination are sent from the hump to a given track in the classification yard. In many yards, the operator must be able to see the body of the yard sufficiently well to determine the extent of track occupancy. On some railroads, personnel are required to move along cars in the body of the classification yard to couple air hoses, etc. At the leaving end of the body of the classification yard, skatemen place track skates to stop moving cars at the desired location and remove the skates later for pullout. Some yards use automatic car stoppers instead of skates.

10.2.3.6 Pull-Out End of Classification Yard

a. The pull-out end of the classification yard includes the area where yard tracks converge into one or more ladder tracks in leaving the yard. In this area, switchmen may walk along the track, ride standing on switcher step, cling to the end car to observe switch position, or step down while still in motion to throw switches as required.

b. Two or more ladder tracks may converge into two pullout tracks which may be inter-connected by crossovers and also connected to the lead tracks to the departure or local yards. Switches for crossovers and lead tracks are sometimes power-operated from an adjacent control point by the switchmen with consequent increased switching speeds. Switchmen must be able to see that the switches take the position directed by the controls.

10.2.3.7 Dispatch or Forwarding Yard

Some railroads pull strings of cars from classification tracks into a dispatch yard to make up a train. Here, air hoses are coupled, and perhaps other inspections are made. As in the receiving yard, the main seeing task in the dispatch yard consists of walking between tracks.

Table 33-10-1. Levels of Illumination - Retarder Classification Yard

Area to be Lighted	Seeing Tasks – Operations Performed	Recommended illumination Level Foot-Candles (Lux)	Location References (Fig. 33-10-1)

1. Receiving Yard			
a. Switch Points – Incoming end	Walking between Cars; Bleeding air systems; Opening journal box covers; Inspecting air hoses and safety appliances; etc.	2.0 (21.53)	A
b. Body of Yard		1.0 (10.76)	B
c. Switch Points – Hump end		2.0 (21.53)	C
2. Hump Area			
a. Entire side of car in view of scale operator and hump conductor	Scale operator checks car numbers and weights; Hump conductor confirms car number and sends car to proper track; Inspection of running gear while car is in motion; Coupling must be easily seen so wedge can be applied with car in motion;	20.0 (215.28)	D
b. Underneath car and both sides of running gear from a point approximately 10 feet ahead of inspection pit to a point just past inspection pit		20.0 (215.28) vertical	D
c. On side of car, as it approaches uncoupler (pin puller), from a point approximately 15 feet ahead of its position to approximately 5 feet past		20.0 (215.28) vertical	D
d. On front of car, as it approaches wedge inserter, from a point approximately 15 feet ahead of his position to approximately 5 feet past		20.0 (215.28) vertical	D
3. Control Tower and Retarder Area			
In a vertical plane parallel to the tracks and at a point 6 feet above the center of the Hump and retarder tracks; if an illumination meter is used to check an installation, it should be aimed in a direction perpendicular to the tracks and toward the Tower side.	Check extent of track occupancy, gauge speed of car coming from Hump and manually set retardation; Check car number against switching list and see that car goes to correct track at correct speed	10.0 (107.64) vertical	E
4. Head End			
Top of rails throughout head end on all "lead" tracks	Operator must see car actually clear switch points so that following cars will not be impeded and take corrective action, if necessary	5.0 (53.82)	F
5. Body			
Top of rails throughout body of classification yard	Walking; Determine extent of track occupancy; Couple air hoses; Place and remove track skates, etc.	1.0 (10.76)	G
6. Pull-Out End			
Top of rails along switch tracks	Walking; Determine switch point positions and operate them, if necessary	2.0 (21.53)	H
7. Dispatch or Forwarding Yard			
Top of rails	Walking; Couple air hoses	1.0 (10.76)	I

10.2.4 HUMP AND CAR RIDER CLASSIFICATION YARDS

a. In contrast to the often highly automated retarder classification yards, there are many yards that do not use retarders and tower operators for classification of cars. This type of yard, referred to as the "hump and car rider" classification yard, depends upon manpower for operation. An incoming freight train is pushed to the hump where it is uncoupled and a car rider climbs aboard each car, or "cut" of a few cars. The cars are allowed to roll from the hump toward the classification yard tracks, where switchmen, often directed by a loudspeaker from the hump, manually operate switches to permit the car to roll onto the proper track. As the car rolls along its classification track, the car rider gauges the distance to other cars on the track and manually applies the car brakes, by turning the brake wheel, to slow the car so that the impact will not be severe. Upon stopping the car, the rider gets off and walks back to the hump to repeat the riding cycle.

b. This type of classification yard may be supported by a receiving yard and a dispatch yard where the same seeing tasks are encountered as in their retarder yard counterparts.

c. The seeing tasks in the classification yard, and around the hump, (see Table 33-10-2) are considerably different in the rider-type yard from those in the retarder yard. Around the hump area, a yard clerk should be able to read car numbers and differentiate colors, cars must be uncoupled, and car riders must be able to see grab irons, ladders, etc., to safely climb onto the cars. Switchmen operating along the lead track must have safe seeing conditions to enable them to walk along the lead track and operate switches. Car riders on the cars rolling into the yard should be able to see cars on the track ahead so that they can brake adequately to reduce impact and prevent consequent damage to lading. The rider must then be able to see to get off the car and walk back along yard tracks to the hump.

Area to be Lighted	Seeing Tasks – Operations Performed	Recommended illumination Level Foot-Candles (Lux)	Location References (Fig. 33-10-1)
1. Receiving Yard			
a. Switch Points	Switchmen walk along lead tracks and throw switches. Car riders on rolling cars must see cars on tracks ahead of them so they can apply brakes adequately to reduce impact and prevent damage. Car rider must see to get off car and walk back along yard tracks to hump	2.0 (21.53)	-
b. Body of yard		1.0 (10.76)	-
2. Hump Area			
a. Side of car	Yard clerk reads numbers, uncouples cars, car rider must see grab irons and ladders to safely climb onto cars.	5.0 (53.82) vertical	-
b. Entire area		5.0 (53.82)	-

Table 33-10-2. Levels of Illumination - Hump and Car Rider Classification Yards

10.2.5 FLAT SWITCHING YARDS

a. Nearly all railroads have many relatively small flat switching yards on their systems. Often a flat switching yard is located adjacent to an industrial area where cars are received from industries and at some period of the day, or night, these cars are moved to a larger classification yard for further forwarding. Empty cars may also be returned to the flat switching yard for distribution locally to industries for loading. Operations at the flat switching yard consist of a switchman at the head end operating one of perhaps a half dozen or so switches to permit a locomotive to push or pull cars onto a given track in the yard. The locomotive may then return for more cars and push or pull them onto another track, etc., until the cars are arranged in the desired order on the yard tracks, from which the cars are pulled out to move to some other location.

b. The only seeing requirement in most yard areas of this type (see Table 33-10-3) is for safe walking conditions for switchmen around the head end and pull-out end switches. A yard supervisor may also be required to read car numbers at the head end of the yard in order to assign cars to their proper tracks. A locomotive pushes the cars into the body of the yard, and in most cases, the locomotive headlight furnishes sufficient light to provide adequate seeing for the locomotive driver.

c. General lighting is recommended over the entire yard to permit switchmen to see the location of standing cars. Additional light should be provided near the switches at the head end and pull-out end of the yard.

d. If a yardmaster or yard clerk must read car numbers, local lighting must be provided at his location.

Area to be Lighted	Seeing Tasks – Operations Performed	Recommended illumination Level Foot-Candles (Lux)	Location References (Fig. 33-10-1)
1. Receiving Yard			
b. Switch points		2.0 (21.53)	-

Table 33-10-3. Levels of Illumination - Flat Switching Yards

10.2.6 TRAILER-ON-FLATCAR YARDS

a. Hauling highway-type trailers loaded on special railroad flatcars has grown rapidly in recent years. There are several types of flatcars in use, and several methods of placing trailers on them. One of the most prevalent methods in use is to provide a ramp leading from the ground level up to the floor level of flatcars. The trailer is backed up the ramp by highway tractor, then backed or pushed from one flatcar to the next until it is on its prescribed car, working from the back car forward. Certain specialized methods are used in some places to lift and pivot the trailer onto flatcars from the side. Once the trailers are on the flatcars, most railroads use specialized tie-down equipment and methods to secure the trailers for shipment by rail.

b. Seeing tasks involved require the tractor operator to be able to back up or drive along the floor of the flatcars, uncouple the tractor and pull off. Personnel must then tie down the trailers to the flatcars, requiring them to be able to see beneath the trailers (see Table 33-10-4).

Table 33-10-4. Levels of Illumination - Trailer-on-Flatcar Yards

Area to be Lighted	Seeing Tasks – Operations Performed	Recommended illumination Level Foot-Candles (Lux)	Location References (Fig. 33-10-1)
1. Receiving Yard			
b. Switch points		2.0 (21.53)	-

Table 33-10-4.

10.2.7 CONTAINER-ON-FLATCAR YARDS

a. In container-on-flatcar yards, demountable load containers are detached from the trailer and loaded onto the railroad flatcars, or vice versa, by crane. Usually, the trailers are lined up parallel with the flatcars. A crane straddling both the trailers and flatcars picks up the demountable containers and places them on the cars.

b. The seeing task involves the transfer of the container between the trailer wheel frame and the flat car, also locating, releasing, and tying down of the container.

c. Other types of container-on-flatcar operations may employ different methods of loading and unloading, but the illumination required is similar (see Table 33-10-5).

Area to be Lighted	Seeing Tasks – Operations Performed	Recommended illumination Level Foot-Candles (Lux)	Location References (Fig. 33-10-1)
1. Receiving Yard	a. any part of the trailer parking yard and place them precisely on flatcars, b. flatcars and place them precisely on trailers 1.0 (10.76)		

Table 33-10-5. Levels of Illumination - Container-on-Flatcar Yards

10.2.8 MAINLINE INTERLOCKINGS

a. In mainline interlockings maintenance-of-way personnel are required to continuously inspect and maintain the operation of interlocking equipment including those for track, signals, communications, and electric traction. This requires the movement of personnel in and about the tracks from home signal to home signal. These interlockings are of vital importance to the safe and effective performance of railroad operations.

b. Specific seeing tasks (see Table 33-10-6) include the inspection, maintenance and testing of switch points and switch machines, electrification system sectionalizing switches and section breaks, central instrument house and local control cases, snowmelter facilities, and miscellaneous conduit and cable installations to support Communications & Signals and Electrification facilities.

c. Lighting for mainline interlockings should be designed with either automatic (photoelectric) controls or local lighting controls.

Area to be Lighted	Seeing Tasks – Operations Performed	Recommended illumination Level Foot-Candles (Lux)	Location References (Fig. 33-10-1)
1. Receiving Yard			

Table 33-10-6. Levels of Illumination - Mainline Interlockings

SECTION 10.3 OUTDOOR AREA LIGHTING IN PASSENGER TRANSIT YARDS AND TERMINALS (2018)

10.3.1 PASSENGER TRANSIT STORAGE AND MAINTENANCE YARDS

THIS SECTION IS UNDER DEVELOPMENT

Area to be Lighted	Seeing Tasks – Operations Performed	Recommended illumination Level (footcandles)Lux	Location References
			a. Switch Points
b. Body of yard		1.0 (10.76)	-

Table 33-10-7. Levels of Illumination - Storage and Maintenance Yards

SECTION 10.4 FACTORS AFFECTING EFFICIENT LIGHTING

10.4.1 GENERAL

a. A proper lighting maintenance program is essential to protecting the return on investment of a lighting system. A proper program periodically raises illumination levels back as nearly as possible to the original design. Lighting levels fall off principally because dirt accumulates on lamps and reflecting surfaces and the normal loss of light output from lamp aging.

b. A good maintenance program should include the periodic cleaning of lamps and fixtures, cleaning or repainting of room surfaces, such as walls and ceilings, replacing failed lamps and ballasts/drivers, and verifying proper voltage at the utilization points.

~~10.4.1~~ c. When setting up a proper lighting maintenance program, it is recommended to follow the guidelines set forth in national standards, such as the National Fire Protection Association 70B - Recommended Practice for Electrical Equipment Maintenance and/or the Illuminating Engineering Society RP 36-20 - Recommended Practice: Lighting Maintenance, should be followed.

~~a. Proper maintenance will provide these features:~~

~~(1) Increased production.~~

~~(2) Fewer errors.~~

~~(3) Fewer accidents.~~

~~(4) Improved morale.~~

~~(5) Improved protection from vandalism.~~

~~b. Protecting the return from investment in a lighting system requires a lighting maintenance program that periodically returns foot-candle levels back as nearly as possible to the original design. Lighting levels fall off~~

Formatted: Body, No bullets or numbering

Formatted: Character scale: 0%

~~principally because dirt accumulates on lamps and reflecting surfaces; there is also the normal loss of light output from lamp aging.~~

~~c. A good maintenance program, to provide the necessary protection, should include the periodic cleaning of lamps and fixtures, cleaning or repainting of room surfaces, such as walls and ceilings, replacing burnt-out lamps, and maintaining proper voltage levels.~~

~~d. In many installations it will be found the light output is only 50% as high as it should be. Light output can be increased by repainting, cleaning fixtures, and by correcting the voltage to designed levels.~~

10.4.2 CLEANING

10.4.2.1 Cleaning Schedule

The cleaning frequency required for a particular plant or office can best be determined by taking periodic light meter readings after the first cleaning. When illumination levels ~~foot-candles~~ have dropped 15% to 20%, it is recommended ~~time~~ to clean again. An alternate method would be to have an annual cleaning program scheduling each office area or shop to be cleaned on ~~at~~ a ~~definite~~ specific date. This method permits one trained crew to do all the cleaning as they progress from one plant to the other. The scheduling can be planned ~~taking~~to take into account dirt conditions, fixture ventilation, time required to clean each luminaire, and size of maintenance crew.

10.4.3 RELAMPING

10.4.3.1 Group Relamping

Studies have shown that ~~T~~the labor costs saved by group relamping, in lieu of spot relamping, ~~–~~usually more than outweighs ~~compensate for~~ the value of the depreciated lamps that are thrown away before they burn out. Other advantages of utilizing a group relamping model are: ~~also accompany group relamping such as more light,~~ fewer work interruptions, better appearance of the lighting system, and less maintenance of auxiliary equipment. Group relamping should be related to lamp life but may be varied slightly to fit into convenient schedules when there will be less interruption of work.

10.4.3.2 Spot Relamping

Some areas require spot replacement because of a hazardous location or to maintain appearances. In these areas and locations where specialized high-cost lamps are in use, spot relamping may prove to be the most economical method of replacement.

10.4.4 VOLTAGES

a. Light sources are designed to operate most economically when supplied with rated voltages. Voltages either too high or too low will affect the life, ~~efficiency~~efficiency, and economy of the lamps.

SECTION 10.5 ELECTRIC LAMP CHARACTERISTICS (~~2018~~2022)

a. For more detailed information, it is suggested that the Illuminating Engineering Society Lighting Handbook, and the electric lamp manufacturers be consulted.

a. Currently, the main electric lamps types may be divided into three categories, namely:

(1) Incandescent-filament: Metal Halide and High Pressure Sodium
(2) Fluorescent: Linear fluorescent and compact fluorescent
(3) Light Emitting Diodes (LEDs).

a. Standard fixtures are available in various voltages ratings including 120, 240, 277 and 480 V. Consultation with the fixture manufacturer is recommended to determine the best fixture for a specific application to include the effect of line voltage on fixture life and rated light output.

~~b. Electric lamps may be divided into three major types, namely: incandescent-filament lamps, electric discharge lamps and light emitting diodes.~~

~~c. The main types of lamps currently in use include Metal Halide, High Pressure Sodium, Fluorescent and LED (Light Emitting Diodes). Standard fixtures are available in various voltages ratings including 120, 240, 277 and 480 V. Consultation with the fixture manufacturer is recommended to determine the best fixture for a specific application to include the effect of line voltage on fixture life and rated light output.~~

SECTION 10.6 EVALUATION MEASUREMENTS AND TESTS (2018)

a. Since the primary considerations in railway yard lighting vary with the accommodations and the task as described, evaluation measurements should be based on tasks or functions normally found in the area of the railway under construction. When evaluating the lighting for any particular area the applicable combination of measurements will have to be employed.

b. The following general factors apply to any tests:

(1) Extraneous light should be excluded where possible.

(2) The voltage should be held constant or the reading corrected for any voltage deviation from normal.

(3) Prior to testing, lamps should be "burned-in" as recommended by the manufacturer.

(4) Systems should be lighted for at least one-half hour before any readings are taken.

Formatted: Font: CentSchbook BT, 10 pt, Font color: Black

Formatted: Indent: Left: 0.17", Space After: 11 pt, Line spacing: At least 12 pt, Don't adjust space between Latin and Asian text, Don't adjust space between Asian text and numbers

Formatted: Indent: Left: 0.75"

(5) When photoelectric cell type devices are used, the ambient temperature should be above 60 degrees F and such devices should have their cells exposed to the approximate levels of illumination to be measured for at least 15 minutes prior to taking any readings.

c. Information should include the following:

(1) Name and type of property.

(2) Location when test is made.

(3) Names of those conducting test.

(4) Date.

(5) Time of Day:

(a) Daylight with shades drawn.

(b) Night with shades drawn.

(c) Night with shades up.

NOTE: Unshaded windows at night are black surfaces with very low reflectance factors. Shades are usually of a much higher reflectance value.

(6) Instruments used, date of last calibration, and whether equipped with color correction filter.

(7) Identification of area tested.

(8) Color and cleanliness of walls, ceiling, furniture and floors.

(9) Type of lighting fixtures and record of which fixtures were lighted.

(10) Conditions of fixtures:

(a) New or old.

(b) Type of reflector and condition.

(c) Cleanliness.

(11) Wattage and rated voltage of lamps.

(12) Correlated Color temperature (CCT) of lamps.

(13) Voltage at switchboard.

(14) Location where readings were taken.

(15) Description of readings:

(a) Horizontal, vertical plane or 45 degree plane.

(b) Distance above floor.