ENTRY CONTROL FACILITY /ACCESS CONTROL POINT

LIGHTING ANALYSIS

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INTRODUCTION

Clanton and Associates conducted an on-site evaluation the NAVFAC Criteria and Programs office to gain an understanding of the current lighting conditions at Entry Control Facilities (ECF). Information gathered from this on-site evaluation was used to validate effective light level requirements for the 2022 revision of UFC 3-530-01.

The ECF area is broken out into three design aspects, see Figure 1:

- Approach Zone
- Access Control Zone
  - In front of canopy
  - Underneath canopy
- Response Zone

Zone	Location	Goals
Safety	Extends in all directions beyond passive and active barriers.	Protect assets and personnel from explosions.
Approach	Installation boundary to a point just before the ID checkpoint.	Reduce speed, sort vehicles, provide stacking room, identify potential threats.
Access Control	A point just before and after the ID checkpoint.	Identify vehicles and personnel; provide surveillance, random inspection, visitor processing, and rejection capabilities.
Response	A point just after the ID checkpoint to the active vehicle barriers.	Provide measures to react to and resist a threat.

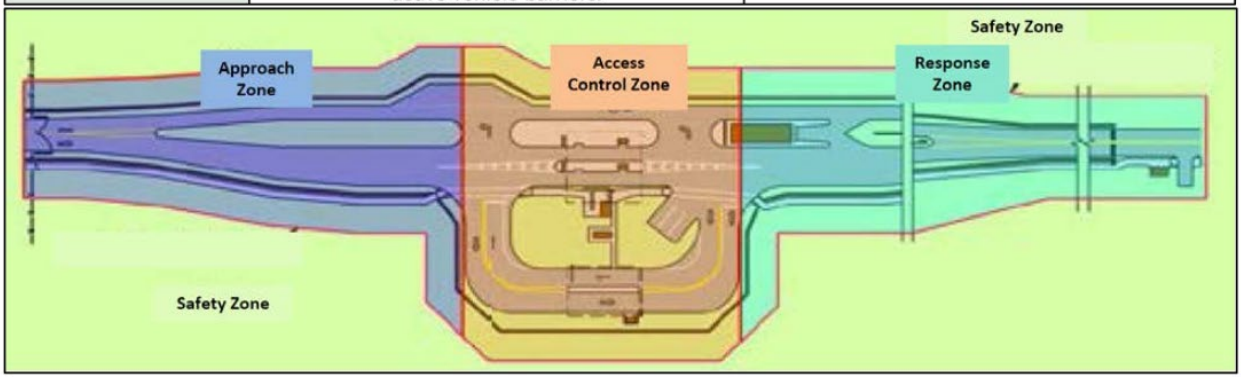

Figure 1 - Layout of ECF from UFC 4-022-01

Approach Zone

The goal of the lighting in the Approach Zone is to facilitate the capability of Security Personnel to assess approaching vehicles and pedestrians for potential threats, and for drivers to see obstacles and navigate the Approach Zone. Security Personnel are standing in the Access Control Zone, which has higher light level requirements, so visual adaptation is important to consider. Drivers of approaching vehicles will be arriving from a variety of lighting conditions, which makes the transitional lighting dependent on the surrounding environment.

Assumptions are made that adjacent roadways are designed to the relevant IES Roadway Criteria at time of design, provided in *IES Recommended Practice 8, Lighting for Roadway and Parking Facilities* (IES RP-8). The Approach Zone is a transitional zone between the Access Control Zone and local roadway lighting conditions.

Access Control Zone

The lighting goal within the Access Control Zone is to allow the Security Personnel to see vehicles and assess potential threats. Underneath the canopy, the task is to read the ID cards and perform a visual check inside the vehicles. The Security Personnel working at these stations are likely to experience glare from the surrounding luminaires in the Approach Zone. Glare can interfere with visual perception and performance caused by an intense light source or reflection within a person's view. It is important to keep this in mind when designing ECF areas. In addition, drivers must be able to navigate around obstacles leading up to and underneath the canopy, and to see visual cues provided by signage and Security Personnel.

Response Zone

The lighting goal within the Response Zone is for Security Personnel to view departing vehicles and respond to threats. Security Personnel underneath the canopy and in the Overwatch Position must be able to view vehicles, but they do not need to have a clear view inside the vehicles. Drivers within the response zone must be able to view signals and signage and transition to the surrounding roadway lighting conditions.

ON-SITE EVALUATION

On November 9th, 2021, Clanton and Associates performed complete on-site evaluations of two ECF's (Gate 2 and Gate 6) located at Naval Station Norfolk, along with a visual daytime assessment of two other ECF's (Main Gate and Back Gate) located at Naval Air Station Oceana.

Gate 2 was initially designed in 2004 and has had minor lighting upgrades since this design. Gate 6 was designed in 2015, using the most recently published UFC 3-530-01 criteria.

Naval Air Station Oceana

Oceana Main Gate

Figure 2 – Approach Zone Lighting

Figure 3 – Narrow and Unlit Pedestrian Path

Existing Lighting Conditions

The Oceana Main Gate approach zone is lighted with tilted LED roadway luminaires positioned like floodlights, see Figure 2. This tilting does not meet the UFC 3-530-01 criteria for “no uplight (U0 rating)”. The UFC 3-530-01 criteria requires fully shielded luminaires mounted in the horizontal plane to reduce glare. These tilted roadway luminaires will produce glare to the surrounding areas and potentially to approaching drivers and Security Personnel. Each luminaire has a motion sensor mounted at the bottom of each light. Their operational effectiveness is unknown.

There is a narrow pedestrian path leading to the Main Gate that is not lighted, see Figure 3. The boundary fences are dark having very low contrast between a possible intruder and background.

Figure 4 - Under Canopy Lighting

Underneath the canopy, there appears to be too few luminaires, see Figure 4. There are a few ceiling wash floodlights around the perimeter, and sparsely located retrofit downlights. Since all the luminaires are retrofit, lighting levels and uniformity should be verified.

Oceana Back Gate

Figure 5 – Approach Lighting

Figure 6 – Under canopy lighting

Existing Lighting Conditions

This gate was closed during the time of the site visit. This is a secondary gate which is only open for specific hours during the day.

The approach lighting is utilizing standard roadway luminaires with no uplight, which meets the UFC 3-530-01 criteria, see Figure 5.

Underneath the canopy, there may not be enough luminaires to meet the under-canopy lighting UFC 3-530-01 criteria of 10 footcandle (fc) minimum, see Figure 6. All the luminaires are retrofitted so lighting levels and uniformity should be verified. The canopy luminaires are illuminated during the day, indicating photocell failure.

Naval Station Norfolk Gates 2 and 6

NAVSTA Gate 2

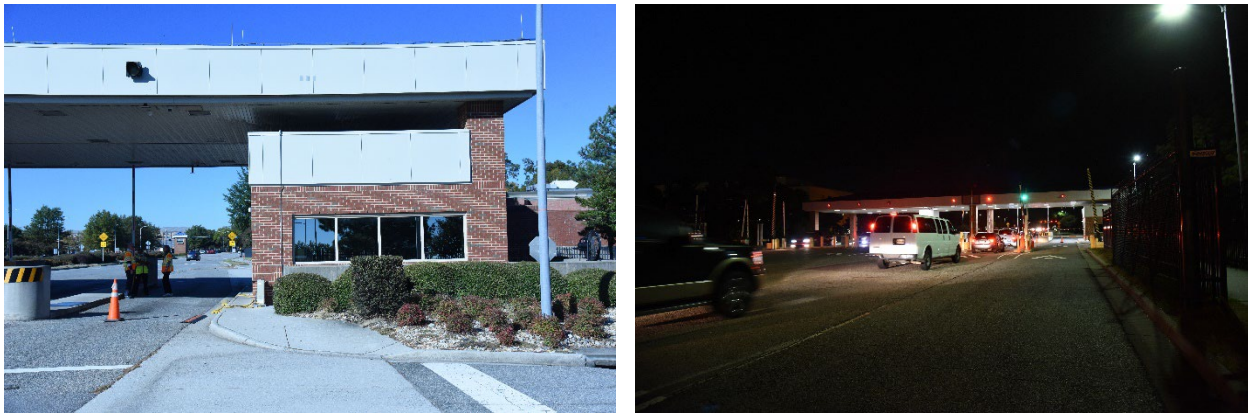

*Figure 7 – Gate 2, Day and Night**
**Actual conditions appeared brighter than shown in image*

Existing Lighting Conditions

NAVSTA Gate 2 has a short approach and a nearby traffic signal. See Figure 7 for day and nighttime photos. There are four light poles with 4000K and 5000K CCT LED luminaire heads in the Approach Zone. The LED luminaires appeared to have been replaced several years ago because they were an older style LED luminaire. The exact date of installation is unknown. One of the four light poles was not operational at night.

The Canopy has recessed, flat lensed, downlights retrofitted with LED replacement lamps. Current UFC 3-530-01 guidelines prohibit LED replacement lamps; therefore, the lighting in the canopy does not meet current criteria. These luminaires only provide downward-directed light and provide very little light on the underside of the canopy, see Figure 8.

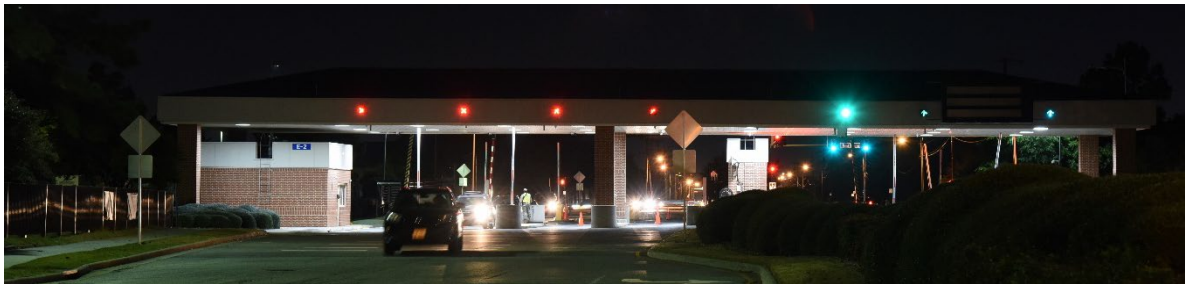

Figure 8 - View of Gate 2 canopy*
**Actual conditions appeared brighter than shown in image*

Analysis

Clanton and Associates evaluated lighting conditions at this gate to observe typical conditions of the gates in the area. The gate was designed from criteria established 20 years ago; however, many of those design recommendations remain consistent today. This gate, like many others, has been partially retrofitted with LED replacement lamps, which does not meet the current UFC 3-530-01 criteria.

Table 1 shows the ECF lighting criteria from the most current published UFC 3-530-01. Table 2 shows the lighting levels measured at Gate 2. The primary issue at Gate 2 is that the lighting levels are too low in the approach zones to allow for sufficient adaptation between the canopy and surrounding areas, see Figure 9. Lighting levels abruptly transition from 0.8 fc in the Access Control Zone, located in front of the canopy, to 10 fc underneath the canopy, and then back down to 0.4 fc in the Response Zone as you exit the Access Control Zone. Measured light levels at the Approach and Response Zones at Gate 2 are below the UFC 3-530-01 criteria published for ECF's.

Table 1: ECF Criteria in most current published UFC 3-530-01, Table 6-1*

Application				**Minimum Illuminance (All Lighted Areas)**		**Maximum Uniformity**
Type	Lighting	Area	Width Feet (m)	Locations to Light	Footcandles (lux)[a]	(Max : Min)
Entry Control Facility	Controlled	Pedestrian	--	Entry	2 (21)	3:1
		Vehicular (Approach/ Response Zones)	15 (50)	Pavement and sidewalk	1 (10)	4:1
		ID Verification	--	Guard station	10 (100)	3:1
		Search Areas	--	Pavement	10 (100)	3:1

*UFC 3-530-01 Table 6-1 Minimum Lighting Criteria for Unaided Security Personnel Visual Assessment

Table 2: Gate 2 Measurements

GATE 2	UFC 3-530-01, Table 6-1 Illuminance, Minimum fc	Illuminance, Average fc	Illuminance, Minimum fc	Illuminance, Maximum fc	Uniformity, Avg:Min
Approach Zone (Transition)	No criteria	0.3	0.1	0.5	3:1
Approach Zone (100-ft from Canopy)	1	0.7	0.4	1.5	2:1
Access Control Zone (outside of Canopy)	1	0.8	0.4	1.5	2:1
Access Control Zone (Canopy)	10	10.8	7.0	15.0	2:1
Canopy at ID Check	10	10.4	10.0	11.0	1:1
Response Zone	1	0.4	0.3	0.5	1:1

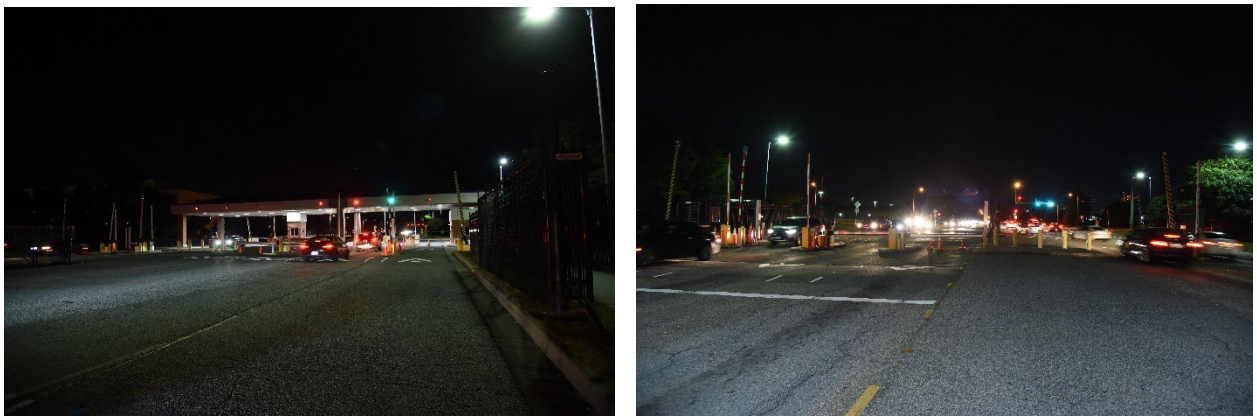

Figure 9 – Gate 2 Approach at night as viewed from approaching vehicles (left) and as viewed from the canopy (right)*
**Actual conditions appeared brighter than shown in image*

The ID Verification, located under the canopy, meets the lighting criteria, where the minimum illuminance is 10 fc, see Table 2.

Gate 2 lighting design does not consider transitional lighting. Light levels directly outside of the canopy quickly drop off, which do not allow for the Security Personnel to visually adapt to darker surrounding conditions. The Response Zone at Gate 2 is an example of this condition, see Figure 10.

Figure 10 – View of Gate 2 Response Zone*
**Actual conditions appeared brighter than shown in image*

Summary

Efficiencies and Benefits of Gate 2 Lighting Conditions

- Light levels under the canopy are uniform and effective. 10 fc at ID check is sufficient for performing the task.

Deficiencies of Gate 2 Lighting Conditions

- Approach Zone lighting does not meet current UFC 3-530-01 criteria of 1 fc minimum and is insufficient for both drivers and Security Personnel. See Table 2 for list of measured illuminance levels in Approach Zones.
- Due to the low light levels in the Approach Zone, headlights appear particularly glary, further reducing visibility and Security Personnel's capability to assess threats in Approach Zone.
- Poor transitional lighting to and from the canopy reduces visibility.
- Canopy luminaires are recessed which eliminates any indirect light on the underside of the canopy.
- Canopy luminaires were upgraded to LED light sources by direct bulb replacement instead of luminaire replacement, which is not allowed per current UFC 3-530-01 criteria.
- Response Zone lighting is insufficient and does not meet current UFC 3-530-01 criteria of 1 fc minimum, see Table 2 for measured illuminance levels in Response Zone.
- Obstacles are hard to identify. Concrete barriers do not meet current criteria and have low contrast with surrounding materials, making them hard to detect.

NAVSTA Gate 6

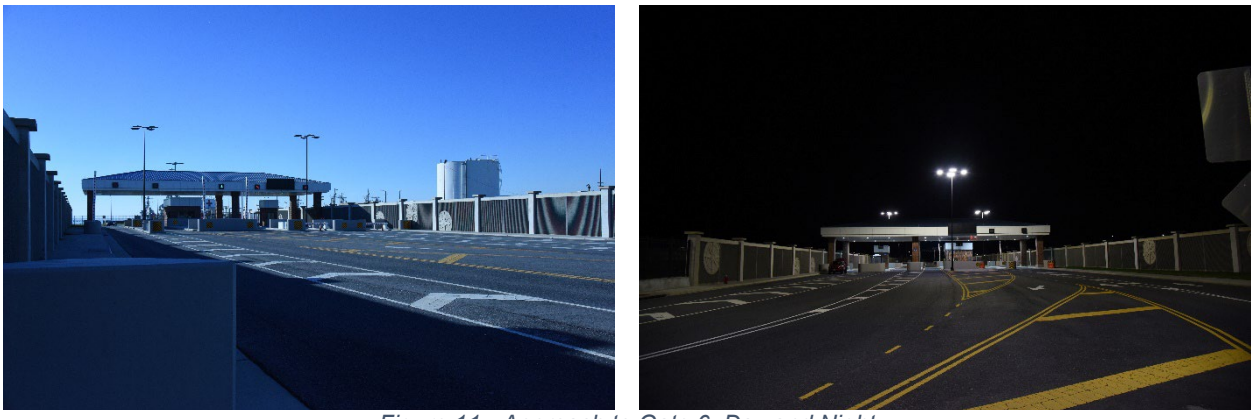

Figure 11 - Approach to Gate 6, Day and Night

Existing Lighting Conditions

NAVSTA Gate 6 has a long approach with median-mounted luminaires on mid-mast poles, see Figure 11. Each pole has four luminaires, 4100K CCT LED, with a very high lumen output of 38,000 lumens per luminaire.

There are also several mid-mast poles in the Response Zone, see Figure 12. As the Response Zone continues away from the Access Control Zone, the quantity of luminaires on each pole transitions from four luminaires per pole to two luminaires per pole.

Figure 12 - Gate 6 Approach at night as viewed from approaching vehicles (left) and as viewed from the canopy (right)

Underneath the canopy, there are 16 semi-recessed LED luminaires, see Figure 13. In addition, the photocells have failed, and the lights are on 24/7. These luminaires only provide downward-directed light and provide very little light on the underside of the canopy.

Figure 13 - Canopy luminaires do not provide any indirect light on underside of canopy

Analysis

Clanton and Associates evaluated lighting conditions at this gate to better understand the issues and barriers with the currently published ECF in UFC 3-530-01 criteria.

The light levels are uncomfortably high, see Table 3. For example, current UFC 3-530-01 criteria is 1 fc minimum in the Approach Zone. The Approach (Transition) and Approach (100-ft from Canopy) were measured to have a 2 fc minimum, which is two times brighter than the existing UFC 3-530-01 criteria.

Table 3: Gate 6 Measurements

GATE 6	UFC 3-530-01 Table 6-1 Illuminance, Minimum fc	Illuminance, Average fc	Illuminance, Minimum fc	Illuminance, Maximum fc	Uniformity, Avg:Min
Approach (Transition)	No criteria	3.3	2.0	4.3	2:1
Approach (100-ft from Canopy)	1	7.5	2.1	13.0	4:1
Access Control Zone (outside of Canopy)	1	15.3	10.0	18.0	2:1
Access Control Zone (Canopy)	10	24.3	10.0	40.0	2:1
Canopy at ID Check	10	14.0	10.0	25.0	1:1
Response Zone	1	9.7	7.0	12.0	1:1

There is discomfort and disability glare among the Security Personnel on duty at the time of evaluation. The disability glare is due to a few factors. First, placement of high mast lighting is too close to the canopy, see Figures 14 and 15. Second, the high lumen output luminaire appears to have a high glare rating, which is not recommended for this type of lighting installation. The maximum glare rating is G2, according to the current UFC 3-530-01 criteria. Last, the pole height of the high mast luminaires is too low. The pole height used for a high glare, high lumen output luminaire should be greater than 40’ in height to avoid visual discomfort.

Light levels underneath the canopy are sufficient for ID check, but too high in adjacent areas, such as the Access Control Zone, see Table 3. The result is wasted energy and adaptation concerns. Placement of luminaires contributes to the problem since they are not placed in relationship with the tasks below. The canopy luminaires are downlight only, which makes the underside of the canopy appear dark. This effect creates a stark contrast between the canopy surface and the luminaires, causing eye adaptation issues and discomfort glare.

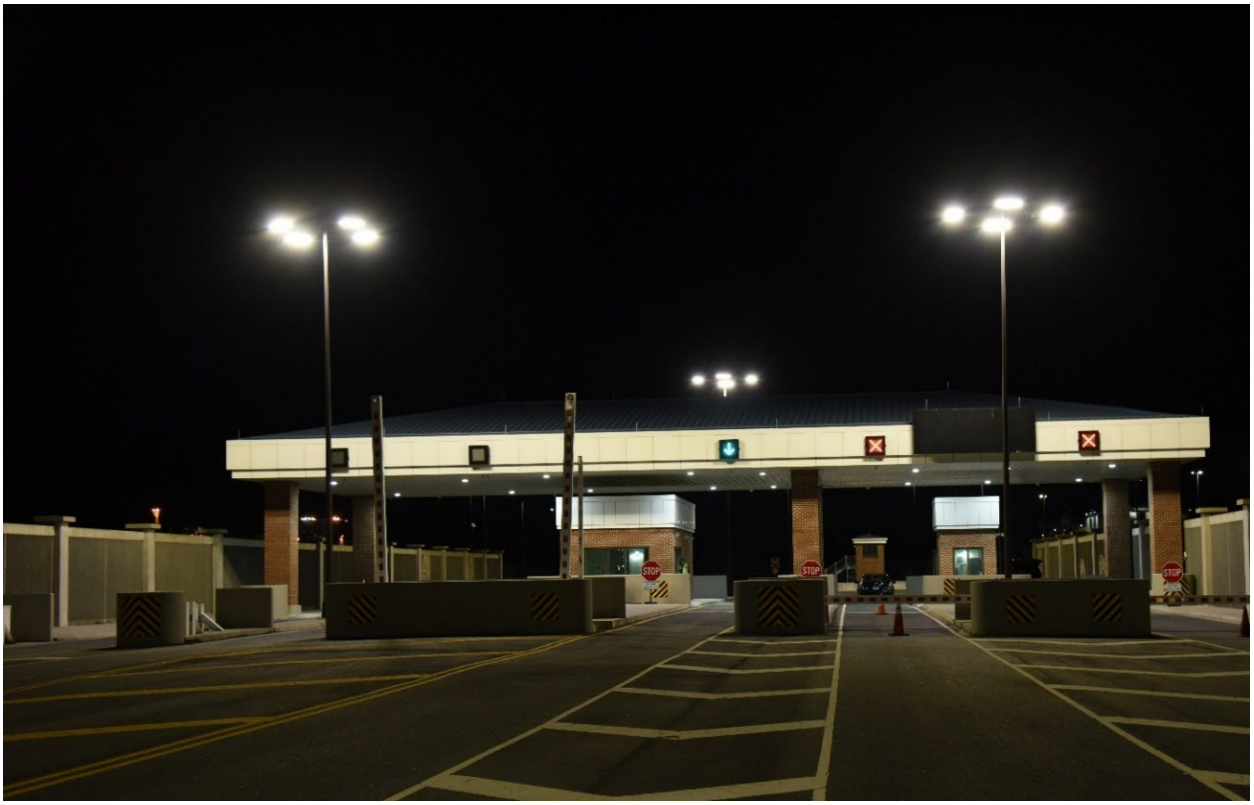

Figure 14 – Gate 6 canopy as viewed from the Approach Zone

Figure 15 – High glare luminaires directly in front of Security Personnel location in Access Control Zone

Gate 6 was designed using the most recently published UFC 3-530-01, but the resulting design has much higher light levels in most locations, see Figure 16. If calculations were performed using a low Light Loss Factor (LLF), such as 0.7 or lower, the design will be well above criteria for the first several years of operation. Additionally, the canopy was designed with a minimum of 10 fc, which results in a maximum illuminance of 40 fc. This requires a higher light level outside of the canopy to provide sufficient visual adaptation.

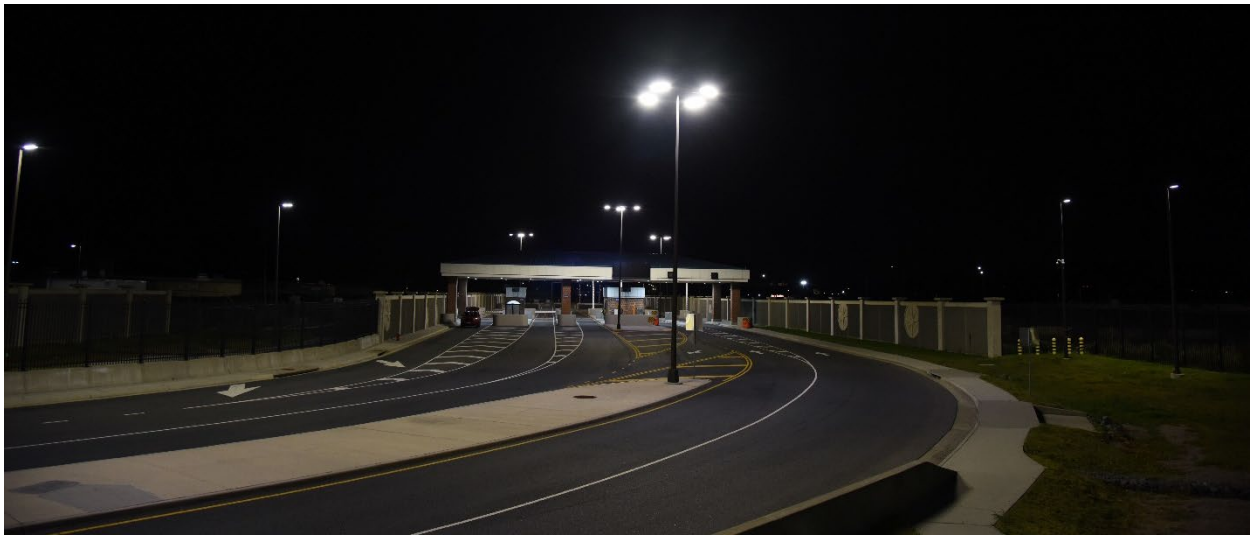

Figure 16 – Gate 6 Response Zone as viewed from the Overwatch Position

Summary

Efficiencies and Benefits of Gate 6 Lighting Conditions

- Light levels underneath the canopy are sufficient for ID check.
- Light levels are high throughout. Once drivers have visually adapted to the high light levels, adaptation within the ECF is acceptable.
- Too much light is better received than not enough light and some Security Personnel interviewed during the evaluation enjoy working in this environment.
- Uniformity meets criteria.

Deficiencies of Gate 6 Lighting Conditions

- Surrounding roadways have much dimmer lighting than in the Approach Zone and Response Zone. This is most dangerous as vehicles are departing the facility and must quickly visually transition from high light levels to typical, lower light levels as drivers merge onto adjacent roadways.
- Canopy luminaires are recessed which eliminates any indirect light on the underside of the canopy which reduces contrast.
- Canopy lighting is higher than necessary, resulting in wasted energy and local light pollution.
- Lighting levels are very high in the Approach Zone and Response Zone which causes driver visual adaptation problems when leaving the Response Zone.
- The luminaires used to achieve this high level of light are glary and cause discomfort and disability glare for Security Personnel.

MOCK ECF DESIGNS

To further understand design challenges and determine appropriate ECF lighting criteria, Clanton and Associates reviewed and performed ECF designs. “Gate A” has been provided by NAVFAC and is a future gate currently in design. “Gate B” is a mock redesign performed by Clanton and Associates of an existing gate.

Gate A

Clanton and Associates reviewed and have the following analysis for the lighting design for an Army Entry Control Facility currently in the design phase. Initial layout and photometrics have been provided by NAVFAC. This is a common large ECF design with parking lots and visitor check points.

Design and Photometrics

Table 4: Luminaire Schedule for Gate A

Description	Manufacturer Part Number	LLF	Lumens	Watts	Mounting Height	BUG Rating
Roadway / Area Light	DSX2 LED P4 40K T4M MVOLT	0.7	32,681	270	30.5’	B3-U0-G5
Canopy Light	PPSQL2 P30 40K_50K XX FC T5M	0.7	4,835	42	17.5’	B3-U0-G1
Wall Pack Outside of Canopy	WST LED P1 40K VF HVOLT	0.7	1,640	14	20’	B0-U0-G0

This design uses an LLF of 0.7, see Table 4. In the practice of lighting design, using an LLF of 0.7 for LEDs will result in an installation that is too bright with too much glare compared to the surrounding context. While LED’s dim over time, designing to 70% of lumen output does not make sense for LED technology. For example, the metal halide lamp is rated at a 0.83 LLF, and their lamp life degrades at a much faster pace than an LED.

It is common design practice to use an LLF of 0.8 for LEDs. This LLF captures a Luminaire Dirt Depreciation (LDD) of 0.9 – 0.95 based off an average LDD given in the IES Handbook, 10th Edition. This value also includes a Lamp Lumen Depreciation (LLD) factor of 0.9, which for many LED light sources, will capture the first 10 years of use. While LED technology is often touted to last for 20+ years, it is not realistic to assume that luminaires will remain untouched for that long. Driver failure, individual diode failure, and changes in space use, etc. are all very likely to occur within a 20-year window.

Unless lumen maintenance dimming is required as part of the control system, which is not currently recommended in the UFC 3-350-01 due to complexity and cost, then a higher LLF is more appropriate since luminaires operate at designed levels.

The Backlight, Uplight, and Glare (BUG) ratings for each luminaire are listed in Table 4. This design uses a high lumen output luminaire for the roadway and area lights with a high Glare rating of G5. UFC 3-530-01 limits the Glare rating to be a G2, meaning this design does not meet criteria. The high G rating will cause discomfort or even disability glare for both drivers and Security Personnel. The result will impede visibility because the visual environment will appear

too glary and bright. A possible reason why the high lumen luminaire was selected may be because of the 0.7 LLF.

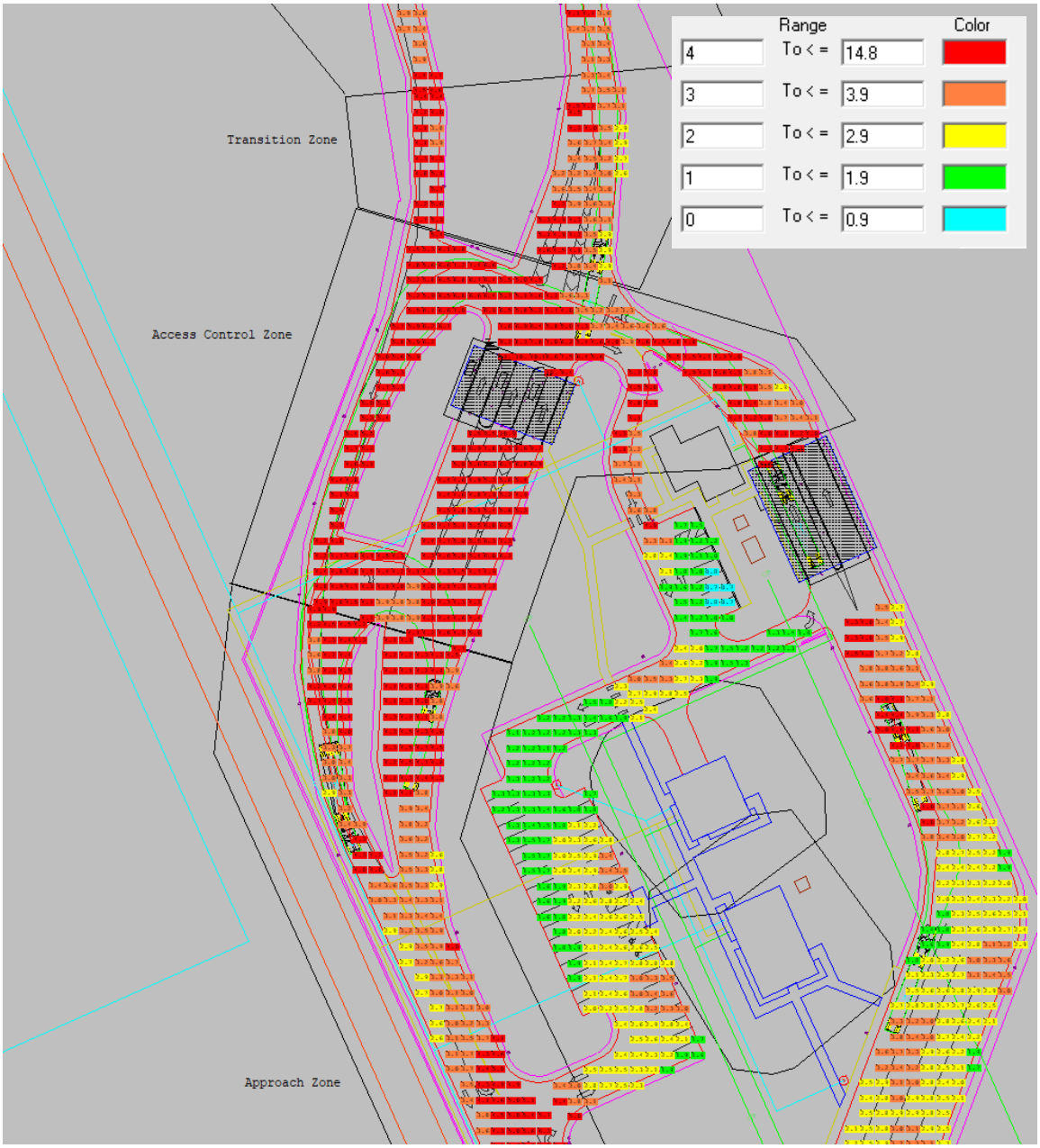

Figure 17 – Gate A Overall Photometric Plan. Values shown in footcandles

Table 5: Calculation Summary

GATE A	UFC 3-530-01 Table 6-1 Illuminance, Minimum fc	Illuminance, Average fc	Illuminance, Minimum fc	Illuminance, Maximum fc	Uniformity, Avg:Min
Adjacent Roadway	No criteria	1.3	0.2	3.4	6:1
Approach (Transition)	No criteria	1.3	0.2	2.8	6:1
Approach (100-ft from ACZ)	1	3.2	1.3	7.0	2:1
Access Control Zone (outside of Canopy)	1	5.2	2.9	11.3	2:1
Access Control Zone (Canopy)	10	11.5	7.6	14.8	2:1
Canopy at ID Check	10	11.8	9.4	13.3	1:1
Response Zone	1	3.7	1.5	5.5	2:1
Response Zone (Transition)	No criteria	1.6	1.5	1.8	1:1

When analyzing the illumination levels only, the transitional lighting is adequately provided in this design, see Table 5. Average illuminance increases as the zones approach the canopy at ID check, which is where the highest light levels are required, see Figure 17 to view the overall photometric plan. The Approach Zone has lower light levels closer to the adjacent roadway and increase within 100-ft of the Access Control Zone, where higher light levels are required. Additionally, there is a second transition zone at the beginning of the Response Zone.

However, the glare rating of the luminaires is a G5, which does not meet current UFC 3-530-01 criteria. The luminaire will cause disability glare and the Security Personnel may have difficulties viewing vehicles entering the Access Control Zone. Coupled with a 0.7 LLF, the lighting in the ECF area may be initially too bright compared to the adjacent roadway, which can produce vision impairment in the Approach Zone for drivers.

There are IES recommendations for transitional lighting specific to Toll Plazas, which have similar design concerns as an ECF. The Recommended Practice for Roadways and Parking Facilities (*IES RP-8-21*) provides the following recommendations:

“Even though the human visual system can easily handle a sudden increased illuminance, it cannot handle a sudden decrease as easily. When exiting the toll collection area, it is recommended that a uniform reduction in the average illuminance level be maintained throughout the departure zone by reducing the average illuminance equally in steps no greater than 3 times the previous step until it matches that of the roadway. However, it should be understood that the average-to-minimum uniformity within each step should be no greater than 3:1. In addition to meeting illuminance and uniformity criteria, the lighting design should also be evaluated for glare. Glare can be debilitating and can quickly generate confusion for the driver.”

GATE B

Clanton and Associates performed a mock gate design, “Gate B”. The primary goal of this design is to explore the transitional lighting necessary to ease drivers from an adjacent roadway and assess the feasibility of hitting proposed targets. Figure 18 shows the transition lighting levels in footcandles between the zones. The design LLF is 0.81, to avoid over-lighting. The luminaires selected have a glare rating of 2 (G2) or less, see Table 6. The Access Control Zone canopy is designed for an average of 10 fc, see Table 7 for the full calculation summary.

The result is a lighting layout with a more comfortable visual environment that will enhance the visibility of the area. Visibility in the nighttime environment is dependent upon context and providing transitional lighting that allows the human visual system time to properly adjust.

Design and Photometrics

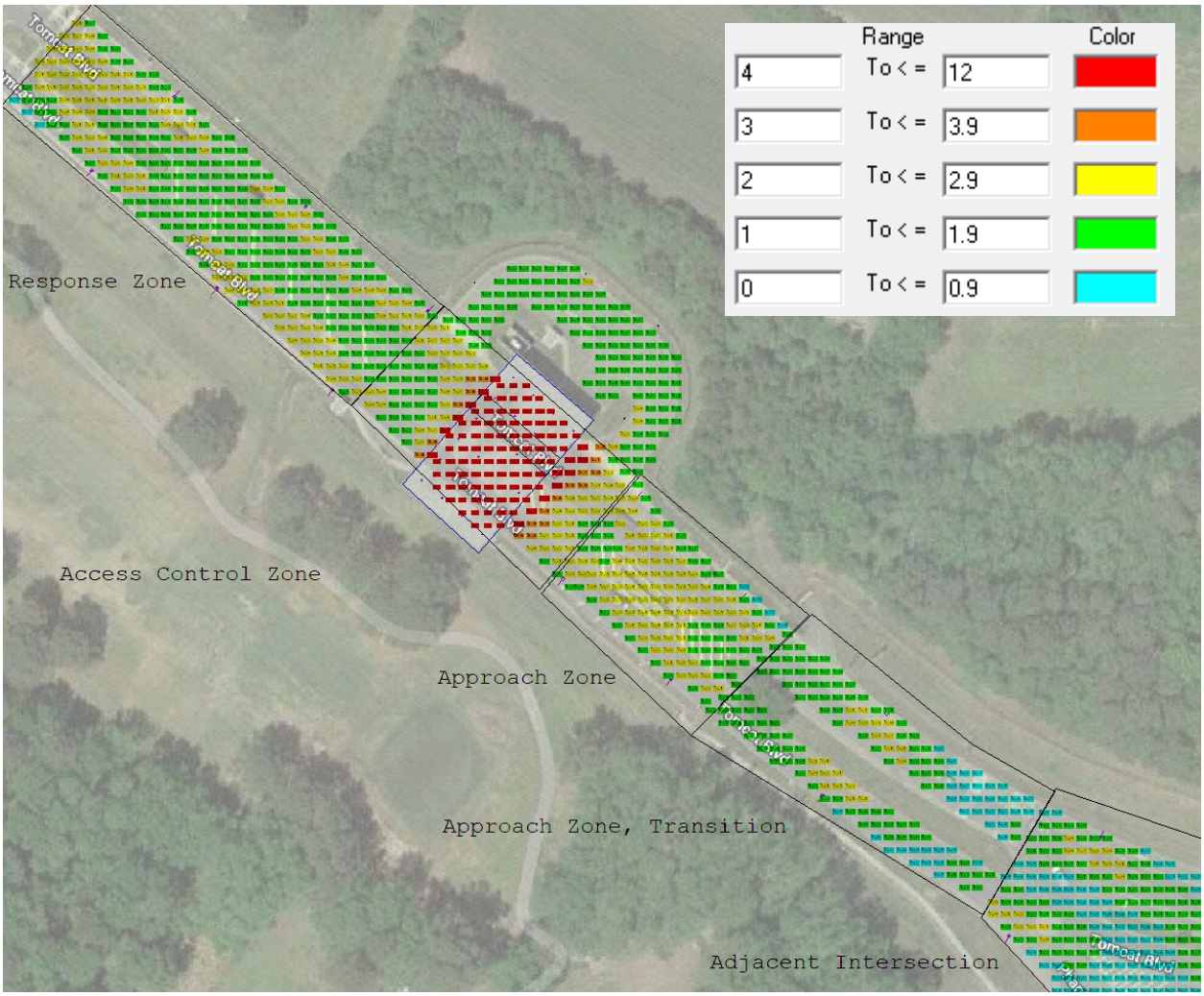

Figure 18 – Overall photometric plan of Gate B. Values shown in footcandles.

Table 6: Luminaire Schedule for Gate B

Description	Manufacturer Part Number	LLF	Lumens	Watts	Mounting Height	BUG Rating
Roadway Luminaire	ALT2-100L-160-27K8-2-CLR	0.81	16,407	158	35’	B2-U0-G2
Parking Lot Area Light	P26-48L-600-WW-G2-4	0.81	11,000	89	30’	B2-U0-G2
Canopy Luminaire	C-CP-C-SQ-3L-40K-xx	0.81	7,205	53.7	19’	B2-U2-G2

Table 7: Calculation Summary for Gate B

GATE B	UFC 3-530-01 Table 6-1 Illuminance, Minimum fc	Illuminance, Average fc	Illuminance, Minimum fc	Illuminance, Maximum fc	Uniformity, Avg:Min
Adjacent Intersection	No criteria	1.1	0.1	2.4	11:0
Approach (Transition)	No criteria	1.4	0.3	2.4	5:1
Approach (100-ft from Canopy)	1	2.1	0.7	2.7	3:1
Access Control Zone (outside of Canopy)	1	2.9	1.4	7.4	2:1
Access Control Zone (Canopy)	10	10.2	6.9	11.8	2:1
Canopy at ID Check	10	10.4	7.8	11.6	1:1
Response Zone	1	1.9	0.7	6.1	3:1

CONCLUSION

Based on the information gathered through the site evaluation and prosed design calculations, Clanton and Associates proposes to revisit the metrics used in the UFC 3-530-01 ECF Designs. Specific Application Pages will be developed or revised for the Approach Zone, Access Control Zone, and Response Zone.

Key Takeaways

- 10-fc average underneath the canopy is adequate for ID Check.
    - Designing to 10-fc **minimum** results in very high light levels underneath the canopy.
    - In the mock designs, when the canopy lighting is designed to 10-fc **average**, the higher light levels occur in the center of the canopy, where ID check occurs.
- Many photosensors at the gates have failed causing the exterior LED lights controlled by them to remain on during daylight hours. The common cause of photosensor failure are inrush currents caused by LED power supply. For LED light sources, have maintenance personnel replace the traditional photosensor with a zero-cross technology (LED Rated) photosensor. A zero-crossing switch limits the in-rush current generated by the LED power supply.
- Transitional lighting is most important.
    - If light levels are too high underneath the canopy, higher light levels are also necessary in the Approach and Response Zones.
    - The human eye cannot handle a decrease in lighting as easy as increase in lighting; therefore, it is vital to provide stepped down lighting zones upon exit of the Access Control Zone.
- Glare is highly disruptive to visibility and comfort. In severe cases, it can be a safety issue for vehicle occupants and security personnel.

Disability and Discomfort Glare

A common lighting design problem at an ECF is discomfort and disability glare, as outlined in previous sections of this report. It is a common issue because of the need to have clear view of entering and exiting vehicles and pedestrians. The lighting of an ECF Approach Zone and Response Zone often use higher lumen output luminaires mounted on poles placed in close proximity to the Security Personnel. These factors are the highest contributor to disability and discomfort glare at an ECF.

To reduce the occurrence of disability and discomfort glare at an ECF, two different parameters should be applied to the lighting design. The first is to define the Disability and Discomfort Glare Visual Field, which creates the peripheral visual field in relation to the Security Personnel position. The second is a mounting height requirement based upon the position of Security Personnel.

Disability and Discomfort Glare Visual Field

The human eye is highly sensitive to glare within a certain horizontal peripheral viewing angle[1]. For the purposes of the Disability and Discomfort Glare Visual Field diagram, the horizontal peripheral visual field is measured 10° to the left and right from the viewer position. Any light sources located within this peripheral range have the potential of causing disability or discomfort glare.

Figure 19 is an example overlay on the example ECF layout. Per every new ECF design, the specific Disability and Discomfort Glare Visual Field must be created.

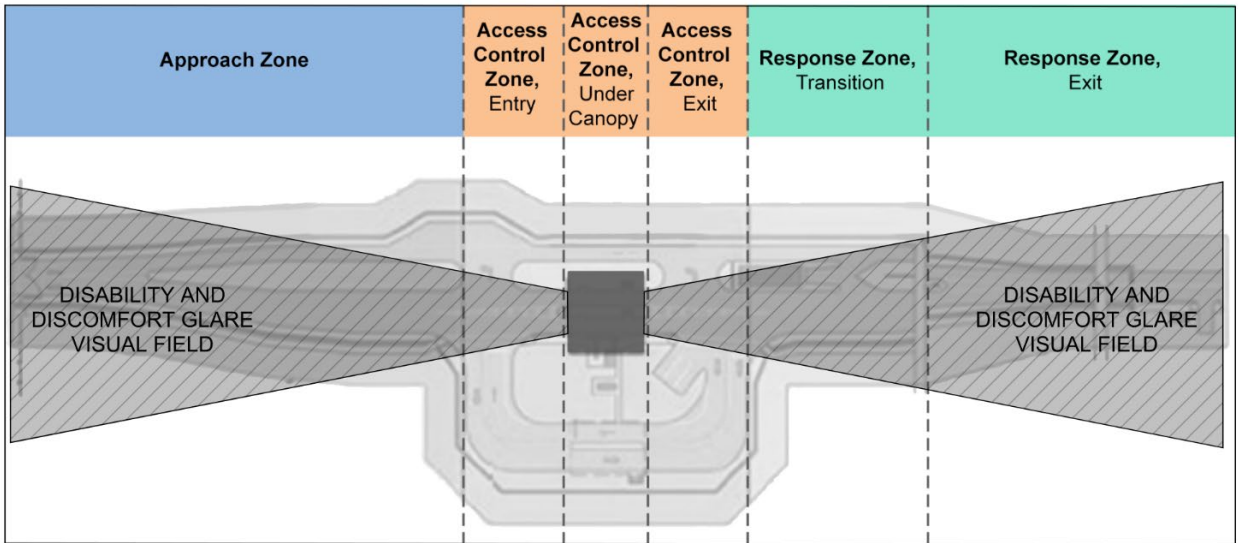

Figure 19 – Example Disability and Discomfort Glare Visual Field

To properly create the Disability and Discomfort Glare Visual Field:

1. Determine the furthest left and furthest right Security Personnel positions located within the drive lanes under the Access Control Zone, Under Canopy area. There should be two on the Approach Zone side and two on the Response Zone side. Mark these positions. There should be four in total. See Figure 20.

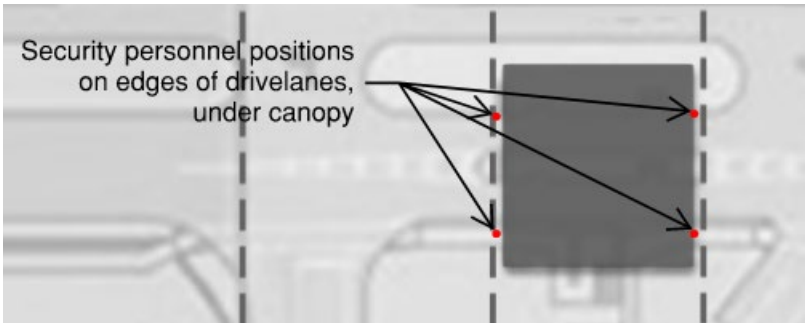

Figure 20 – Security Personnel Locations

[1] Vos, Johannes J. (2003). On the cause of disability glare and its dependence on glare angle, age, and ocular pigmentation. Clinical and Experimental Optometry, 86(6). 363-370.

2. From both the Approach Zone and Response Zone side, measure 10° to the left and 10° to the right from both positions, looking towards the Approach or Response Zone. See Figure 21.

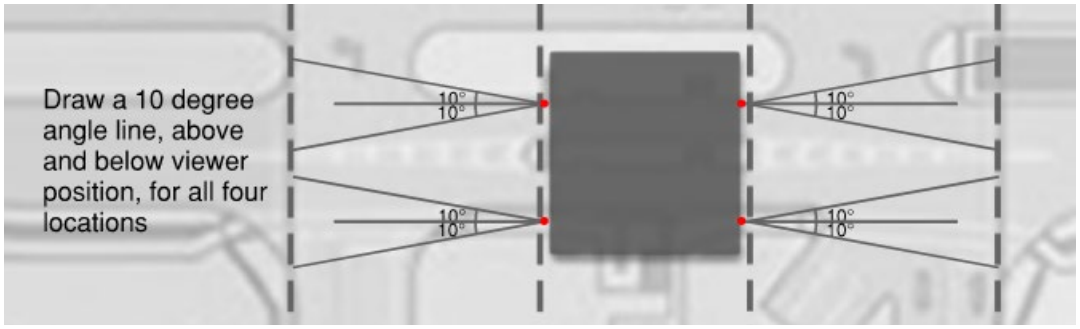

Figure 21 – Angle Measurements from Security Personnel Locations

3. Extend the two top angles on the topside of canopy and the two lower angles on the lower side of canopy. The lines should extend to the boundary of the Approach Zone and the Response Zone. Shade in this boundary. See Figure 22.

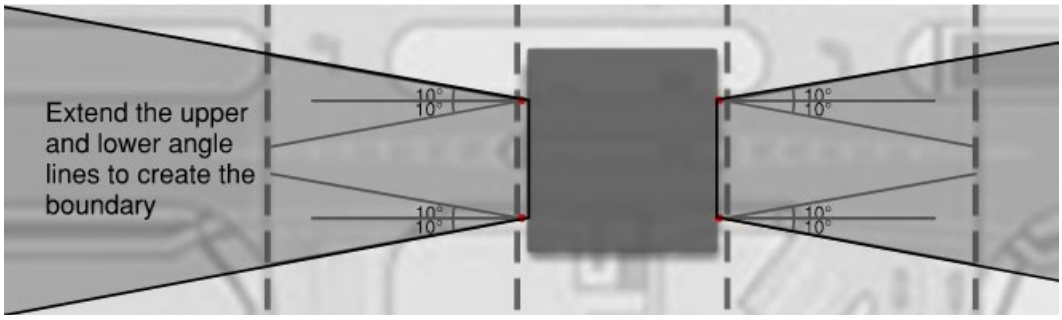

Figure 22 – Shaded Boundary of Disability and Discomfort Glare Visual Field

4. Any luminaires located within this visual field shall have a glare rating of G1 or less.

Glare Sensitivity in the Upper Visual Field

The human eye is sensitive to light sources in the upper visual field. This visual field is above 25°, measured from the standard horizontal line of sight, see Figure 23. Light sources located above this upper visual field range can cause discomfort and disability glare because of the position of the light source in relationship to the viewer.

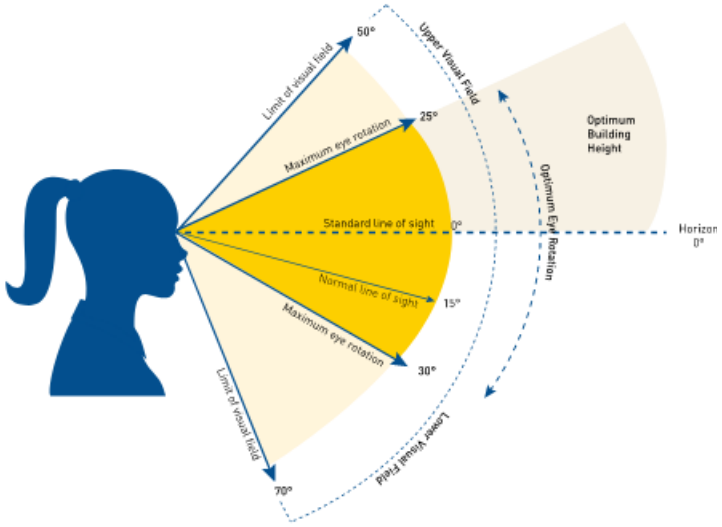

Figure 23 – Visual Field[2]

The simplest method to mitigate glare based on the line of site is to control the mounting heights of the luminaires. The basic rule of thumb is that the closer the luminaire is to the viewing source, the lower the mounting height should be.

Table 8 dictates the mounting height per distance from security personnel position. The security personnel position should be measured from the edge of the access control zone canopy.Table 8: Maximum Luminaire Mounting Height for Luminaires in the Disability and Discomfort Glare Visual Field

Distance from Security Personnel Position	At 20’ (6m)	At 30’ (9m)	Between 40’ (12m) and 60’ (18m)	Between 60’ (18m) and 80’ (24m)	Between 80’ (24m) and 100’ (34m)	>100’ (34m)
Maximum Luminaire Mounting Height*	14’ (4m)	18’ (5m)	Between 22’ (7m) and 32’ (10m)	Between 32’(10m) and 40’(12m)	Between 40’ (12m) and 50’ (15m)	>50’ (15m)

*Maximum luminaire mounting height is measured to the underside of luminaire.

[2] Cree Lighting (2022). Is street lighting damaging our health? 1-13.

Visual Adaptation Zones

The human visual system can easily handle increased illuminance but not decreased illuminance. To allow proper visual adaptation, the Approach Zone, Access Control Zone, and Response Zone are broken down into sections with minimum recommended distances and average illuminance levels, based on the speed of the driver and eye adaptation levels. See Figure 24. These distances and light levels are derived from *IES RP-8-21* transitional lighting specific to Toll Plazas and Port of Entry criteria.

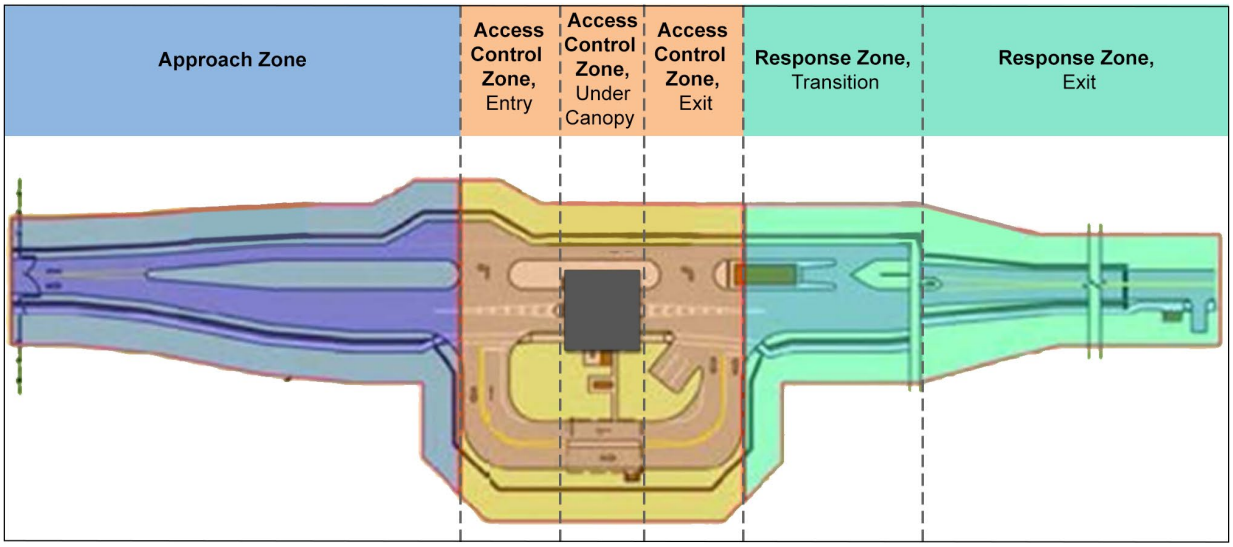

Figure 24 – Proposed Zones for ECF

These zones allow the optimum distance upon approach and exit for the eye to adapt. Because it is more difficult for the human visual system to adapt from high light levels to low light levels, there are three zones that step down in lighting levels after the vehicle exits the brightest area of the Entry Control Facility, which is the Access Control Zone, Underneath Canopy where the light levels are 10fc average. Below are the minimum distances per each zone:

- Approach Zone: Minimum 200-ft before Access Control Zone is needed to achieve adequate transitional lighting.
- Access Control Zone
    - Entry: Minimum 40-ft before canopy, approach to ID check
    - Under canopy: At ID check, entire lane underneath canopy.
    - Exit: Minimum 40-ft after canopy
- Response Zone
    - Transition: Minimum 60-ft
    - Exit: Minimum 80-ft

Proposed Values

Clanton proposes using Average Illuminance as the primary metric, with Average to Minimum Uniformity Ratios, see Table 9. This will prevent over-lighting, a typical outcome of designing to minimum light levels, but will ensure that the design does not have an unacceptable minimum through uniformity requirements.

Application Pages will be revised as follows:

Table 9: Proposed Values for UFC 3-530-01

Zone	Minimum Distance (ft.)	Illuminance, Average fc	Illuminance, Minimum fc*	Uniformity, Avg:Min
Approach Zone	200	1.5	0.2	4:1
Access Control Zone, Entry	40	3	0.7	4:1
Access Control Zone, Underneath Canopy	--	10	3	3:1
Access Control Zone, Exit	40	3	0.7	4:1
Response Zone, Transition	60	1.5	0.3	4:1
Response Zone, Exit	80	0.5	0.1	4:1

*Minimum illuminance will not be given as target criteria but is listed here to show what the minimum illuminance will be if the uniformity requirements are met.
**Recommended values will be dependent on the neighboring lighting conditions.

Critical Design Issues

- Provide transitional lighting between bright and dark regions for the Approach and Response Zones of the gate to improve visual adaptation.
- Canopy luminaires should be semi-recessed or surface mounted with an uplight component. They will provide more illuminance onto the canopy ceiling surface, which improves uniformity and reduces contrast.
- Underneath the canopy, prioritize lighting at the ID check island, where ID Check is occurring.
- Use luminaires with a G-Rating of G0 or G1 for canopy luminaires.
- Use luminaires with a G-Rating of G0 or G1, only use G2 for special conditions for roadway or area luminaires.
- For luminaires in the Discomfort and Disability Glare Visual Field, follow the design parameters outlined in section 6-3-4.1.