

Technical Report #1

Existing Lighting Conditions and Design Criteria



Maryland Transportation Authority
Police Training Facility
Hawkins Point, Baltimore, MD

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October 5, 2007

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EXECUTIVE SUMMARY

Technical Report 1 examines the existing lighting system of the Maryland Transportation Authority Police Training Facility. Descriptions of the existing lighting conditions are included. Also, an analysis and critique was performed for the four spaces which will be redesigned in a later portion of this thesis. Design criteria were established for each of the four spaces and the existing design was critiqued based on the newly developed criterion. The four spaces analyzed were a large classroom, the 11,000 square foot shooting range area, the first floor lobby and corridor circulation spaces, and the front exterior façade.

The major design consideration for the classroom and the range is flexibility and control of the lighting system. The circulation spaces and front entrance façade criterion focus more on the appearance of the space, with security being an addition issue for the exterior façade.

Some of the spaces met the design criteria better than others. The façade, for example, met most of the design criteria. The firing range and classroom could include more control and flexibility which is important for the multiple uses of these spaces. Non-uniformity of light and high quality fixtures could add to the appearance of the circulation spaces.





Basic lighting designs were used throughout the space. As a training facility, a high quality visual appearance is not the number one priority for this building. However, a quality environment is not just important to make an impression on visitors, it also has impact on the health attitudes of the everyday users of the space. Therefore, visual appearance should not be overlooked even though it may not be the most critical aspect of design.

Lighting power density (LPD) was also examined for each of the four spaces and compared to the ASHRAE Standard 90.1. The lighting power density for the lobby and corridors was just above the ASHRAE 90.1 space-by-space limit. The three other spaces met or were under the standard's limits.

CLASSROOM 'A'

Existing Lighting System

Classroom 'A' is the largest classroom space in the Maryland Transportation Authority Police Training Facility. Most of the other classrooms have similar lighting layouts, materials, and furnishings, so the information contained in this section will apply loosely to all classrooms. Classroom 'A' has dimensions of 30'-8" by 40'-7". The intended use of this space is for instructional lectures, training classes, and large meetings. The lighting system in the classroom consists mostly of 2'x4' recessed parabolic fixtures to provide ambient light to the task plane. Each classroom is equipped with a 16' whiteboard, an 8' tack board with continuous display rail, a wall-mounted 27" TV bracket, an 8' wide projection screen, and a 16' long countertop with base cabinets and wall shelving above. Wall mounted fixtures are provided in combination with the built in wall shelving and cabinet units. All lighting will be controlled by local switches.

LIGHTING FIXTURE SCHEDULE - CLASSROOM 'A'										
FIXTURE TYPE	SYMBOL	MANUFACTURER	CATALOG #	LAMPS		BALLASTS		VOLTS	MOUNTING	DESCRIPTION
				NO.	TYPE	NO.	TYPE			
M		COLUMBIA	P4024-332G-MA36-S-EB8LH-277	3	F32, T8	1	ELECTRONIC	277	RECESSED	PARABOLIC FIXTURES CLASSROOM FIXTURES TWIN BALLAST 1/2 BULB
K		COLUMBIA	SA2-225-EB8LH277	2	25W, T8	1	ELECTRONIC	277	WALL MOUNTED MH=7' AFF	HOOD LIGHT WEAPONS CLEANING ROOM
E		PRESCOLITE LIFE SAFETY	GC-1-G-E-W		LED BATTERY BACKUP	---	---	277	UNIVERSAL	GREEN EMERGENCY LIGHTING UNITS PROVIDE PROTECTIVE WIRE GUARD IN GYM AREAS
S		HUBBELL	LZ30-10W	2	10W HALOGEN	1	ELECTRONIC	277	WALL MOUNTED	DUAL LITE LOW PROFILE HIGH OUTPUT EMERGENCY LIGHT PROVIDE PROTECTIVE WIRE GUARD IN GYM AREAS (WGEL)



M



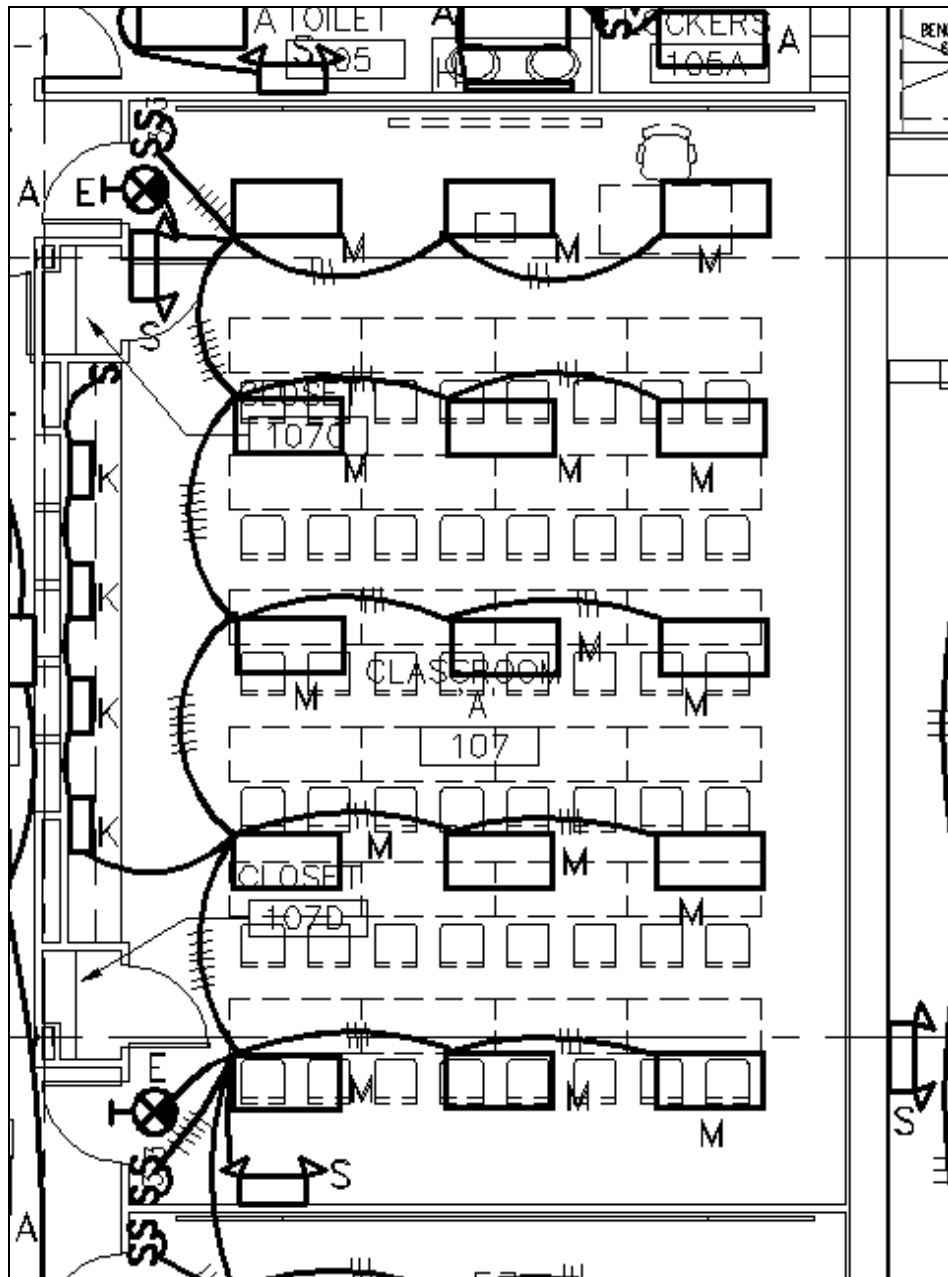
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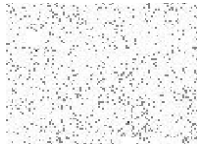
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Classroom 'A' Lighting Plan

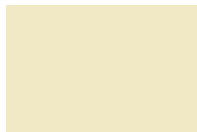
LIGHT LOSS FACTORS - CLASSROOM 'A'										
LUMINAIRE DESIGNATION	MAINTENANCE CATEGORY	ROOM ATMOSPHERE	CLEANING INTERVAL	INITIAL LUMENS	MEAN LUMENS	BALLAST FACTOR	LLD	RSDD	LDD	LLF
M	IV	CLEAN	12 MONTHS	2800	2520	0.88	0.9	0.98	0.89	0.690782
K	V	CLEAN	12 MONTHS	1950	1755	0.95	0.9	0.98	0.88	0.737352

Materials and Reflectances



Ceiling

- Acoustical Ceiling Tile (ACT)
- Reflectance = 0.86



Walls

- Painted Gypsum Board
- Reflectance = 0.91



Floors

- Vinyl Composition Tile (VCT) Flooring
- Reflectance = 0.31



Desks, Cabinet, and Shelving

- Wood finish
- Reflectance = 0.22

Design Criteria

Illuminance Levels (to perform task)

The most important consideration for the lighting design of the classroom is meeting the illuminance levels required for the performance of the visual tasks at hand. Paper task on the desk plane is most crucial, but other tasks such, as viewing the white board or projection screens, should not be ignored. The IESNA recommends 30fc on the horizontal task plane for the paper tasks that will typical occur in the classroom.

Light Distribution of Task Plane

Again, lighting for the task is crucial in a classroom space. Uniformity of light distribution on the task plane of the desk surface should be achieved to allow for easy completion of tasks throughout the room.

Control and Flexibility

The classroom may be used for different functions, such as meetings, lectures, and presentations. The desk plane, white board, or projection screen could become the critical viewing surface at any time, and the lighting system should be flexible to meet the

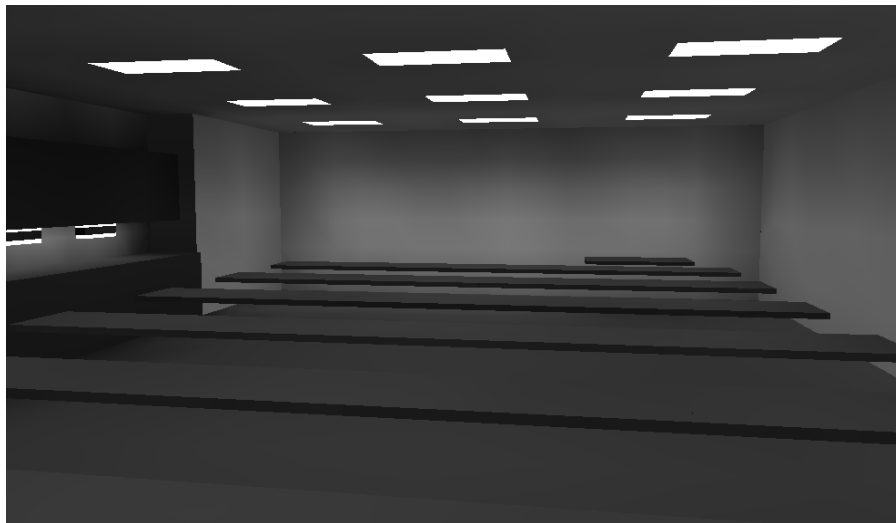
changing needs of each situation. Multiple switching options can be utilized to achieve this versatility.

Lighting Power Density

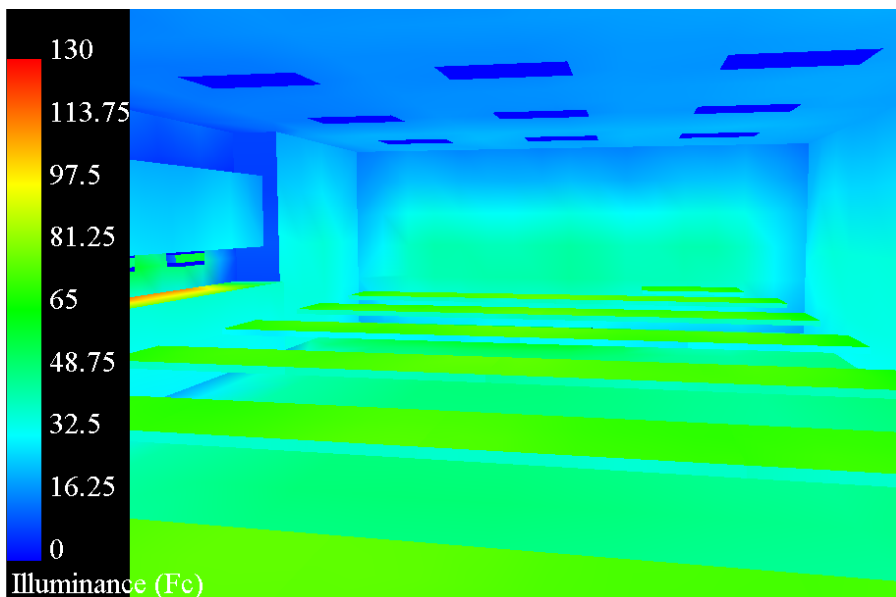
ASHRAE Standard 90.1 1.4 W/ft²

Designed LPD = 1640W/1145ft² = 1.4 W/ft²

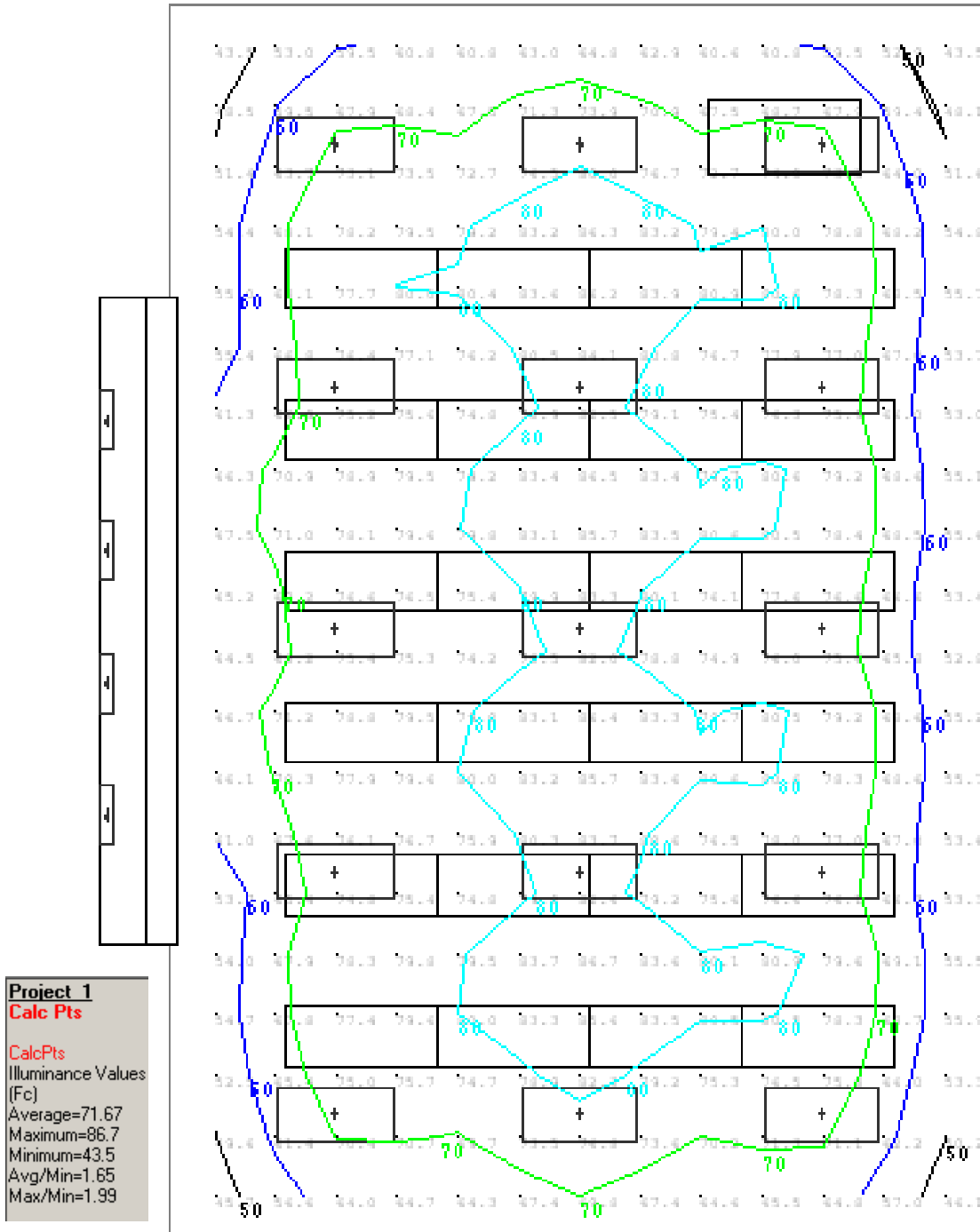
Analysis of Existing Lighting System



AGI Grey Scale Rendering



AGI Pseudo Color Rendering



AGI Calculations and Isolines

Critique of Existing Lighting System

The existing lighting system of Classroom 'A' meets some and falls short of other design criterion. The AGI model rendering and calculations of the existing spaces will be a helpful tool in examining in what areas the lighting meets the design criteria.

Illuminance is an area where positive and negatives can be seen. The simple array of recessed parabolic luminaries successfully achieves a uniform distribution on the task plane of the desk surfaces. The AGI pseudo color rendering illustrates this uniformity since the desk surfaces are rendered in a consistent color. Also, the calculation points summary lists the ratio of the maximum to minimum illuminance values. For this system, the max to min ratio is about 2, which is good for a space such as this. The illuminance values themselves however are rather high for a classroom. The IESNA recommends an average of 30 footcandles on the task plane for typical paper tasks. The AGI calculation summary lists the average illuminance of 72 fc, more than two times the recommended value.

Control and flexibility is not an issue that is addressed in the existing lighting system in Classroom 'A'. There is only one switching option for the overhead lighting. This only allows for all fixtures "on" or all fixtures "off", no in between. The inflexibility provides a difficult viewing situation for a combination of whiteboard, paper, and projection screen viewing. Multiple switching and controlling options is desirable.

Lighting power density is limited by ASHRAE Standard 90.1 to $1.4\text{W}/\text{ft}^2$ for a classroom. The existing lighting power density is just above this limit at $1.43\text{ W}/\text{ft}^2$.


FIRING RANGE AREA

The firing range has three separate areas: the control room, the firing area, and the bullet trap. Each of these areas has a different lighting system, dimensions, and materials, however, for the design criteria and critique they will be examined together.

Control Room:

Existing Lighting System

The control room is a small enclosed area within the firing range with painted CMU walls (30" high) with sound proofing below and bullet resistant glass (6' high) above. In this 12'-0"x15'-0" enclosure sits the person who controls the firing range lighting and targets. A couple of recessed parabolic 2'x4' fixtures take care of the lighting needs of this small space.

LIGHTING FIXTURE SCHEDULE - CLASSROOM 'A'										
FIXTURE TYPE	SYMBOL	MANUFACTURER	CATALOG #	LAMPS		BALLASTS		VOLTS	MOUNTING	DESCRIPTION
				NO.	TYPE	NO.	TYPE			
M		COLUMBIA	P4024-332G-MA36-S-EB8LH-277	3	F32, T8	1	ELECTRONIC	277	RECESSED	PARABOLIC FIXTURES CLASSROOM FIXTURES TWIN BALLAST 1/2 BULB



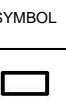




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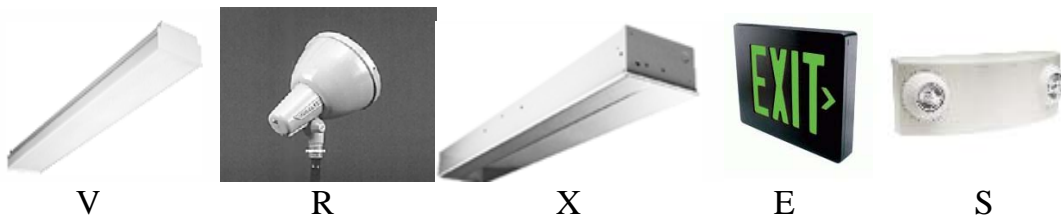
Firing Area:

Existing Lighting System

As this is a police training facility, the Firing Area is a significant portion of the building. It is comprised of 20 firing lanes at 5'-0" width each and has overall dimensions of 110'x100'. The space is enveloped by reinforced CMU walls with 2" thick Tectum panel, acoustical in nature, attached to 1/2" cement board attached to a lightweight steel suspension system. Steel plates are suspended from the roof structure above the ceiling for bullet containment. The painted concrete floor has firing position insets recessed in the floor at each firing lane, a total of 80 insets. Other significant features are the 10' wide by 10' tall overhead door, 20 fixed targets that are capable of rotating 90 degrees, and a moving target track that is remote controlled. Part of the

original schematic design was to provide a combination of fixtures to be used for general, target area, firing line, target lighting, and training lighting. Much flexibility and potential for different training scenarios would have been a product of this original design concept. Unfortunately, much of the original concept was dropped later in the design process and a fairly “bare-bone” lighting system remains. Ambient lighting is supplied by 2’x4’ surface mounted fluorescent fixtures. PAR 38 halogen lamps illuminate the targets and surface mounted wall wash kickers line one wall. The range control room has a master control panel to control all type of lights. General lighting luminaries can also be controlled from the range entrance.


LIGHTING FIXTURE SCHEDULE - FIRING RANGE AREA										
FIXTURE TYPE	SYMBOL	MANUFACTURER	CATALOG #	LAMPS		BALLASTS		VOLTS	MOUNTING	DESCRIPTION
				NO.	TYPE	NO.	TYPE			
V		COLUMBIA 2'X4' FLUORESCENT	AWW4-432-EB8277	4	F32, T8	1	ELECTRONIC	277	SURFACE	LOW PROFILE WRAPAROUND 4' 4 BULB FLUORESCENT TWIN BALLAST 1/3 BULB
R		SYLVANIA LAMP HUBBELL LAMPHOLDER HUBBELL BOXCOVERS	45PAR38/CAP/SP/WSP12 103 SERIES HUBBELL LAMPHOLDER S-319-B MOUNTING BOX	1	45W HALOGEN	1	ELECTRONIC	120	BOX MOUNTED	PAR 38 LAMP WITH KNUCLE JOINT LAMPHOLDER AND MOUNTING BOX
X		COLUMBIA	PW84-2-50TSM-LDK-EBTT-277-LENZ	2	50W, BIAX CF	1	ELECTRONIC	277	SURFACE	FIRE RANGE WALLWASH KICKER
E		PRESCOLITE LIFE SAFETY	GC-1-G-E-W		LED BATTERY BACKUP	---	---	277	UNIVERSAL	GREEN EMERGENCY LIGHTING UNITS PROVIDE PROTECTIVE WIRE GUARD IN GYM AREAS
S		HUBBELL	LZ30-10W	2	10W HALOGEN	1	ELECTRONIC	277	WALL MOUNTED	DUAL LITE LOW PROFILE HIGH OUTPUT EMERGENCY LIGHT PROVIDE PROTECTIVE WIRE GUARD IN GYM AREAS (WGEL)



Bullet Trap Area:

Existing Lighting System

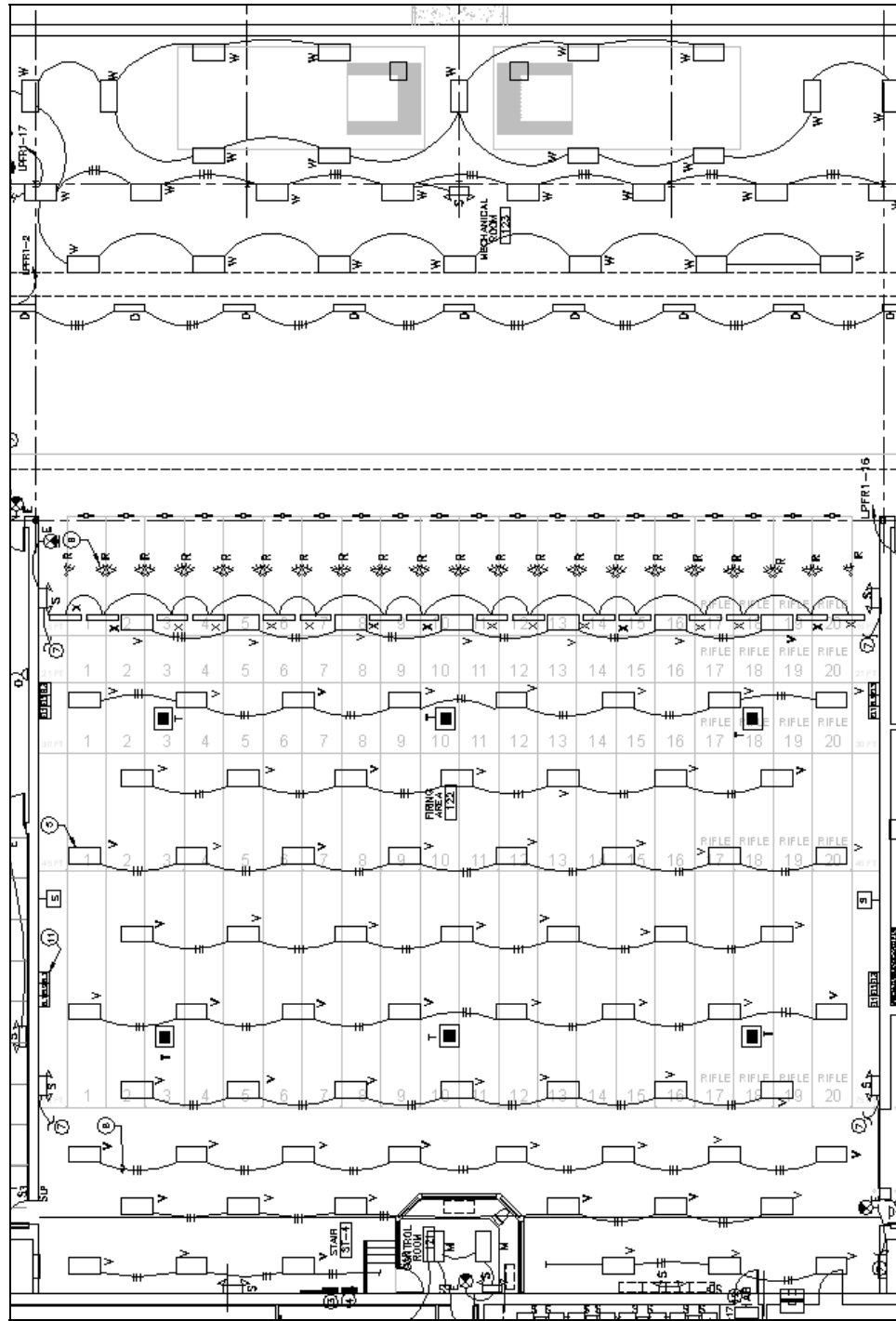
The bullet trap area consists of steel plates that make up the trap. There is sealed concrete flooring underneath and exposed structure above the steel plates of the trap. The space is approximately 25’ deep and 100’ across the width of the range. The space is illuminated with pendant mounted fluorescent fixtures suspended 9’ above the floor. These fixtures area again controlled from the main control panel in the firing range control room.

LIGHTING FIXTURE SCHEDULE - FIRING RANGE BULLET TRAP										
FIXTURE TYPE	SYMBOL	MANUFACTURER	CATALOG #	LAMPS		BALLASTS		VOLTS	MOUNTING	DESCRIPTION
				NO.	TYPE	NO.	TYPE			
D		COLUMBIA	R04-132-EB8LH-277	1	F32, T8	1	ELECTRONIC	277	PENDANT MOUNTED MH=9' AFF	SUSPENDED BULLET TRAP FIXTURE

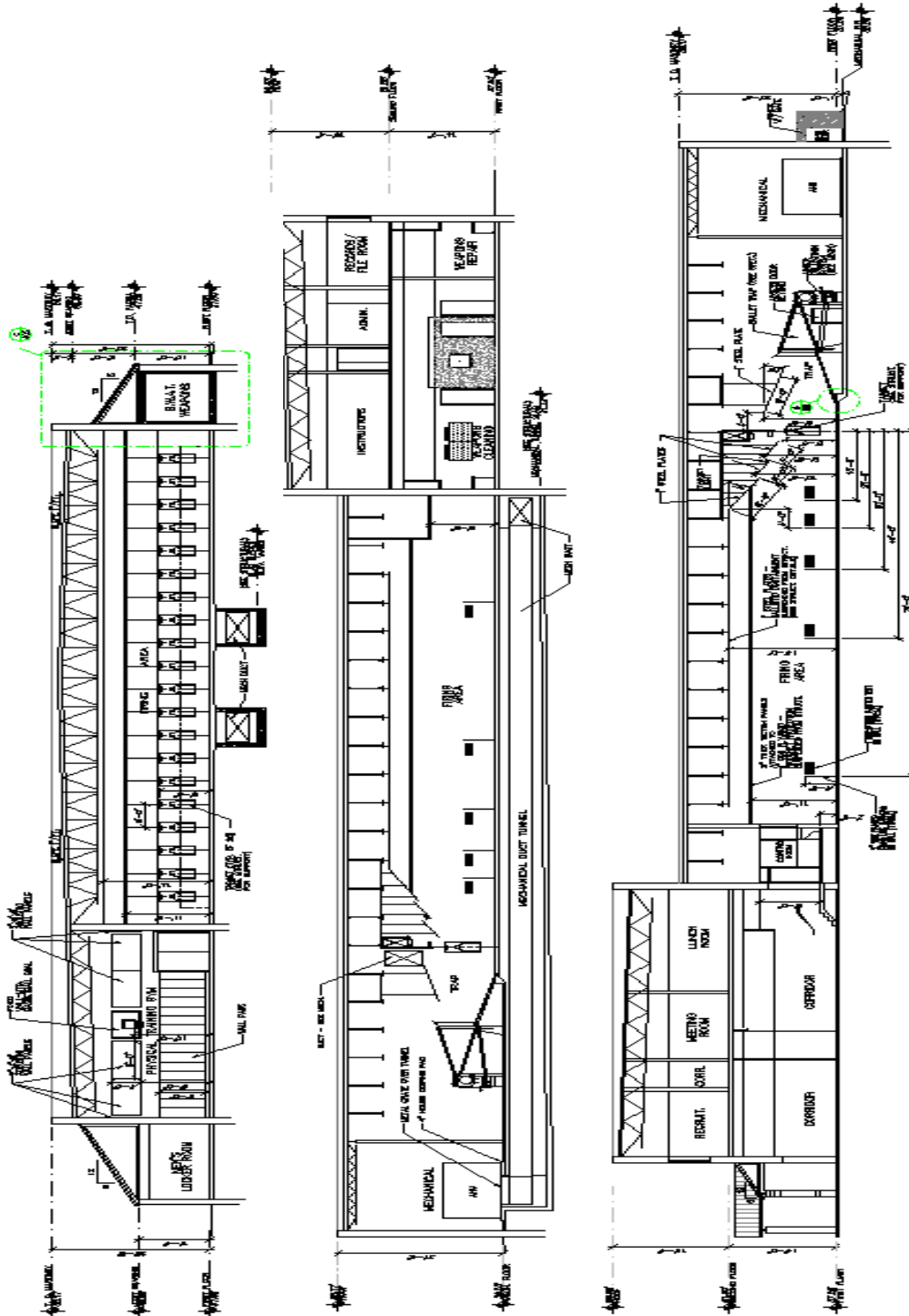


Firing Range Area

LIGHT LOSS FACTORS - FIRING RANGE										
LUMINAIRE DESIGNATION	MAINTENANCE CATEGORY	ROOM ATMOSPHERE	CLEANING INTERVAL	INITIAL LUMENS	MEAN LUMENS	BALLAST FACTOR	LLD	RSDD	LDD	LLF
M	IV	CLEAN	12 MONTHS	2800	2520	0.88	0.9	0.98	0.89	0.690782
V	IV	CLEAN	12 MONTHS	2800	2520	0.88	0.9	0.98	0.89	0.690782
R	I	CLEAN	12 MONTHS	3000	---	0.87	0.97	0.93	0.93	0.729889
X	IV	CLEAN	12 MONTHS	4300	3870	0.85	0.9	0.98	0.89	0.667233
D	V	CLEAN	12 MONTHS	2800	2520	0.9	0.9	0.98	0.88	0.698544



Firing Range Lighting Plan



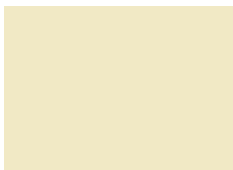
Firing Range Sections

Materials & Reflectances



Ceilings and Walls

- Tectum Paneling
- Reflectance = 0.75



Walls – Lower

- Painted CMU
- Reflectance = 0.85



Floors

- Sealed Concrete
- Reflectance = 0.36

Firing Range Area Design Criteria

Direct Glare

The primary concern in the firing area is safety. Direct glare from fixtures can be disabling to the shooter which can create a potentially dangerous situation. Lower cutoff angles for fixtures will avoid direct glare issues.

Reflected Glare

Reflected glare from surfaces creates a similar concern as that of direct glare. Diffuse materials and luminaire placement (affecting reflection angles) should be considered to limit this type of glare.

Light Distribution on Task Plane

Uniformity is of importance. The IESNA Handbook designates that the ratio of the maximum to the minimum illuminance values should be 3:1 or less. Light patterns on the task plane can be distracting or confusing, which should be avoided in the range environment.

Illuminance Levels

Illuminating the vertical face of the targets is essential in the firing range target area, while horizontal illuminance is more crucial in the shooting lines. The IESNA Handbook determines that a training facility is a Class III of Play having no provisions for spectators. Rifle and Pistol Ranges that are Class III have illuminance recommendations of 20fc on the horizontal for the shooting lines and 50fc on the vertical for the targets.

Luminaire Noise

Noise created by the parts of a luminaire can provide annoyance or distraction. Luminaire should be limited avoiding the use of electromagnetic ballasts and air-handling fixtures.

Control and Flexibility

The firing range is an instructional and training tool. Generating pseudo-realistic training environments affords a quality learning environment. Multiple lighting systems incorporated into the design will offer diverse training scenarios. The possibility exists for the integration of a control system with preset lighting scenes that will make for easy transitions between the different lighting scenarios.

Lighting Power Density

ASHRAE Standard 90.1 1.4 W/ft²
Designed LPD = 13,096W/14,215ft² = 0.92 W/ft²

Critique of Existing Lighting System

The lighting system in the firing range provides reasonable coverage and uniformity of light distribution on the task plane. The range addresses illuminance levels adequately. Vertical faces of the targets receive a higher amount of vertical illuminance from the halogen floodlights, while the 2'x4' fixtures provide a uniform layer of light through out the shooting lines.

The use of electronic ballast, instead of electromagnetic ballasts, will hopefully negate the luminaire noise issue. The Maryland Transportation Authority Police Training Facility has not yet been built, so there is no data to confirm that luminaire noise is not an issue.

Control and flexibility is an area where the range falls short of meeting the design criteria. The original design intent was to have multiple lighting systems so both indoor and outdoor environments could be simulated. The existing system does not have much flexibility. This is an area that could really make for an interesting and innovative




learning environment. The Control Room is already part of the range design so this would be a great opportunity to include preset scene controls.

Lighting power density requirements are met for the range. The ASHRAE Standard 90.1 value for an exercise facility is 1.4 W/ft². The actual LPD is 0.9 W/ft¹, significant under the upper limit.

LOBBY AND FIRST FLOOR CORRIDORS

Existing Lighting System

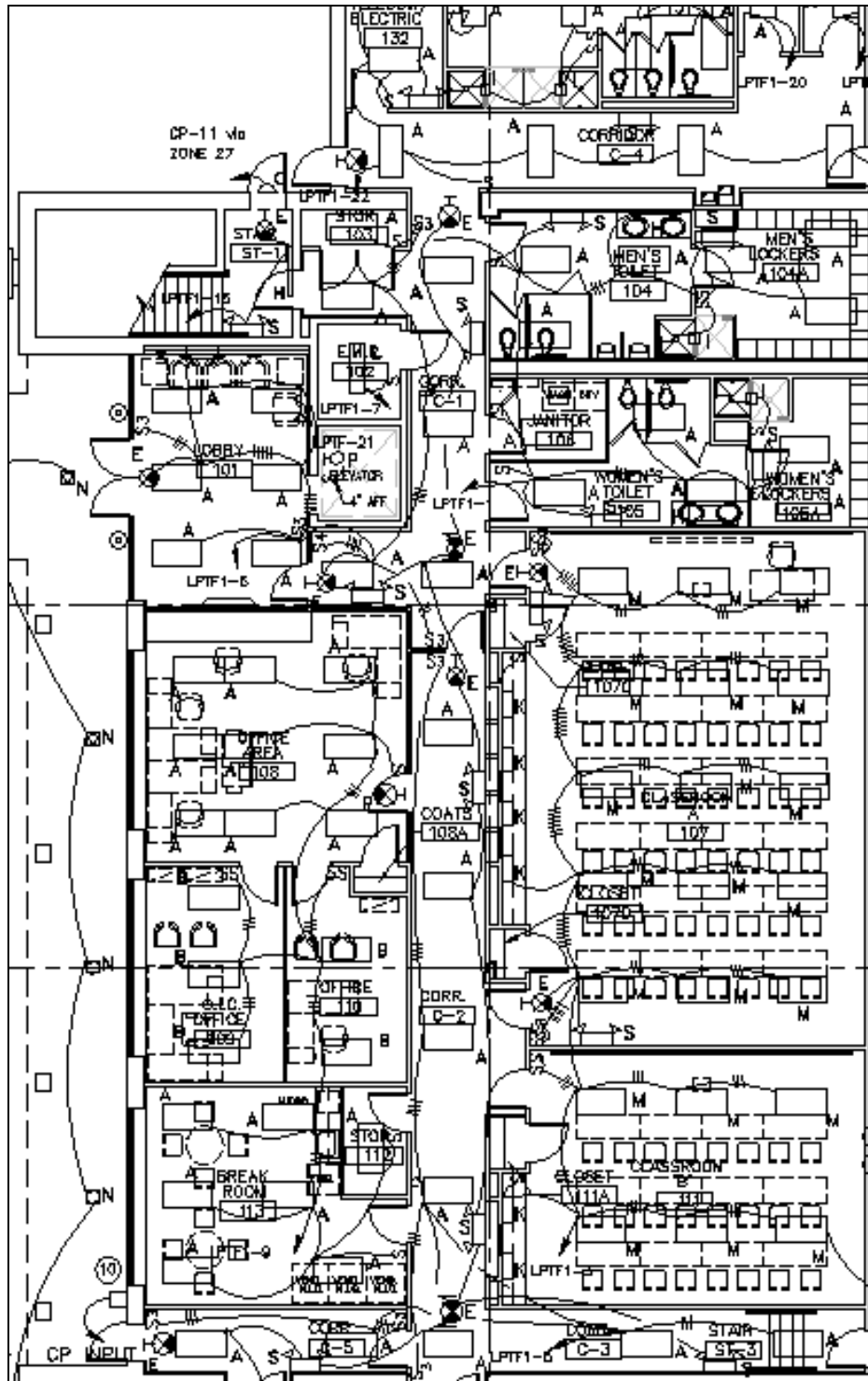
The lobby at the entrance is a small space with dimensions of 13'-4" by 19'-3". It serves as a bridge between more public and more private spaces. It acts as a welcoming space for the users of the building as well as any visitors. It is the first impression of the interior of the building. Simple 2'x4' lensed troffers are the fixtures used throughout the lobby and the connecting first floor corridors. Local switches serve as the controls for the lobby and corridor lighting.

LIGHTING FIXTURE SCHEDULE - FIRING RANGE CONTROLS ROOM										
FIXTURE TYPE	SYMBOL	MANUFACTURER	CATALOG #	LAMPS		BALLASTS		VOLTS	MOUNTING	DESCRIPTION
				NO.	TYPE	NO.	TYPE			
A		COLUMBIA	ST824-232G-FS-A12-EB8LH-277	2	F32, T8	1	ELECTRONIC	277	RECESSED	LENSED 2'X4' TROFFER
E		PRESCOLITE LIFE SAFETY	GC-1-G-E-W		LED BATTERY BACKUP	---	---	277	UNIVERSAL	GREEN EMERGENCY LIGHTING UNITS PROVIDE PROTECTIVE WIRE GUARD IN GYM AREAS
S		HUBBELL	LZ30-10W	2	10W HALOGEN	1	ELECTRONIC	277	WALL MOUNTED	DUAL LITE LOW PROFILE HIGH OUTPUT EMERGENCY LIGHT PROVIDE PROTECTIVE WIRE GUARD IN GYM AREAS (WGEL)



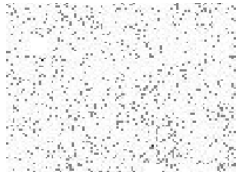
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LIGHT LOSS FACTORS - LOBBY AND CORRIDORS										
LUMINAIRE DESIGNATION	MAINTENANCE CATEGORY	ROOM ATMOSPHERE	CLEANING INTERVAL	INITIAL LUMENS	MEAN LUMENS	BALLAST FACTOR	LLD	RSDD	LDD	LLF
A	IV	CLEAN	12 MONTHS	2800	2520	0.88	0.9	0.98	0.89	0.690782



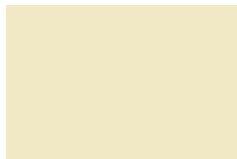
First Floor Circulation Lighting Plan

Materials & Reflectances



Ceiling

- Acoustical Ceiling Tile
- Reflectance = 0.86



Walls

- Painted Gypsum Board
- Reflectance = 0.91



Floors

- VCT Flooring
- Reflectance = 0.31

Design Criteria

Light Distribution on Surfaces

In the case of the lobby and corridors, thoughtful use of non-uniform light distributions and patterns on surfaces can create visual interest in the space. The lobby in particular is the first interior impression of the facility. The lighting in these spaces is a chance to create a pleasant and enjoyable atmosphere.

Sense of Direction

Circulation is the purpose of these spaces. The lighting should help building occupants to easily determine which way they should be headed. Creating a hierarchy of spaces through variations in intensity may help in way-finding and providing visual directional cues.

Points of Interest

The lobby does not have many points of interest on its own, but by provide decorative lighting or adding artwork to be accented, the lobby can become a congregational area where people feel free to linger.

Lighting Power Density - Lobby

ASHRAE Standard 90.1 1.3 W/ft²

Designed LPD = $384\text{W}/280\text{ft}^2 = 1.37 \text{ W/ft}^2$

Lighting Power Density - Corridors

ASHRAE Standard 90.1 0.5 W/ft²

Designed LPD = 960W/1215ft² = 0.79 W/ft²

Critique of Existing Lighting System

The fixtures in the lobby and corridors are 2'x4' lensed troffers, which do not lend much aesthetic appeal. This very basic light design does not meet much of the design criteria set forth. The only distribution we have here is the potential for scallops on the walls, which is typically not very favorable. A higher end fixture can add to the appeal of the space and produce interesting patterns of light when applied correctly.

The circulation spaces do not provide a sense of direction. Since all lighting throughout the lobby and corridors is comprised of one fixture type, no variations in importance are developed through a hierarchy of light. Varying fixtures and distinguishing the lighting of the lobby from that of the corridors can create a sense of place, allow the building occupants to understand where one space ends and the next begins. It also allows the lobby to be a stand along space that can start to transform into a congregational area.



The circulation spaces are enclosed by painted gypsum board walls. There are no points of interest included in part of the design, which will add to a positive impression of the space.

Both the lobby and the corridors exceed the lighting power density limits of ASHRAE Standard 90.1. The standard restricts lobby power density to 1.3 W/ft² and corridor power density to 0.5 W/ft². The designed lighting power density in the lobby and corridors are 1.37 and 0.79 W/ft¹, respectively.

FRONT ENTRANCE FAÇADE

Existing Lighting System

Stretching 153'-0" in length and 30'-0" in height, the façade has several different materials and architectural elements. The basic façade is comprised of sections of ground face CMU and split face CMU. There is a roof cover at the first floor level which is a standing seam metal. Window trim and finishes are pre-finished aluminum and there are two pre-cast concrete logos, one at either end of the façade. All exterior lighting will be controlled by photocells.

LIGHTING FIXTURE SCHEDULE - FIRING RANGE CONTROLS ROOM										
FIXTURE TYPE	SYMBOL	MANUFACTURER	CATALOG #	LAMPS		BALLASTS		VOLTS	MOUNTING	DESCRIPTION
				NO.	TYPE	NO.	TYPE			
N		HUBBELL	HVLG-070H8-1	1	70W, MH	1	ELECTRONIC	277	WALL MOUNTED 4" AFF	CANOPY AND FRONT ENTRANCE WALLPACK LIGHTING
Q		AAL PIVOT	PVT5HO-48-MAL-HBC	1	54WT8HO	1	ELECTRONIC	277	WALL MOUNTED ABOVE LOGOS	BUILDING LOGO LIGHTING 4' PENDANT MOUNT

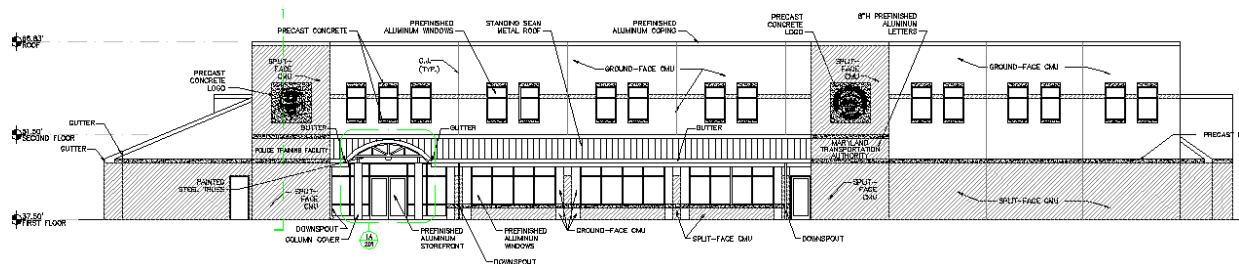


N



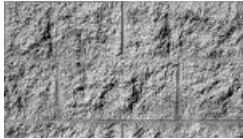
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LIGHT LOSS FACTORS - EXTERIOR BUILDING FAÇADE										
LUMINAIRE DESIGNATION	MAINTENANCE CATEGORY	ROOM ATMOSPHERE	CLEANING INTERVAL	INITIAL LUMENS	MEAN LUMENS	BALLAST FACTOR	LLD	RSDD	LDD	LLF
N	---	CLEAN	5 YEARS	5700	4560	0.88	0.8	---	0.92	0.64768



Front Entrance Façade

Materials & Reflectances



Split-Face CMU
- Reflectance = 0.6



Ground Face CMU
- Reflectance = 0.45

Design Criteria

Sense of Direction

The main canopy and entrance should be well lit so that it can easily be determined where one should enter the facility. Higher light levels will inherently lead people in the desired direction.

Points of interest

The precast concrete logos can become a focal point of the building façade when illuminated at night. In this way, the building becomes more interesting and pleasant.

Direct Glare

Direct glare from fixtures should avoid being carried into parking lot areas. Glare can be disabling which could lead to safety issues.

Light Pollution / Trespass

Uplight fixtures should be avoided luminaires with good cutoffs should be considered. Lighting should not be aimed toward the property line to avoid trespass problems.

Modeling of Faces and Objects

In the nighttime hours, safety and security becomes more of a concern. Modeling of faces and objects is important for visual recognition on the surroundings by people as well as security cameras.

Light Distribution on Surfaces

The distribution of light on the façade surfaces should be non-uniform to create visual interest, a hierarchy of light should be established to create areas of light and dark. Architectural features, such as the precast logos should be highlight as one of the upper levels of the hierarchy to stand out.

Lighting Power Density - Canopy

ASHRAE Standard 90.1 1.25 W/ft²

Designed LPD = 350W/740ft² = 0.47 W/ft²

Lighting Power Density – Building Facades

ASHRAE Standard 90.1 0.2 W/ft²

Designed LPD = 108W/4650ft² = 0.02W/ft²

Critique of Existing Lighting System

The existing exterior façade lighting meets the design criteria fairly well. Approaching the building, the under-canopy lighting provides a higher level of light, directing the building's users toward the main entrance doors. The lighting design is fairly simple. It could provide more of a statement about the building than it does. However, the main object to provide direction is fulfilled.

Wallwash fixtures graze light down the two large precast concrete logos on the front façade. This type of lighting makes the logos a point of interest, which is part of the prescribed design criteria. Also, by focusing the light downward, light pollution issues are avoided.

The lighting design does create a hierarchy of lighting, however, it only establishes a limited number of level: the bright canopy lighting, the logo lighting, and the dark unlit surfaces. More elements could be brought into the design to allow for a greater variety of light distribution the façade surfaces. This will also made the façade more visually interesting.

A major issue for the police training facility is modeling of faces and objects for security reasons. The lighting system was designed to provide enough light for closed circuit television to capture images of those who approach and enter the building. Therefore, the existing lighting design meets this criterion as well.