

Technical Report 1 Part 2

Lighting Existing Conditions and Design Criteria Report

AE 481: AE Senior Thesis

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Executive Summary

The following report consists of four interior spaces and one exterior space from the Susquehanna Center, Harford Community College located in Bel Air, Maryland. The spaces were analyzed and evaluated through a set of quantitative and qualitative criteria, referenced through the *IES Handbook 10th Edition* and *ASHRAE 90.1* standards.

The five spaces are as follows:

1. Classroom 113
2. Arena
3. Main Lobby
4. Façade
5. Fitness Center

The existing design solution is relatively energy efficient through the use of compact fluorescents and linear fluorescent lamps. A LEED Silver accredited building; the Susquehanna Center incorporates a simplistic and functional approach. However, a more creative and expressive design solution would work well in complementing the contemporary architectural style, as well as providing different lighting solutions for each space that would suit different occasions.

Large Workspace – Classroom 113

Existing Conditions

Description:

Located on the main level in the South end of the building, Classroom 113 is a simple basic workspace consisting of smart boards and white boards primarily used by teachers for lectures, while desks and chairs provide works space for students. The main tasks performed in this space include lecturing, reading and writing.

Dimensions:

Area= 840 SF

Approximate width= 27.5ft

Approximate length= 30.4ft

Ceiling Height= 9ft

Smart board/White board height= 6 – 6.5ft

Materials Finishes:

	Tag	Name	Color/Material/Style	Reflectance
Floor Finish	CPT-1	Carpet Tile	Reminiscent/Interface Flor/Happening 2'x2' Tile	0.2
Base Finish	B-1	Rubber Base	71 Storm Cloud/Johnsonite/4" Rubber Base	0.2
Wall Finish	P-1	Paint	Simply White OC-117/Benjamin Moore	0.8
	P-6	Paint	Baby Boy Blue 2065-50/Benjamin Moore	0.6
Ceiling Finish	ACT-1	Acoustical Ceiling Tile	White 2'x 4'	0.75

Glazing Types:

Type	Description	Visible Transmittance	Exterior Reflectance
G1	Insulated Glass Clear	0.3	0.11
G2	Insulated Glass VLT 26%	0.26	0.24
G4	Insulated Glass VLT 62%	0.62	0.11
G6	Insulated Metal Panel	0	0.7

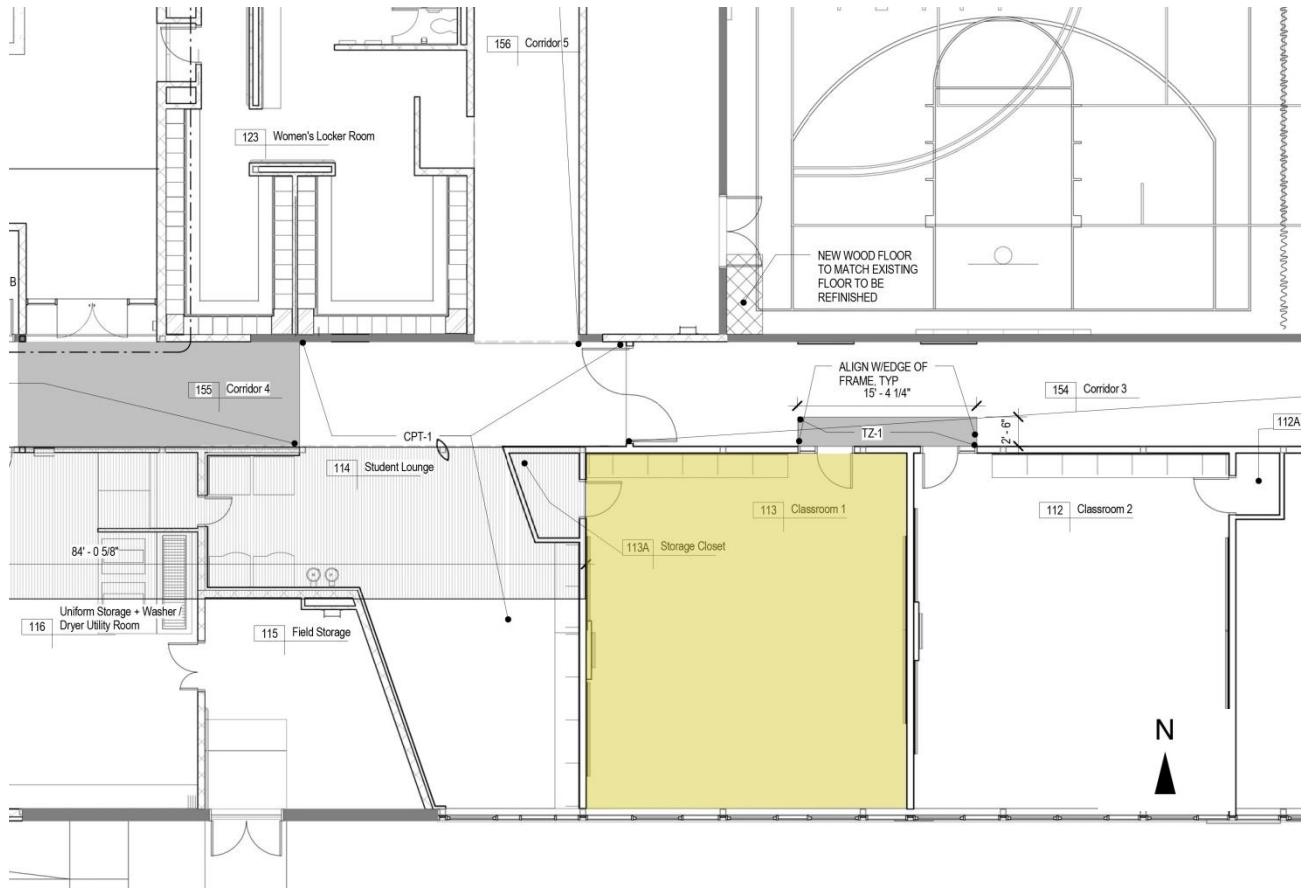


Fig 1. Classroom 113 Floor Plan.

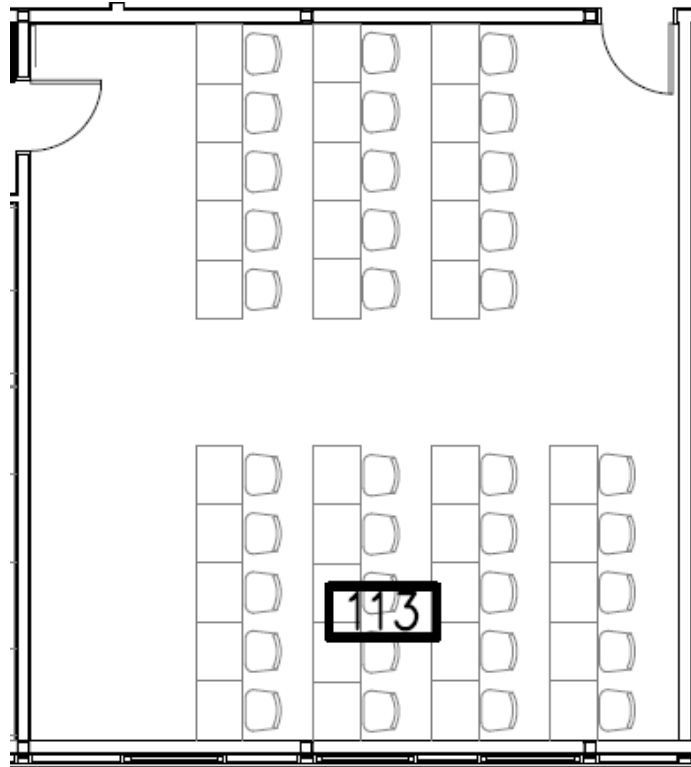


Fig 2. Classroom 113 Furniture Plan.

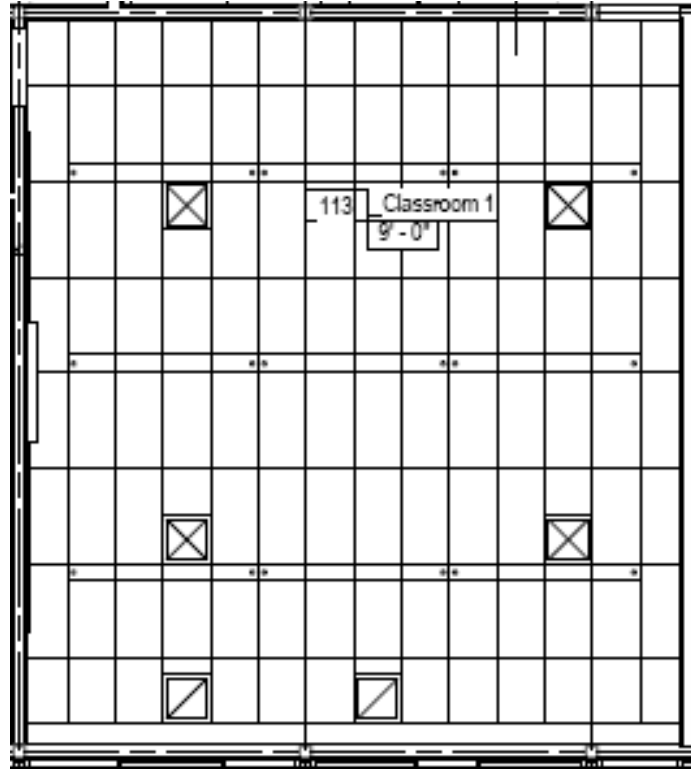


Fig3. Classroom 113 Reflected Ceiling Plan.

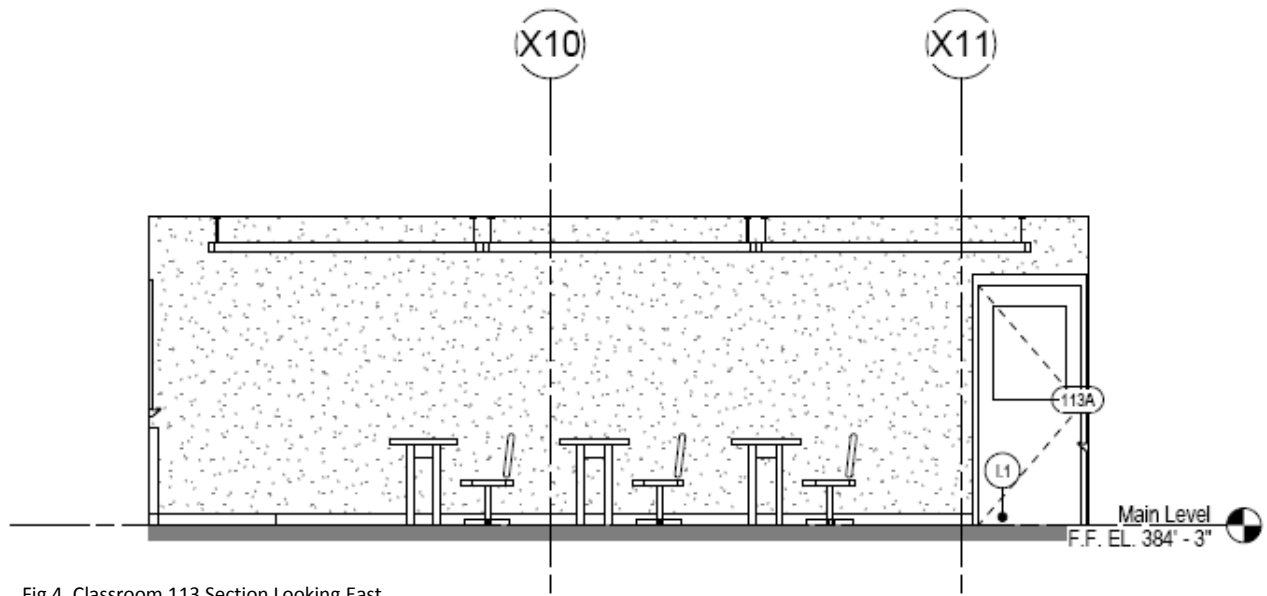


Fig 4. Classroom 113 Section Looking East.

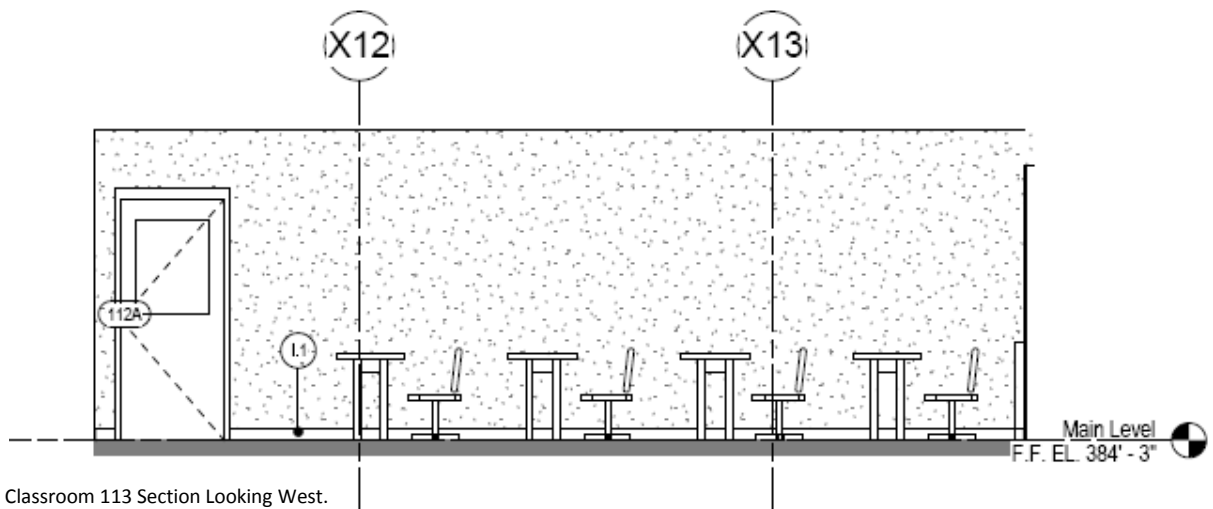


Fig 5. Classroom 113 Section Looking West.

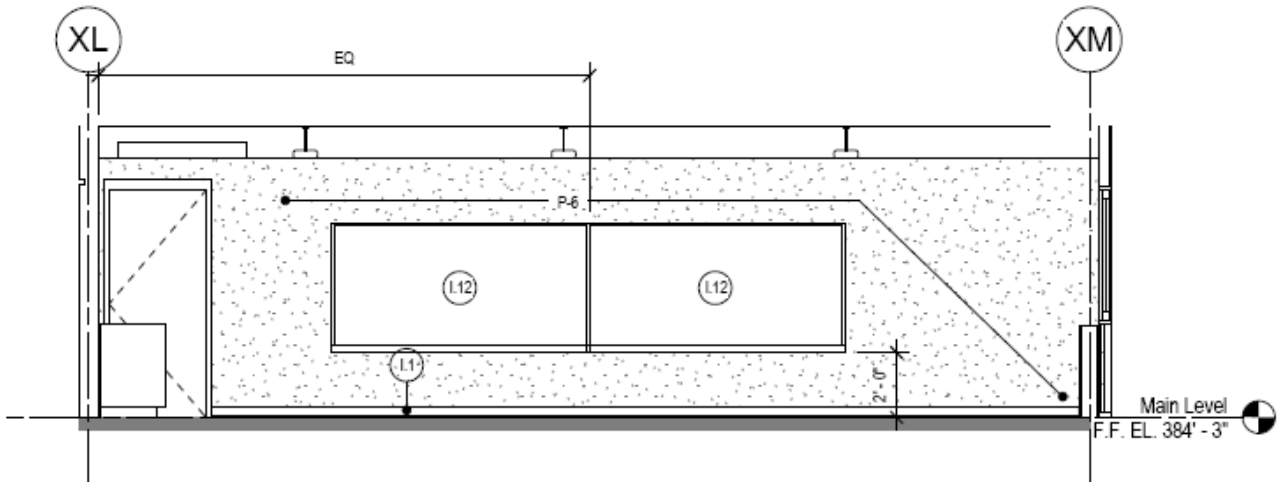


Fig. 6 Classroom 113 Section Looking North.

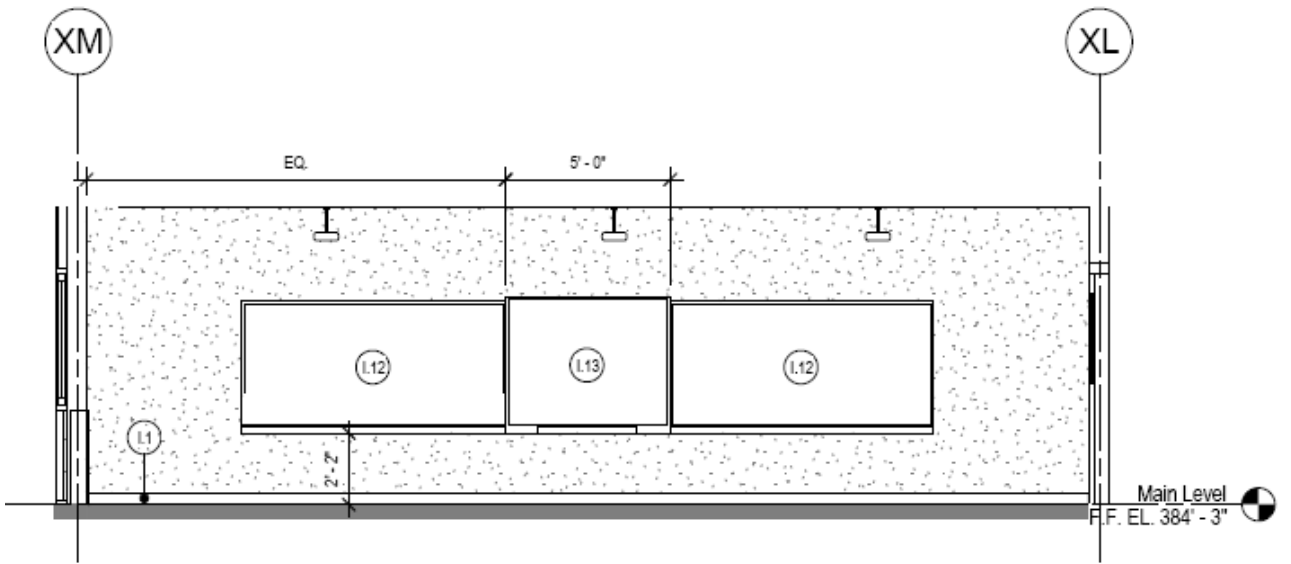


Fig. 7 Classroom 113 Section Looking South.

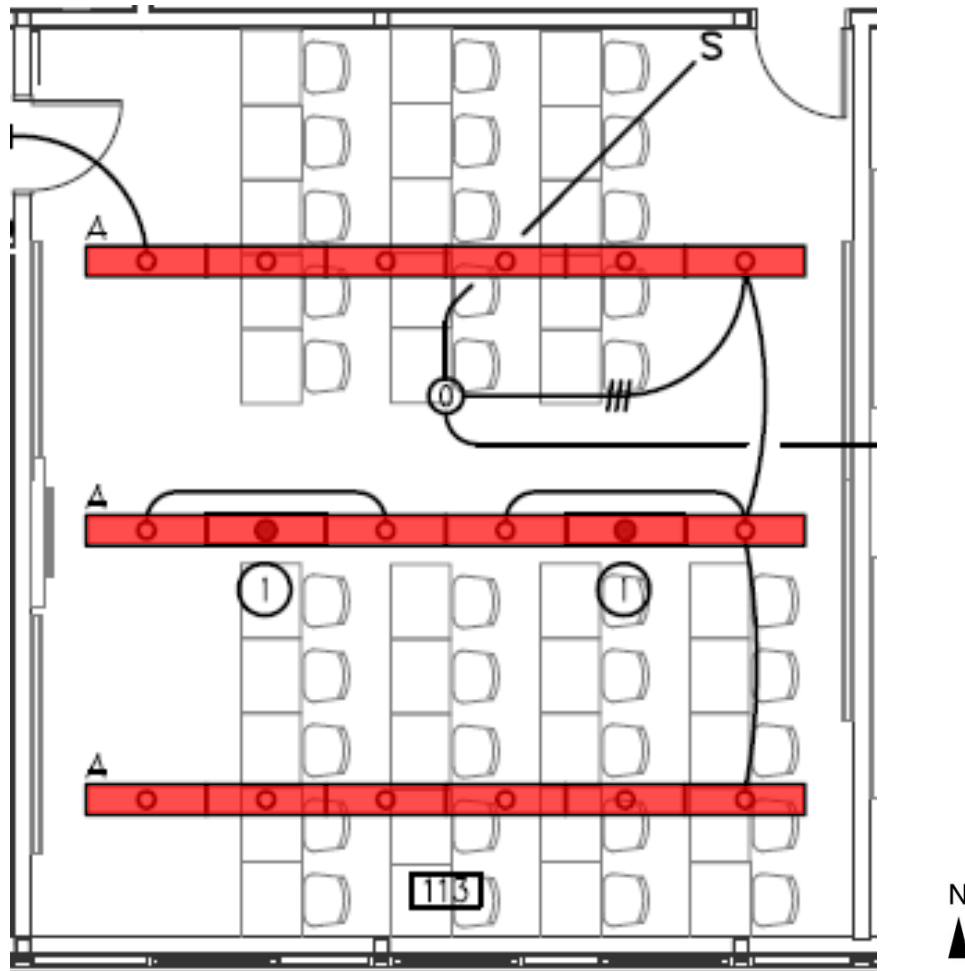


Fig 8. Classroom 113 Lighting Plan.

Lighting Fixtures:

Color	Tag	Description	Manufacturer	Model	V	LampNumber and Type
Red	A	SUSPENDED SEMI-INDIRECT FLUORESCENT WITH REFLECTOR PAN	Corelite	AP-WP-1T5-UNV-AC48=X-LENGTH AS REQ	120/277	(1)PER 4' SECTION FP54/835/HO/ECO

Design Criteria

Qualitative Criteria

Classroom lighting should be focused primarily on influencing and improving attention, allowing both students and teachers to work in a pleasant educational environment without distractions from visual glare and shadows caused by non-uniform lighting. This is important as task visibility and visual performance affects educational experience. In consideration of such requirements, illuminance values and uniformity should be carefully calculated and analyzed.

Additionally, colleges also provide night classes. Daylight integration and lighting controls should be considered to create a more visually comfortable and energy efficient space.

Special lighting effects, which can be integrated in less functional spaces to highlight the architecture and create specific psychological impressions, should be of less significance in a functional space, such as, a classroom.

Quantitative Criteria

The following quantitative criteria were referenced from the IES Handbook 10th Edition, Chapter 24 – Lighting for Education, Table 24.2:

	$E_h(\text{fc})$	E_h location	$E_v(\text{fc})$	E_v location	Uniformity Target	Daylight Integration	Veiling Reflection (0-3)	Area of Coverage
Desk	30	2'6" AFF	7.5	4' AFF	1.5:1	Yes	2	Task Area

Energy Allowance

The following energy allowance is calculated using the ASHRAE Standard 90.1 version 2010 Building Area Method:

Maximum Lighting Power Density (W/SF) for School/University: 0.99

Space	Area (SF)	Max. Lighting Power Density (W/SF)	Power Allowance (W)
Classroom 113	840	0.99	831.6

Evaluation

The existing solution portrays a standard classroom design with suspended semi-indirect fluorescent luminaires to achieve illuminance levels. However, various other luminaires like troffers and downlights with color filters can be incorporated to adjust to different class settings, such as, presentations, and meetings.

Lighting controls and occupancy sensors would benefit energy efficiency light levels can be adjusted according to the amount of daylight penetration into the space.

Special Purpose Space – Arena

Existing Conditions

Description:

The 46 feet arena is located in the East end of the building characterized by an exposed truss ceiling with a gradual slope, and is the largest space in the Susquehanna Center facility. The expansion creates a 2,552 seat arena primarily used for basketball and volleyball games, and various entertainment and academic activities, such as, concerts, exhibitions, trade shows and commencements. From the above mentioned activities, the main tasks performed in the arena will be sports, recreation and the occasional function of holding exhibits, large lectures and other large entertainment purposes.

Dimensions:

Area = 18,270 SF

Approximate width = 158ft

Approximate length = 180ft

Ceiling Height = 37ft – 46ft

Materials Finishes:

	Tag	Name	Color/Material/Style	Reflectance
Floor Finish	WD	Wood Athletic Floor, Arena	Maple Flooring w/Seal	0.7
Base Finish	B-6	Rubber Vented Cove Base	Johnsonite/4" Rubber Base	0.2
Wall Finish	P-1	Paint	Simply White OC-117/Benjamin Moore	0.8
Ceiling Finish	X	Exposed Structure	Structural Steel	-
	P-1	Paint	Simply White OC-117/Benjamin Moore	0.8

Glazing Types:

Type	Description	Visible Transmittance	Exterior Reflectance
G4	Insulated Glass Clear	0.62	0.11
G5	Insulated Glass Blue	0.3	0.11
G6	Insulated Metal Panel	0	0.7
G10	Insulated Glass Green	0.3	0.19

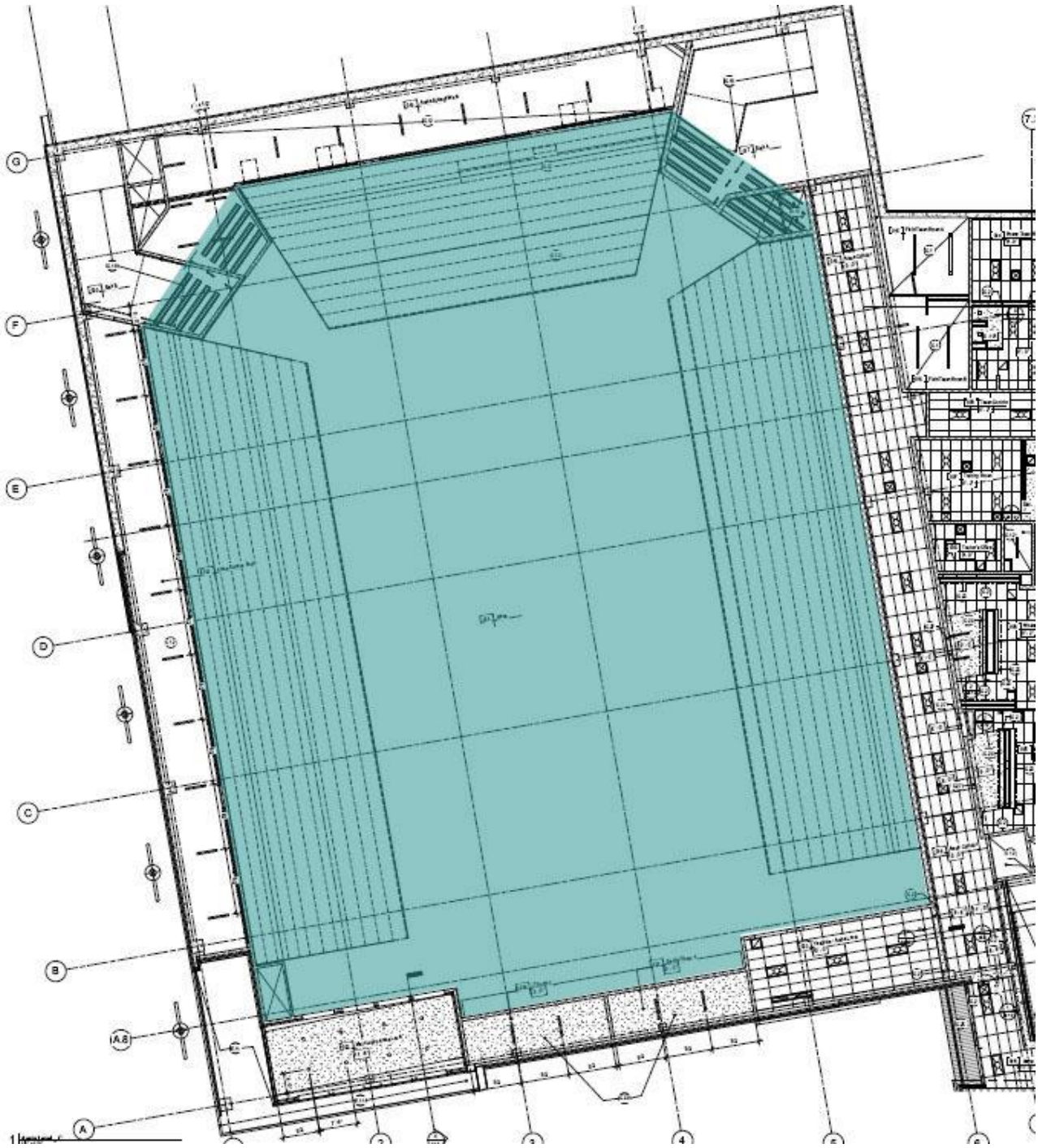


Fig 9. Arena Floor Plan.

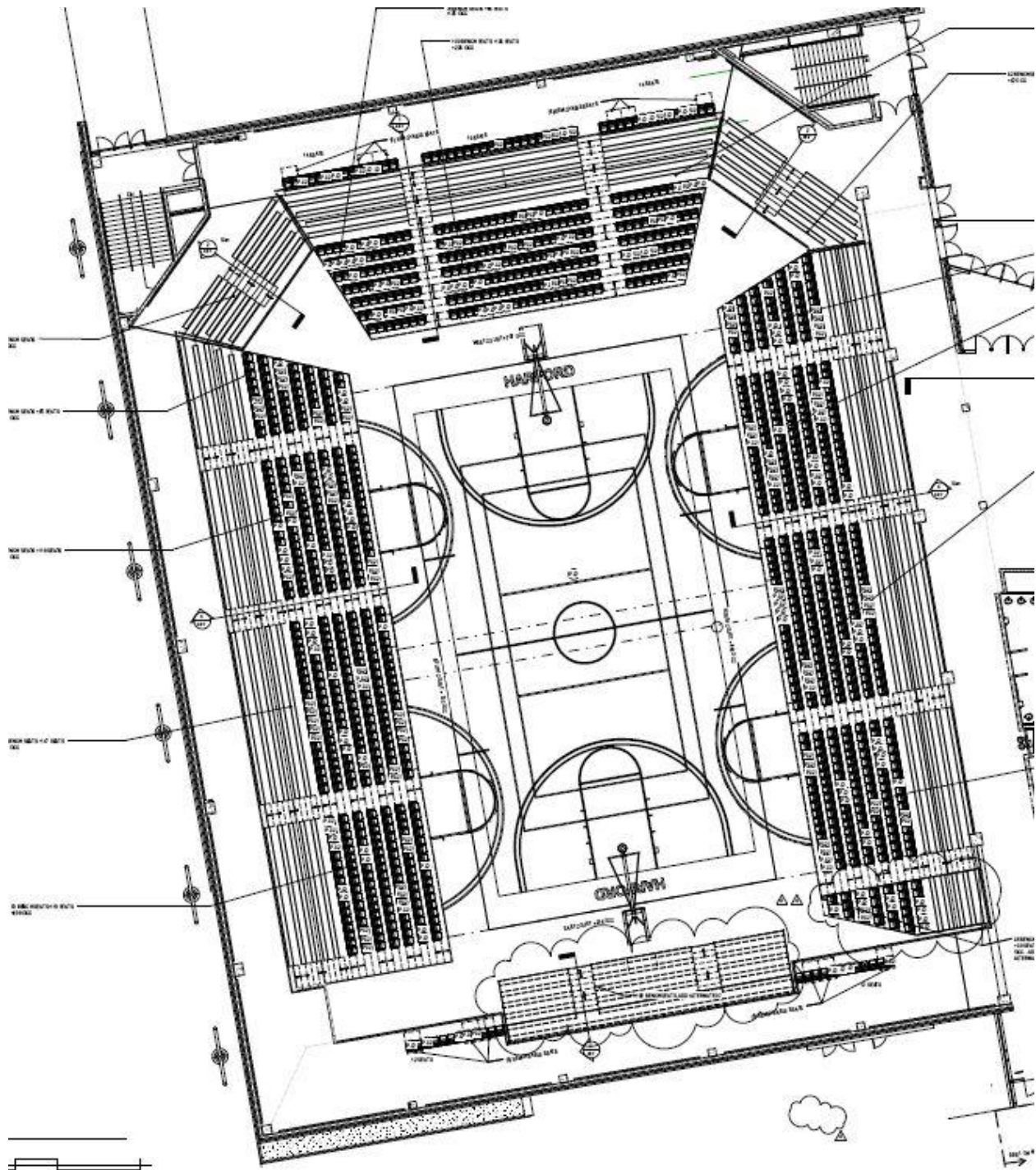


Fig 10.Arena Furniture Plan.

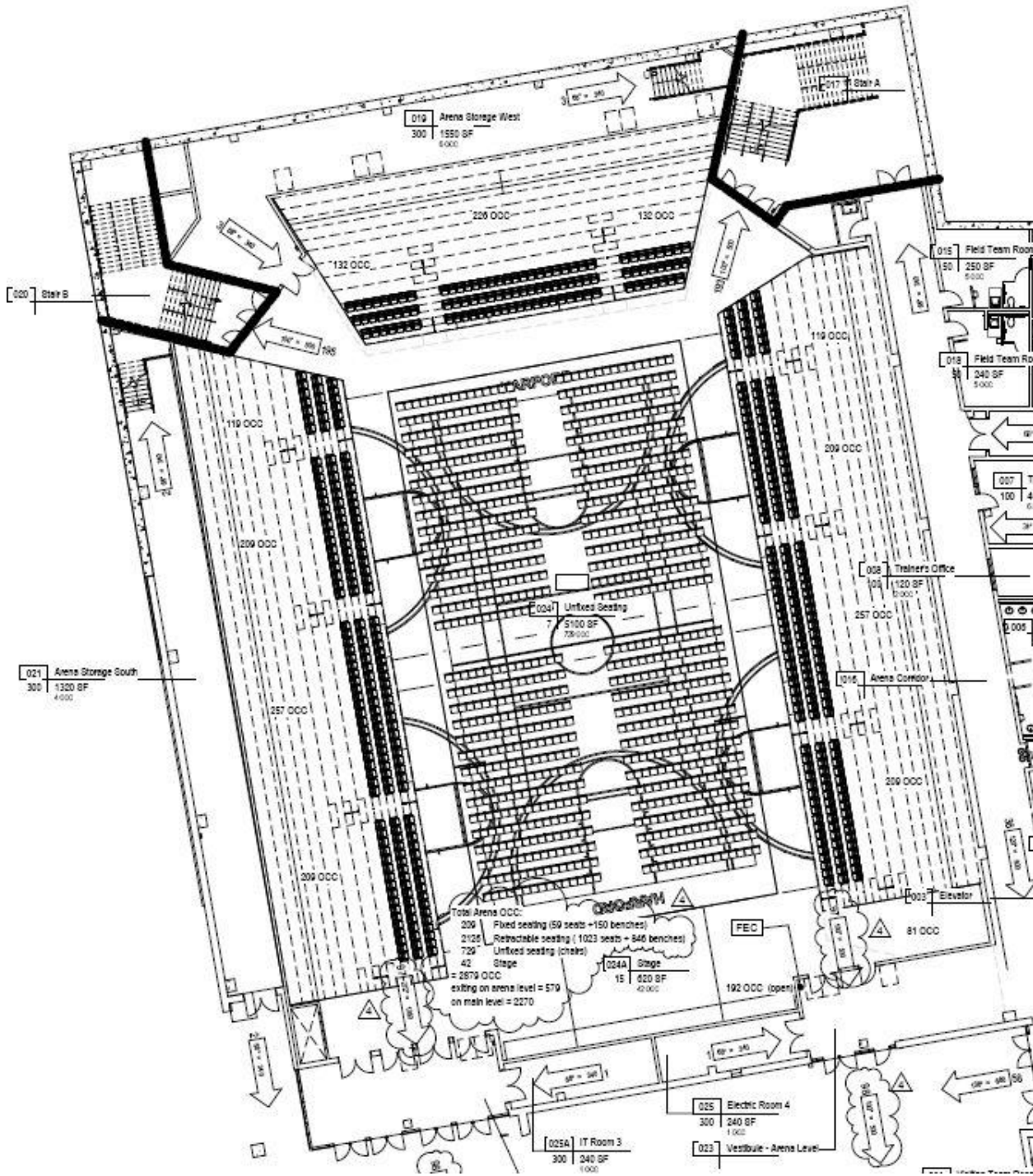


Fig 11. Arena Furniture Plan (Unfixed Seating).



Fig 12. Arena Reflected Ceiling Plan.

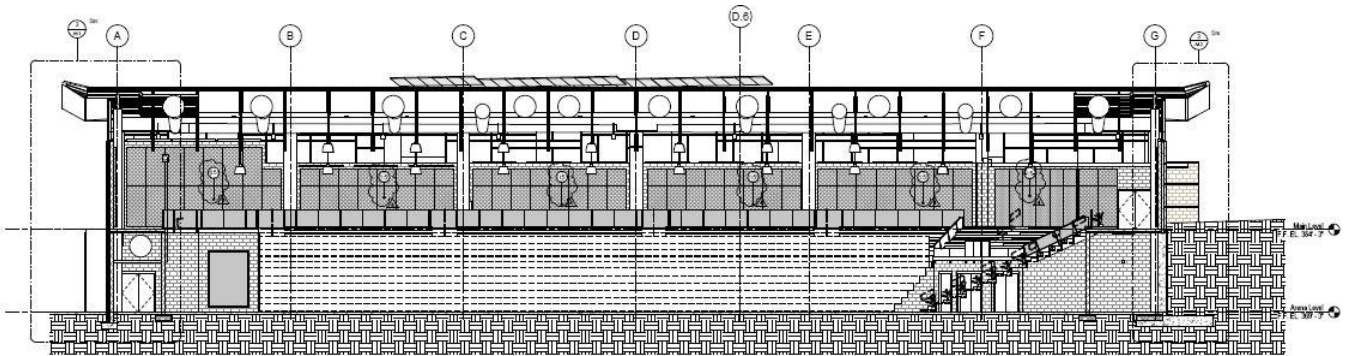


Fig 13. Arena Section Looking West.

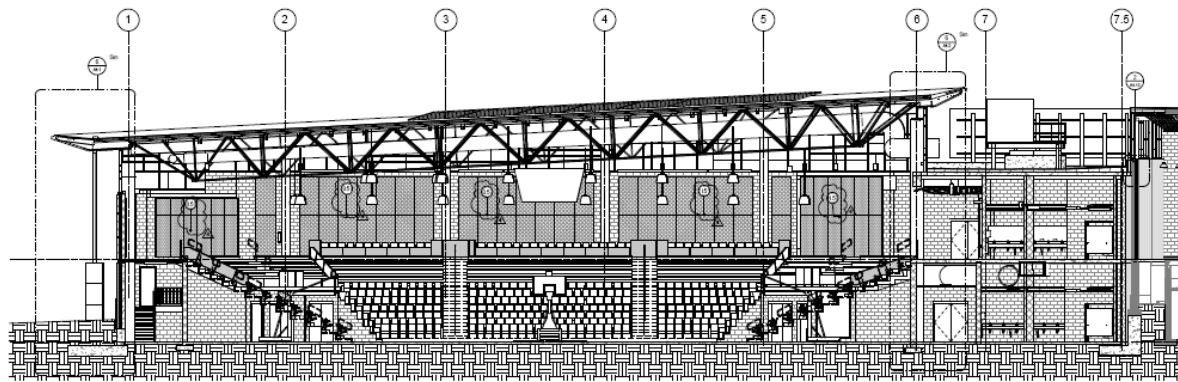


Fig 14. Arena Section Looking North.

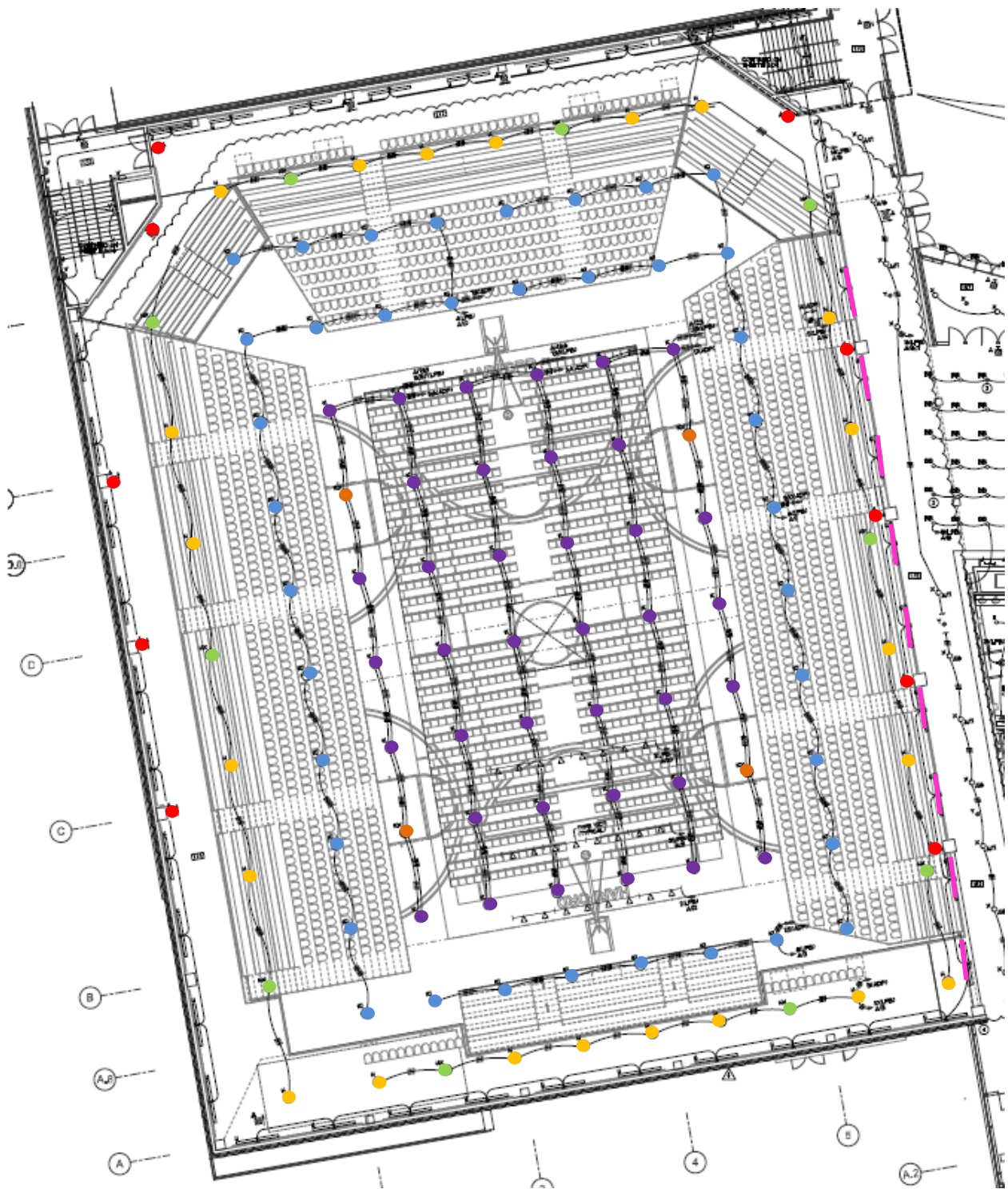


Fig 15. Arena Lighting Plan.

Lighting Fixtures:

Color	Tag	Description	Manufacturer	Model	V	Lamp Number and Type
Red	A	SUSPENDED SEMI-INDIRECT FLUORESCENT WITH REFLECTOR PAN	Corelite	AP-WP-1T5-UNV-AC48=X-LENGTH AS REQ	120/277	(1)PER 4' SECTION FP54/835/HO/ECO
Yellow	H	ARCHITECTURAL GRADE COMPACT FLUORESCENT HIGH BAY	PHILIPS SPORTLITE	TDX4-T42-35K-21AL-277-2SL-21WG-SC-H	277	(4) CF42DT/E/IN835/ECO
Green	HX	ARCHITECTURAL GRADE COMPACT FLUORESCENT HIGH BAY WITH BODINE GENERATOR TRANSFER DEVICE	PHILIPS SPORTLITE	TDX4-T42-35K-21AL-277-2SL-21WG-GTD-SC-H	277	(4) CF42DT/E/IN835/ECO
Purple	K	ARCHITECTURAL GRADE COMPACT FLUORESCENT HIGH BAY	PHILIPS SPORTLITE	TDX8-T70-35K-25AL-277-4SL-25WG-SC-H	277	(8) CF42DT/E/IN835/ECO
Orange	KX	ARCHITECTURAL GRADE COMPACT FLUORESCENT HIGH BAY WITH BODINE GENERATOR TRANSFER DEVICE	PHILIPS SPORTLITE	TDX8-T70-35K-25AL-277-4SL-25WG-GTF-SC-H	277	(8) CF42DT/E/IN835/ECO
Blue	K1	ARCHITECTURAL GRADE COMPACT FLUORESCENT HIGH BAY	PHILIPS SPORTLITE	TDX4-T70-35K-25AL-277-4SL-25WG-SC-H	277	(4) CF42DT/E/IN835/ECO
Pink	U	LINEAR FLUORESCENT DIRECT ASYMMETRICAL SURFACE PENDANT & WALL	SE'LUX	M1A-1T5-SD-W-008-WH-277 110-08401-48-05-XX	277	(1)FP28/835/ECO

Design Criteria

Qualitative Criteria

Basketball and volleyball are considered multi-directional sports, where both the athletes and the spectators in the stands view the game from different directions and angles. Thus, it is especially important that the athletes' performance is not affected by visual glare while the spectators can also watch the game comfortably. Therefore, horizontal and vertical illuminance values should be taken into heavy consideration. Uniformity is another important factor that affects visual performance and should be considered to prevent hot spots/dark spots from occurring in the space. Visual glare can be controlled by locating luminaires away from the most frequent viewing directions of the occupancy. (*IES Handbook 10th Edition*)

Daylighting should be incorporated into the space, as to take advantage of the multi-colored glass strip aligned at the top portion of the arena space, to provide an energy-efficient and comfortable space during the day time when other activities can be performed in the arena.

Despite being a relatively functional space, the aesthetic appearance of the lighting design should be considered as the arena can also be used for other activities, but not to the extent of highlighting architectural elements. The three lighting design concepts should uniquely accommodate the mood and atmosphere of different activities, for instance, an art exhibit and a concert would require a different lighting concept.

The following quantitative criteria were referenced from the IES Handbook 10th Edition, Chapter 35 – Lighting for Sports and Recreation, Table 35.2 and Table 35.3

Class of Play= II (Spectator Capacity Under 5000) for a College Facility

	E_h (fc)	E_h location	E_v (fc)	E_v location	Uniformity Target	Daylight Integration	Area of Coverage
Arena	75	3'	20	12'	2.5:1	Yes	Task Area

Energy Allowance

The following energy allowance is calculated using the ASHRAE Standard 90.1 version 2010 Building Area Method:

Maximum Lighting Power Density (W/SF) for Sports Arena: 0.78

Space	Area (SF)	Max. Lighting Power Density (W/SF)	Power Allowance (W)
Arena	18,270	0.78	14,250.6

Evaluation

Although using compact fluorescent lamps for the arena may be a relatively good solution, another design approach is to replace them with LEDs to improve energy efficiency and maintenance costs. Color rendering for LEDs are generally consistent and would be an excellent alternative to compact fluorescents. Lighting controls can adjust the different settings suited to various activities performed in the arena.

Circulation Space – Main Lobby

Existing Conditions

Description:

The main lobby provides an excellent transitional and circulation space between the arena and other facilities in the building, such as, the swimming pool, fitness center, and classrooms and offices. The tasks performed in the lobby are mainly circulation, and socializing.

Dimensions:

Area=850SF

Approximate width= 15ft-35ft

Approximate length = 41ft

Ceiling Height = 18.5ft

Materials Finishes:

	Tag	Name	Color/Material/Style	Reflectance
Floor Finish	TZ	Terrazzo New	Terrazzo	0.6
Base Finish	-	-	-	-
Wall Finish	-	Concrete	Concrete Block	0.3
		Brick	Brick	0.25
Ceiling Finish	GB	Gypsum Board Painted	-	0.1
	P-1	Paint	Simply White OC-117/Benjamin Moore	0.8

Glazing Types:

Type	Description	Visible Transmittance	Exterior Reflectance
G1	Insulated Clear	0.3	0.11

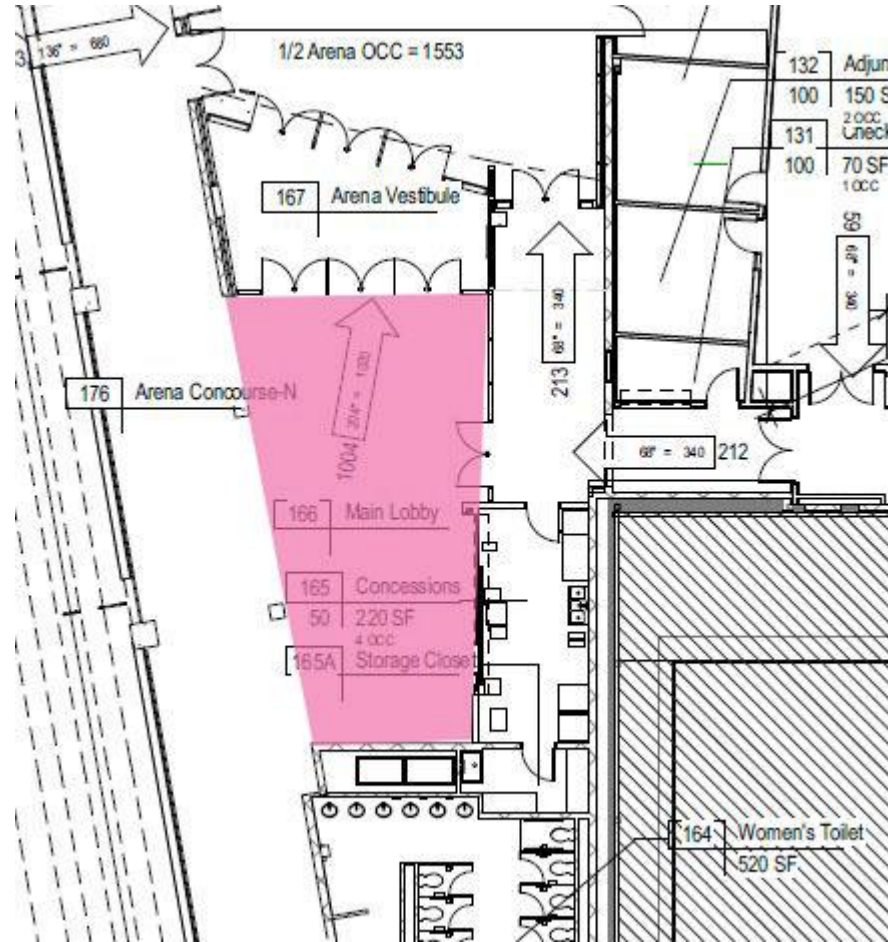


Fig 16. Main Lobby Floor Plan.

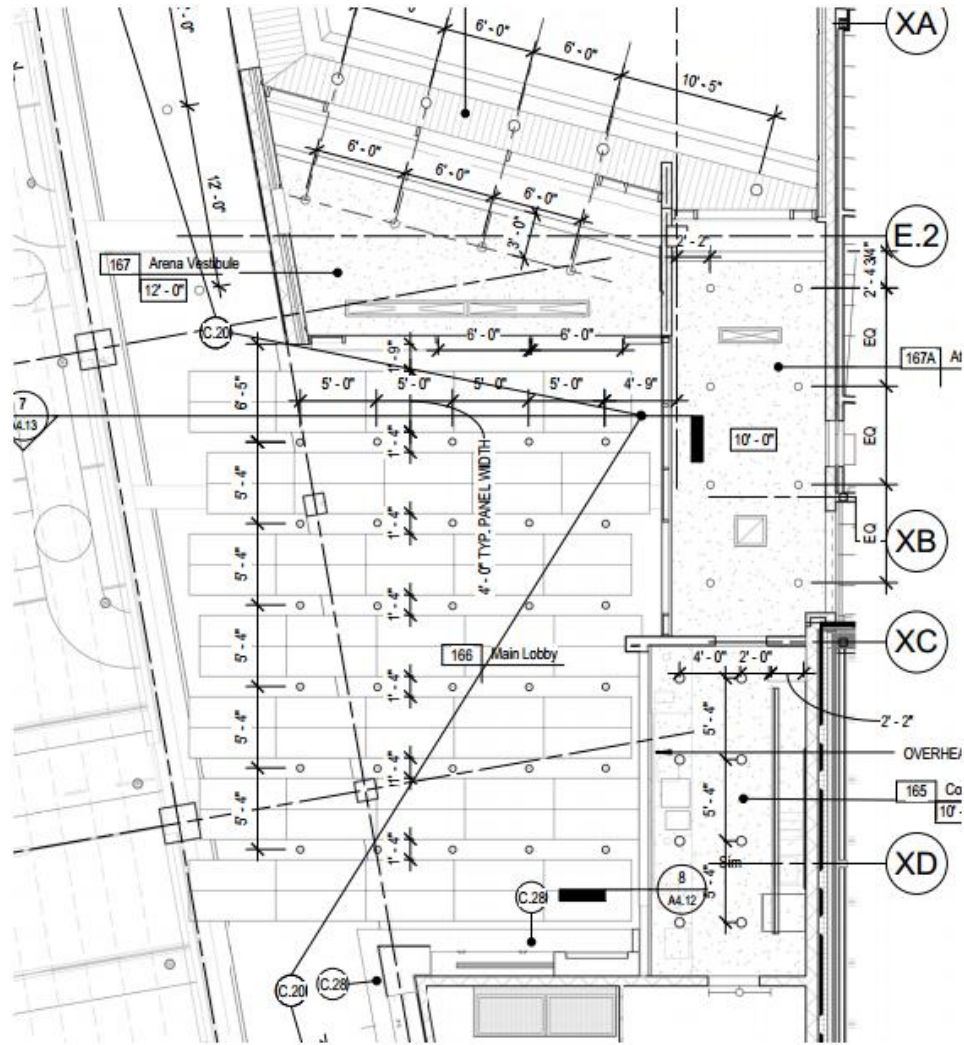


Fig17. Main Lobby Reflected Ceiling Plan.

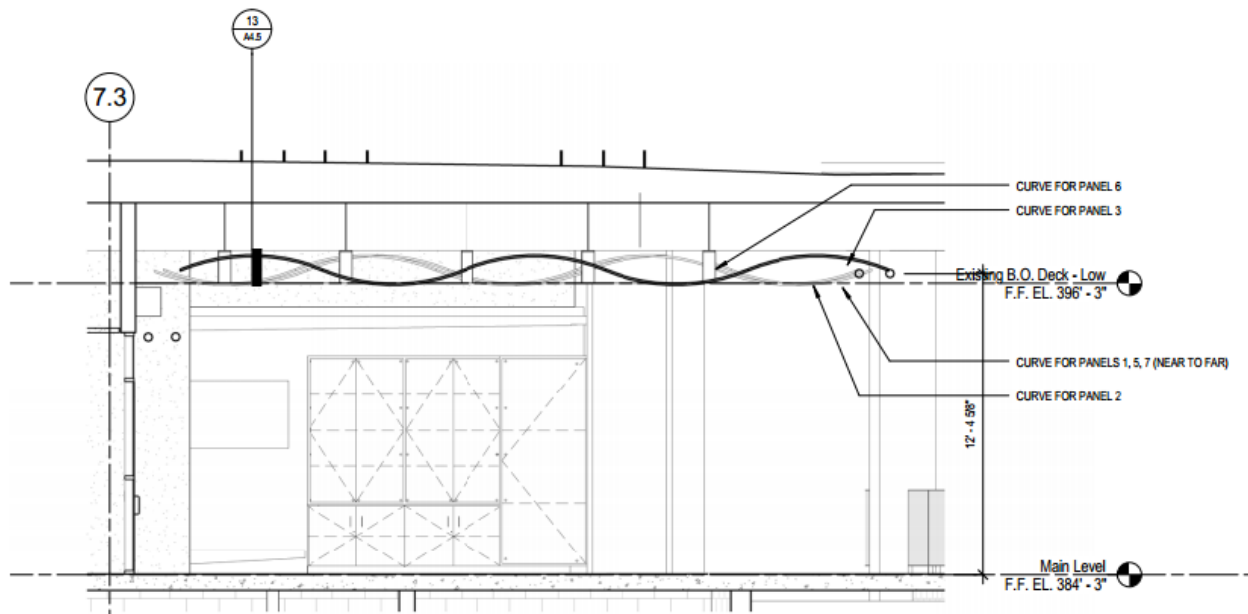


Fig18. Main Lobby Section Looking East.

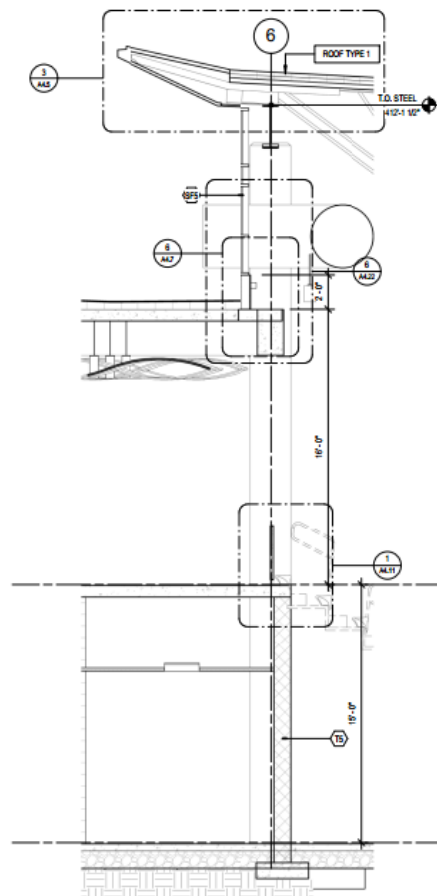


Fig19. Main Lobby Section Looking West.

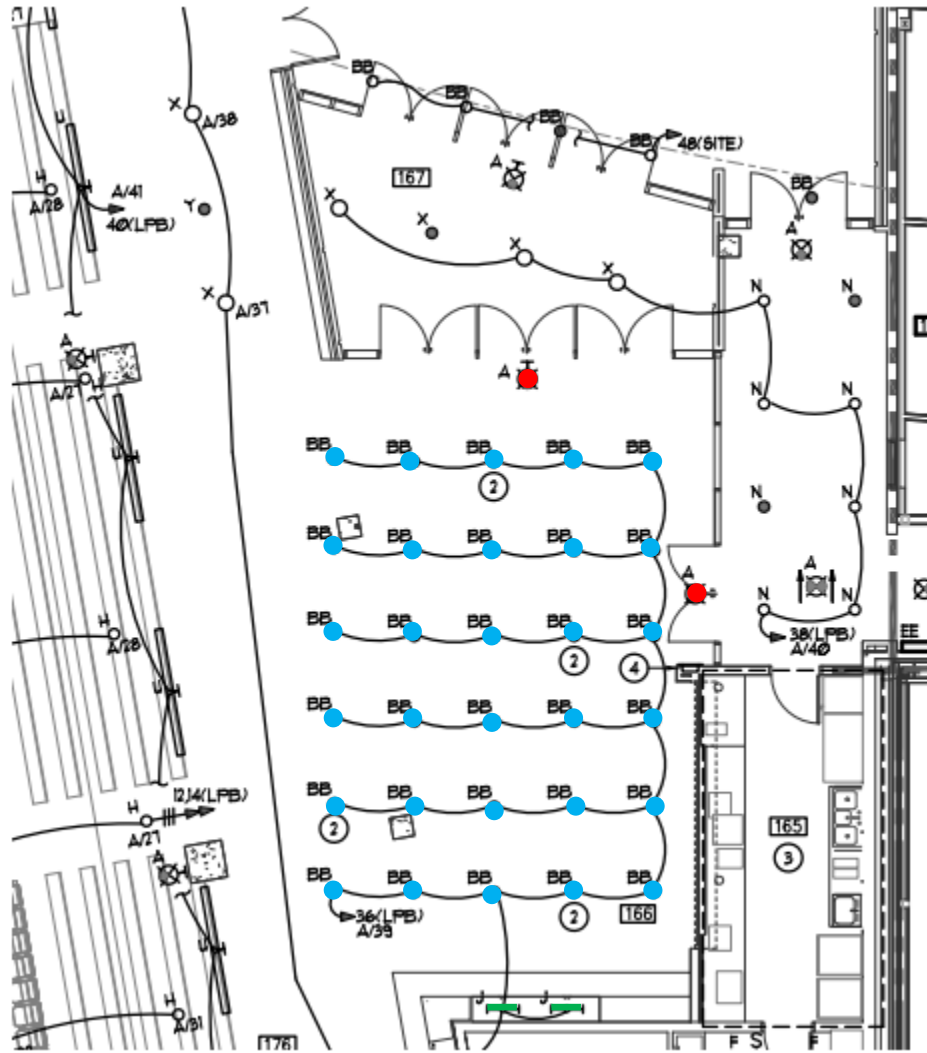


Fig 20. Main Lobby Lighting Plan.

Lighting Fixtures:

Color	Tag	Description	Manufacturer	Model	V	Lamp Number and Type
Red	A	SUSPENDED SEMI-INDIRECT FLUORESCENT WITH REFLECTOR PAN	Corelite	AP-WP-1T5-UNV-AC48=X-LENGTH AS REQ	120/277	(1)PER 4' SECTION FP54/835/HO/ECO
Blue	BB	7-3/8" SURFACE CYLINDER COMPACT FLUORESCENT WITH LOW INDESCENT FINISH AND ELETRONIC BALLAST	Cooper	C17042EP 7400LI C836P	120/277	(1) CF42DT/E/IN/835/ECO
Green	J	LINEAR FLUORESCENT NARROW STRIP WITH BUILT-IN BALLAST	Cooper	SNF-117/25-UNV-EB81-U	120/277	(1)FO17/25/835/ECO

Design Criteria

Qualitative Criteria

Serving as the circulation space and the first space where people will encounter when entering the building, the main lobby serves a very important purpose in setting ‘first impressions’ of the architecture and the building itself. The main lobby also serves as a guide to different parts of the building and can be reinforced with the use of lighting effects. Aesthetic appearance needs to be heavily addressed to create memorable and breathtaking ‘first impressions’ of festivity in this rather simplistic yet important space. This will ultimately set the tone and mood of athletes, spectators, and even regular students to enter a state of excitement and adrenaline. Using various techniques, such as, wall-washing and wall-grazing to complement the architecture, it also serves a purpose in creating visual interest.

Illuminance levels need to be addressed accordingly to control visual glare and to provide visual comfort through the transition from the exterior environment to the interior of the building.

Quantitative Criteria

The following quantitative criteria were referenced from the IES Handbook 10th Edition, Chapter 35 – Lighting for Sports and Recreation, Table 22.2.

	E_h (fc)	E_h location	E_v (fc)	E_v location	Uniformity Target	Daylight Integration	Area of Coverage
Day	10	floor	3	5' AFF	4:1	Yes	Entire Area
Night	5	floor	2	5' AFF	4:1	No	Entire Area

Energy Allowance

The following energy allowance is calculated using the ASHRAE Standard 90.1 version 2010 Building Area Method:

Maximum Lighting Power Density (W/SF) for School/University: 0.99

Space	Area (SF)	Max. Lighting Power Density (W/SF)	Power Allowance (W)
Arena	850	0.99	841.5

Evaluation

The main lobby comprises of various glass showcases and glass doors that which should not be illuminated directly to prevent visual glare problems. Wall sconces and cove lighting can be implemented to achieve the desired effect, while creating a comfortable and pleasant ambience to the space. Wall-grazing and wall-washing techniques can be used to highlight the architecture and to create visual interest. A simplistic approach should be taken as lighting should only be used here to complement the architecture and not challenge it. Energy-efficient LEDs and compact fluorescent downlights can be used to provide adequate illuminance levels but can also be used to create strikingly interesting effects.

The introduction of sculptural luminaires can also used to create feelings of festivity. However, careful selection must be taken into account as to not deviate from the desired lighting design concept.

Outdoor Space- Exterior Promenade

Existing Conditions

Description:

The main exterior curvilinear promenade located in the North end serves as the main façade of the building. Unlike the rest of the architecture, which is quite rectangular in shape, the promenade lends perfectly to create the perfect welcoming reception before people enter the building. The promenade also serves as a shading device with light baffles to block out low angle sun from entering the fitness center. One of the prominent features of the building, the space is mainly used for circulation and socializing.

Dimensions:

Area = 2483SF

Approximate width = 16 ft

Approximate length = 160 ft

Height = 18.5 ft

Materials Finishes:

	Tag	Name	Color/Material/Style	Reflectance
Shading Device	E.14	Perforated Aluminum Light Baffle	Perforated Aluminum	0.6
Split Face Concrete Block	E.7	Split Face Concrete Block	Earth Tone, Color 21-B	0.3

Glazing Types:

Type	Description	Visible Transmittance	Exterior Reflectance
G1	Insulated Clear	0.3	0.11

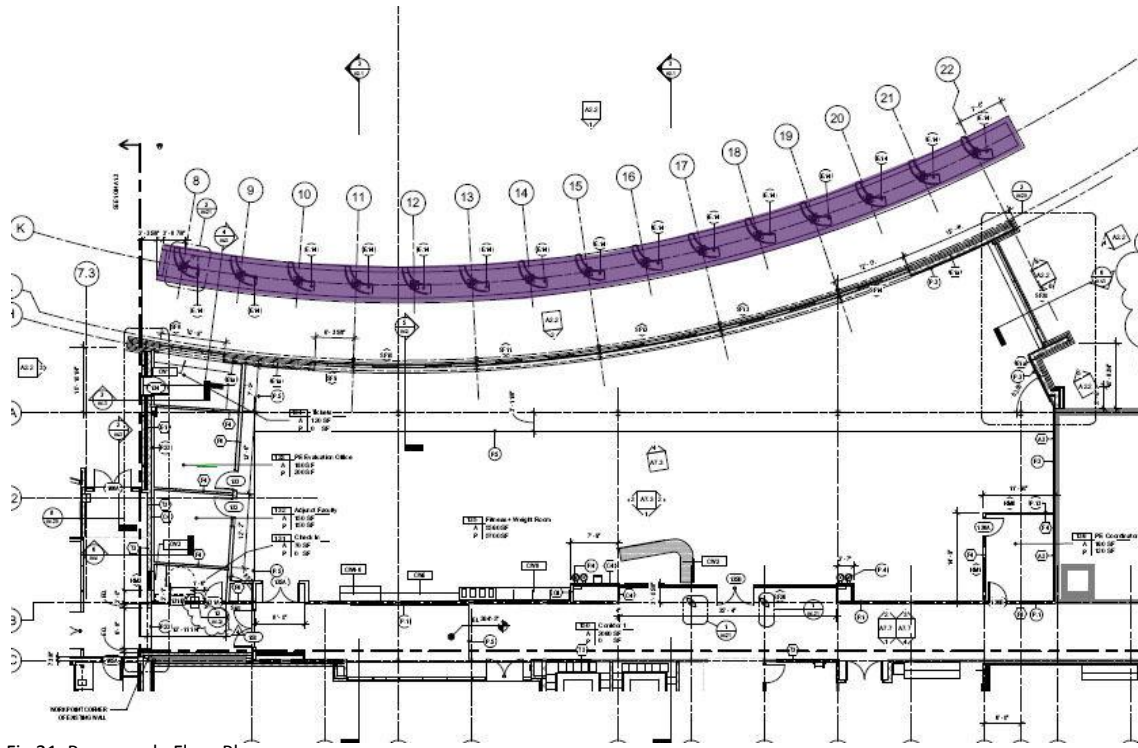


Fig 21. Promenade Floor Plan.

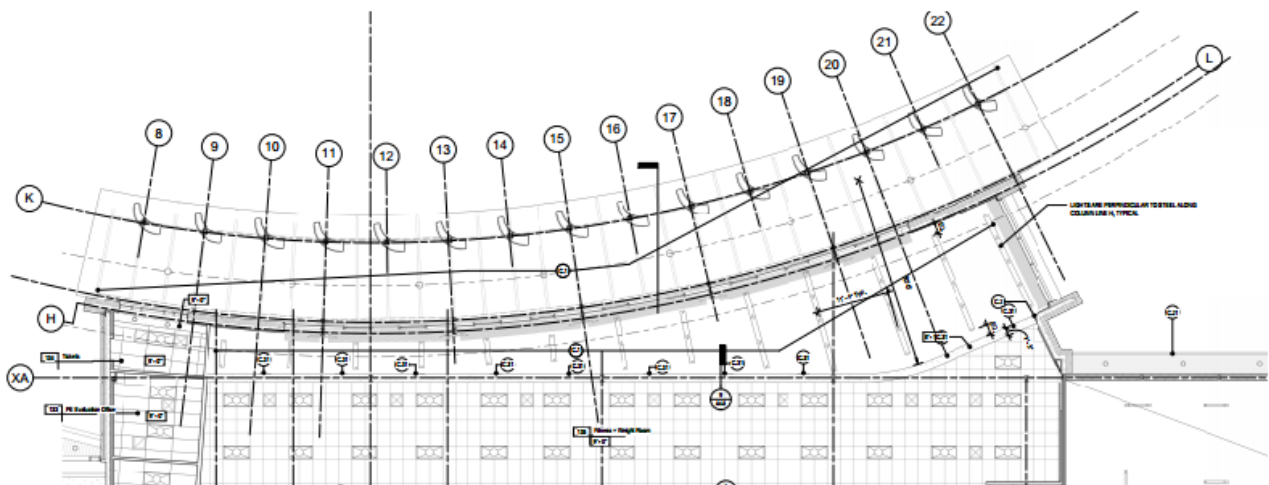


Fig 22. Promenade Reflected Ceiling Plan.

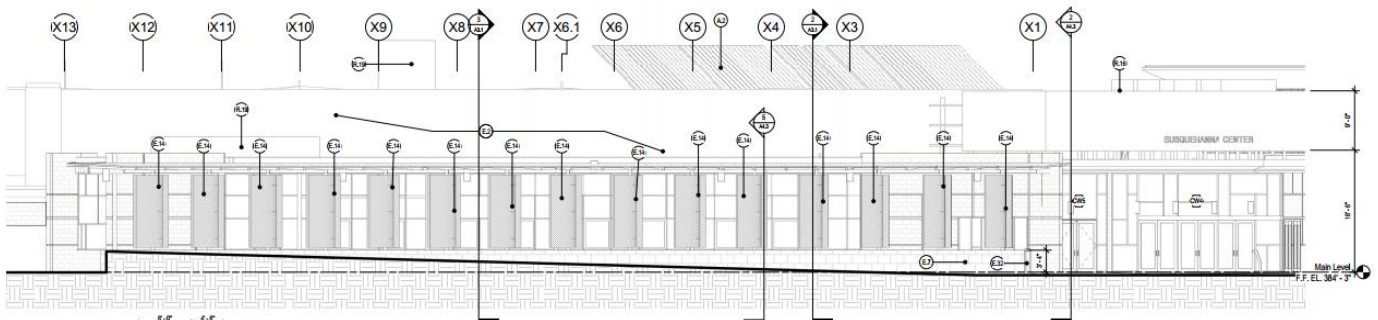


Fig 23. Promenade Section Looking South.

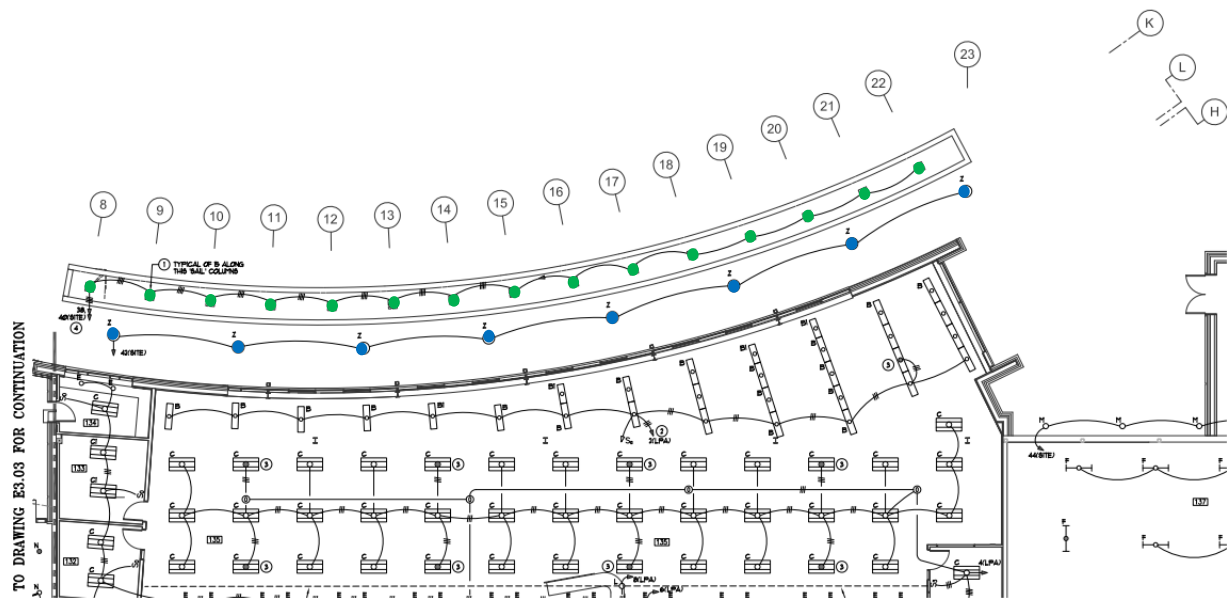


Fig 24. Promenade Lighting Plan.

Luminaire Fixtures:

Color	Tag	Description	Manufacturer	Model	V	Lamp Number and Type
Green	J	LINEAR FLUORESCENT NARROW STRIP WITH BUILT-IN BALLAST	Cooper	SNF-117/25-UNV-EB81-U	120/277	(1)FO17/25/835/ECO
Blue	Z	7-3/8" SURFACE CYLINDER COMPACT FLUORESCENT WITH ELECTRONIC BALLAST	Cooper	C17042EP 7400LI	120/277	(1)CF42D/E/IN/834/ECO

Design Criteria

Qualitative Criteria

Exterior and façade lighting should be designed with appropriate illuminance levels to provide adequate lighting for circulation purposes, especially pathways and entrances leading to the building. According to the *IES Handbook 10th Edition, Chapter 26 Lighting for Exteriors*, color rendering and color temperature has a strong influence on normalcy and visual appeal. That being said, being more prominent architectural of the building, the promenade should be visually interesting at night. The aluminum perforated light baffles can be appropriately accented and highlighted to create a contemporary, modern and simple appearance that complements the surrounding architecture and the exterior environment.

Because outdoor lighting lacks the architectural enclosure to contain, capture and redistribute light, skyglow must be controlled to minimize its negative impact on the environment and the surrounding neighborhood. Therefore, vertical illuminance levels for outdoor lighting needs to be evaluated.

Quantitative Criteria

The following quantitative criteria were referenced from the *IES Handbook 10th Edition, Chapter 26 – Lighting for Exteriors, Table 26.2*.

	E_h (fc)	E_h location	E_v (fc)	E_v location	Uniformity Target	Daylight Integration	Area of Coverage
Facade	-	-	10	-	0	No	Entire Area

Energy Allowance

The following energy allowance is calculated using the ASHRAE Standard 90.1 version 2010 Building Area Method:

Maximum Lighting Power Density (W/SF) for School/University: 0.78

Space	Area (SF)	Max. Lighting Power Density (W/SF)	Power Allowance (W)
Arena	2483	0.78	1937

Evaluation

Although the perforated aluminum light baffles' is a shading device used to control direct sun penetration during the day, the interior structure are actually column supports for the promenade roof. At night, wall-grazing techniques using recessed uplights can help transform the shading device into a visually interesting architectural feature.

The existing design concept for the promenade roof incorporates down lights for highlighting the pathway underneath it. An alternative solution is to completely leave the underside dark, as interior lighting from the fitness center can provide adequate lighting for the pathway. Putting luminaires on the underside of the promenade and accenting the light baffles could create a plain two dimensional appearance, while also minimizing the visual interest of the light baffles.

Additional Space- Fitness + Weight Room

Existing Conditions

Decription:

The North end of the fitness center shares the same unique curvilinear shape of the promenade and provides an excellent view of the exterior with the shading of the promenade. Located in the North end of the building, the fitness center’s main tasks are running and weight lifting.

Dimensions:

Area = 5560 SF

Approximate width = 62 ft

Approximate length = 144 ft

Ceiling Height = 18.5 ft

Materials Finishes:

	Tag	Name	Color/Material/Style	Reflectance
Floor Finish	CPT-1	Carpet Tile	Reminiscent/Interface Flor/Happening 2’x2’ Tile	0.2
	R-1	Rubber Floor Tile	583 Sicily/Johnsonite/Roundel Matera 24”x 24” Tile	0.2
Base Finish	B-1	Rubber Base	71 Storm Cloud/Johnsonite/4” Rubber Base	-
Wall Finish	P-1	Paint	Simply White OC-117/Benjamin Moore	0.8
	P-6	Paint	Baby Boy Blue2065-50/Benjamin Moore	0.6
	P-7	Paint	Deep Ocean 2058-50/Benjamin Moore	0.2
Ceiling Finish	ACT-1	Acoustical Ceiling Tile	2x4	0.75
	GB	Gypsum Board Painted	Gypsum Board	-
	P-1	Paint	Simply White OC-117/Benjamin Moore	0.8

Glazing Types:

Type	Description	Visible Transmittance	Exterior Reflectance
G1	Insulated Clear	0.3	0.11

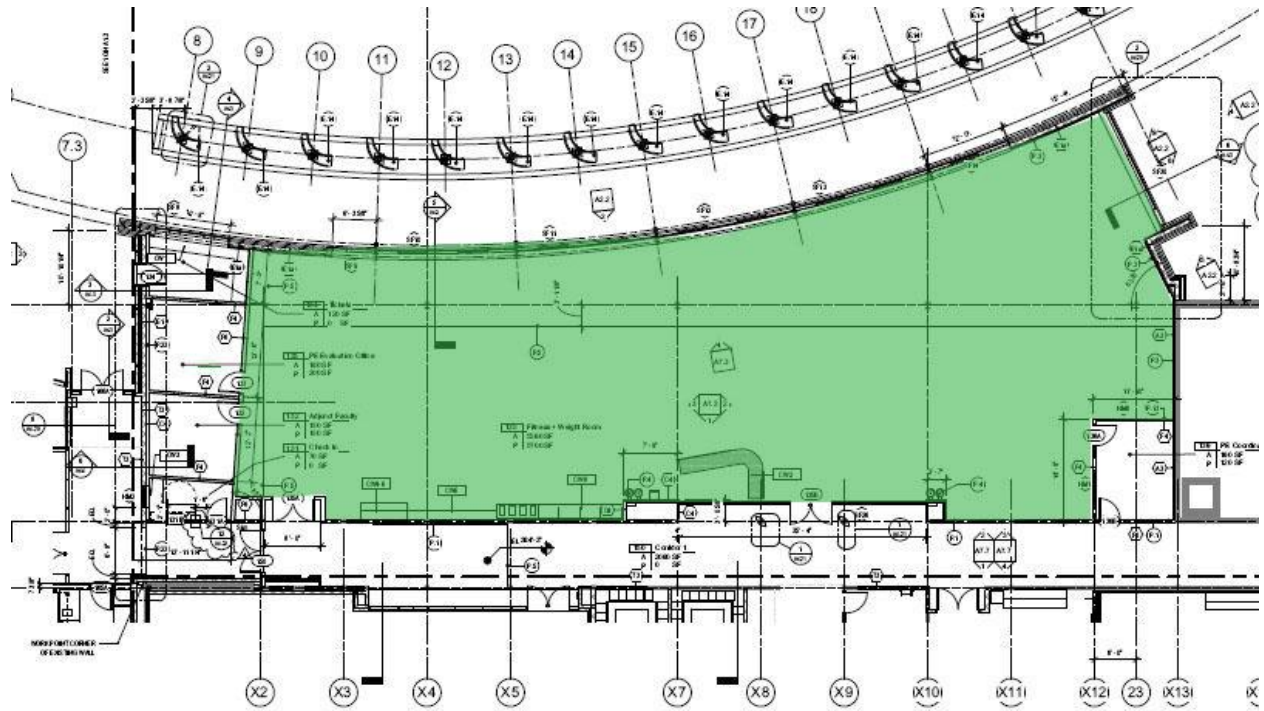
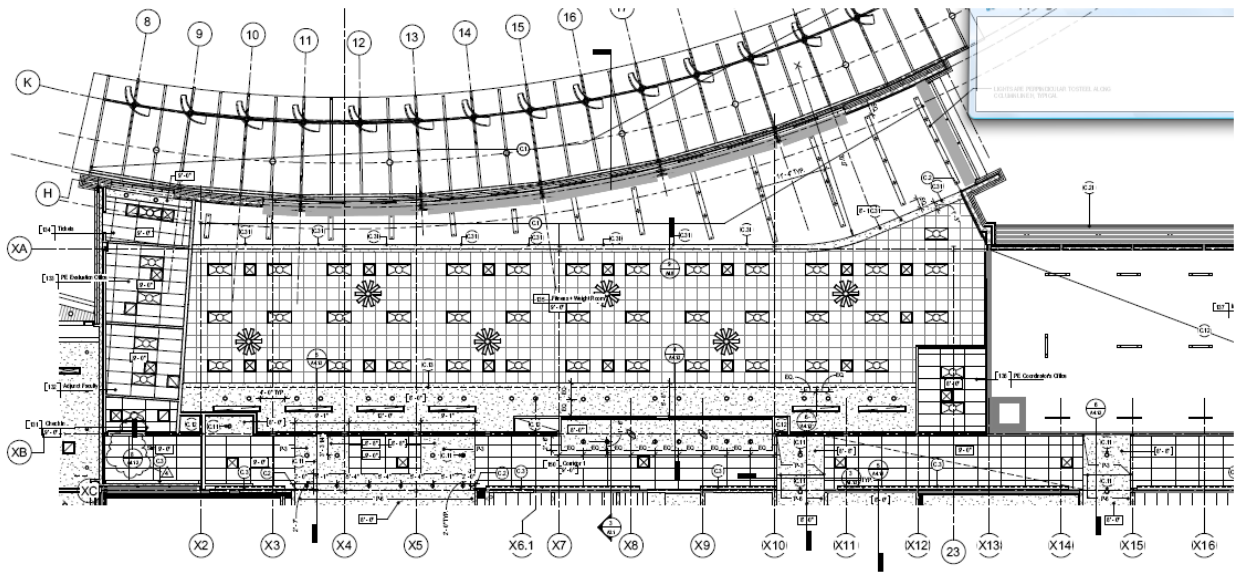


Fig 25. Fitness Floor Plan.



Main Floor A

Fig 26. Fitness Center Reflected Ceiling Plan.

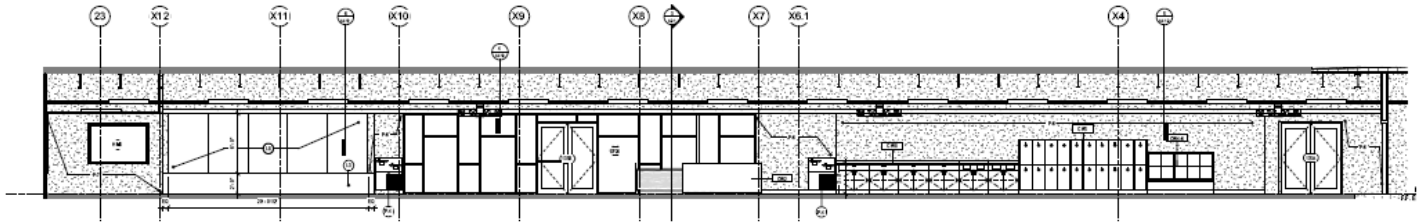


Fig 27. Fitness Center Looking South.

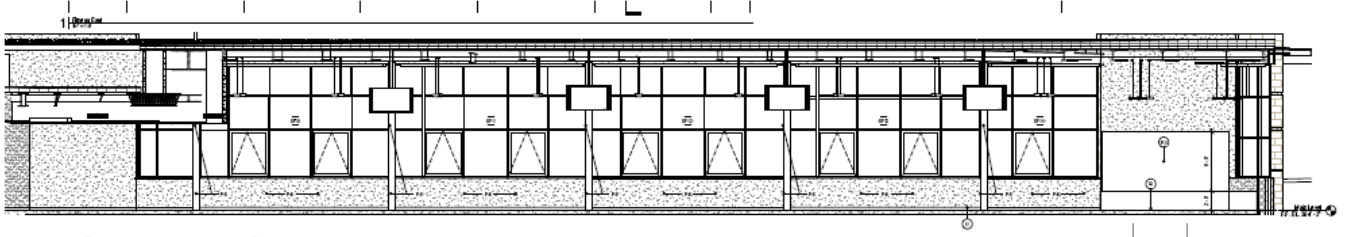


Fig 28. Fitness Center Looking North.

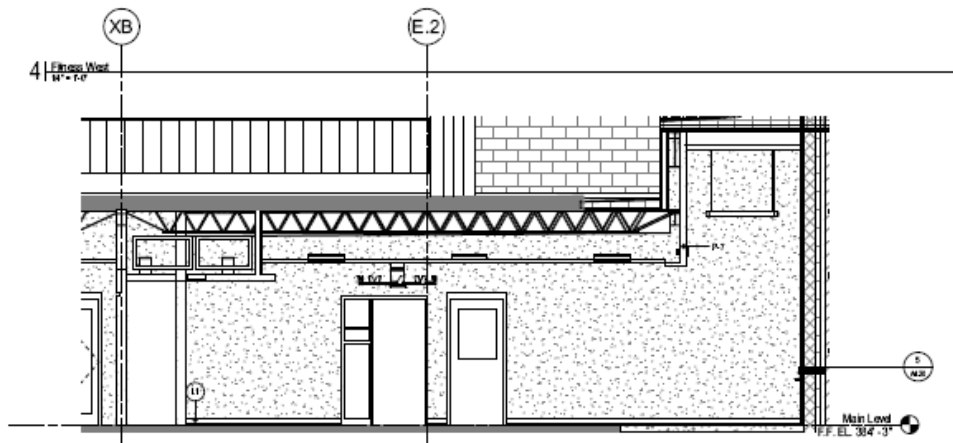


Fig 29. Fitness Center Looking West.

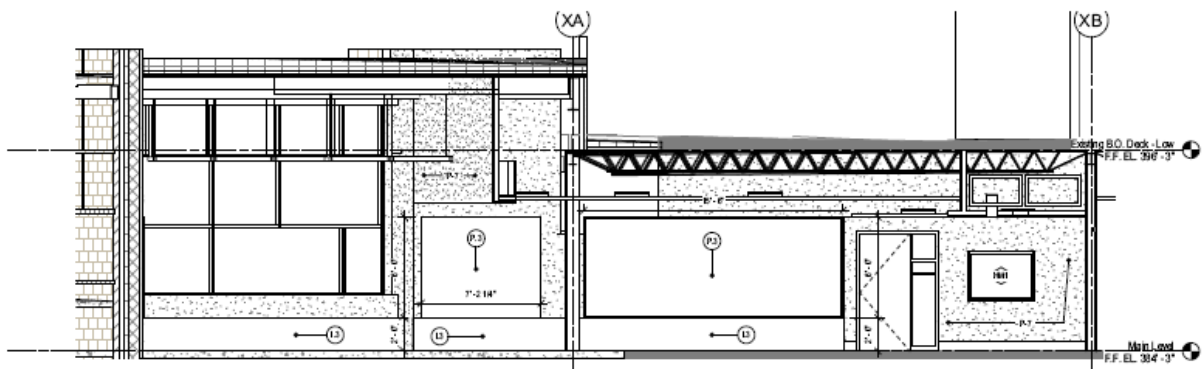


Fig 30. Fitness Center Looking East.

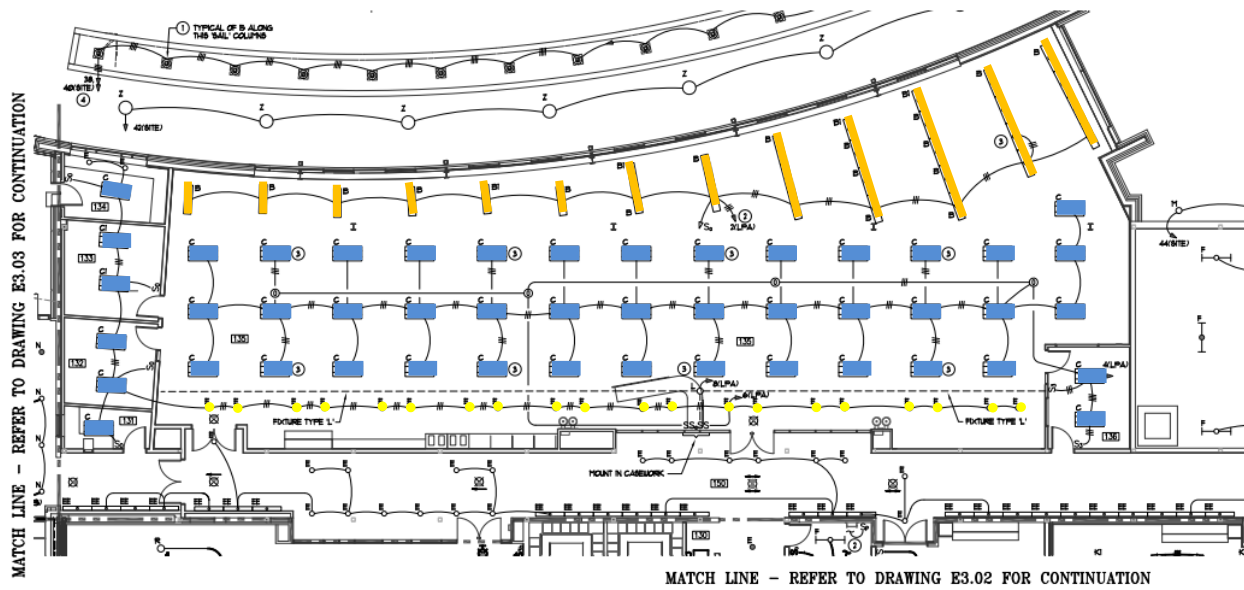


Fig 31. Fitness Center Lighting Plan.

Luminaire Fixtures:

Color	Tag	Description	Manufacturer	Model	V	Lamp Number and Type
Orange	B	SUSPENDED DIRECT-INDIRECT FLUORESCENT LUMINAIRE	Corelite	S1WB-2N5-1D-277-AC12-X-DL70	277	(2) PER 4' SECTION FP28/835/ECO
Blue	C	FLUORESCENT TROFFER	Cooper	2AC-228T5-UNV-EBT1-U	120/277	(2) FP28/835/ECO
Yellow	E	6" OPEN DOWNLIGHT WITH ELECTRONIC BALLAST	Cooper	C6226E 6251LI HB26	120/277	(2) CF26DD/E/835/ECO

Design Criteria

Qualitative Criteria

Similar to the performance functions of the arena space, multi-directional sports is performed in this space and requires consideration for horizontal and vertical illuminance values. However, since there are no spectators, the design criteria for the fitness center will be slightly different. Once again, a simplistic and functional design approach should be taken, just like the arena, with the primary purpose of providing adequate illuminance levels and uniformity to the space that will affect performance and safety of the occupants. Direct glare should also be avoided.

During the day, the fitness center will see a decent amount of indirect sunlight penetration, with the aid of light baffles on the exterior. Daylighting should be implemented to provide an energy-efficient space that is natural and visually comfortable for the occupants. It is important to note that natural day light has a very good color rendering properties, and thus, will enhance the performance of occupants.

Quantitative Criteria

The following quantitative criteria were referenced from the IES Handbook 10th Edition, Chapter 35 – Sports and Recreation, Table 35.3.

	E_h (fc)	E_h location	E_v (fc)	E_v location	Uniformity Target	Daylight Integration	Area of Coverage
Facade	75	3'	20	12'	1.7:1	Yes	Entire Area

Energy Allowance

The following energy allowance is calculated using the ASHRAE Standard 90.1 version 2010 Building Area Method:

Maximum Lighting Power Density (W/SF) for Sports Arena: 0.78

Space	Area (SF)	Max. Lighting Power Density (W/SF)	Power Allowance (W)
Arena	5560	0.78	4337

Evaluation

Incorporating cove lighting into the space would minimize the use of downlights and ultimately visual glare to the space. Ambience can be achieved by using such lighting technique and even though the primary design approach is towards a functional solution, aesthetics is secondary but can be incorporated into the fitness center to create a more energetic yet relaxing environment.

Additionally, I believe the promenade and the fitness center should have design characteristics that complement each other, although their respective purposes are very different. The complementing spaces can ultimately create visual interest which will draw occupants into the space.