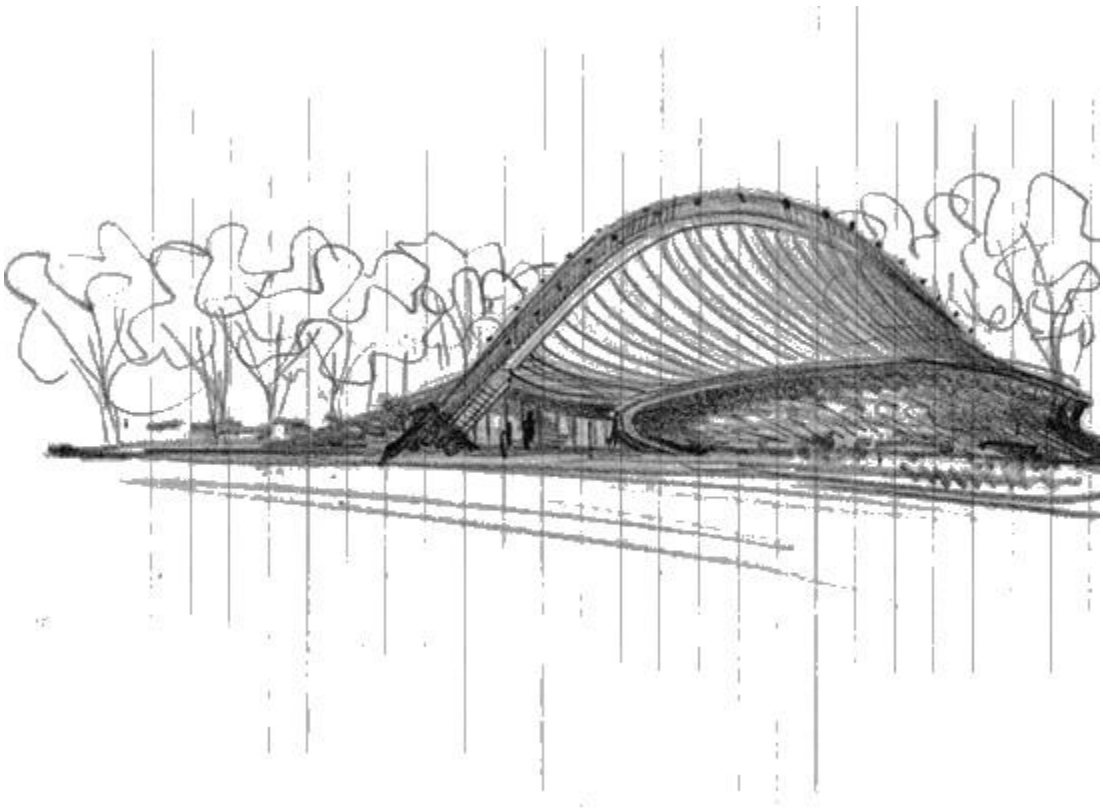

David S. Ingalls Rink

73 Sachem Street, New Haven, CT 06501

Final Thesis Report

Amy Chengyue Huan

Lighting/Electrical

Faculty Advisor: Dr. Houser

04/09/13

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I would like to thank everyone for helping me complete my thesis.

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All fellow AE friends

~ For Mama and Papa ~

Executive Summary

This thesis report contains detailed building system analysis and proposed changes for David S. Ingalls Rink. Investigation of existing building system was conducted with the goal of finding potentials in new design solutions. Detailed contents include lighting depth, electrical depth and two breadths studies. Senses of seeing, feeling, hearing are engaged through alternative design solutions in lighting, electrical, acoustic, architecture and structure.

The lighting depth involves design of four spaces: building exterior, circulation corridor, rink, and Schley Club Room. With an overall concept of HABITATION, the proposed lighting design is aimed for an illuminated environment that suites both for the architecture and the people. Elements such as architectural statistics, design criteria and system implementation were comprehensively studied and analyzed to achieve the ultimate lighting solution. Calculations and renderings were generated to simulate the design outcome.

Three topics studied for electrical depth include branch circuit analysis, short circuit analysis and copper vs. aluminum wire cost estimation. With proposed system lighting, new panel board loads were analyzed for evaluation of feeder upsizing potentials. Short circuit analysis was performed at five selected points to ensure feeders are effectively rated for fault protection. A cost analysis of copper versus aluminum wire was conducted to compare and investigate the possibility of saving labor and material cost.

For acoustic breadth, a calculation of reverberation time was conducted to evaluate the acoustic performance of the rink area. A change in ceiling material was proposed to optimize the sound absorption performance. The structural breadth contains research of Saarinen, the building architect, and his architectural practice in material. Wind analysis and glazing load resistance analysis were examined for building structural stability.

Table of Contents

|Background

Building name: David S. Ingalls Rink
Date Constructed: 1953 - 1959 (Renovation 2008-2010)
Location: New Haven, CT
Site: 73 Sachem St, New Haven, CT
Building Occupant Name: Yale University
Occupancy or function types: Assembly A-4. The constructed building contains ground floor Rink, Concourse, lower level Locker Rooms, Fitness Center, Schley Club Room and other utility rooms.

Site Area:	1.48 ac
Building Footprint:	47,983 sf
Total gsf:	61,646 sf
Num. of Stories above Grade:	1
Total Levels:	2

Primary Project Team (Renovation)

Client:	Yale University
Architect:	Kevin Roche John Dinkeloo and Associates LLC
Landscape Architect:	Towers | Golde
Lighting Consultant:	Atelier Ten Consulting Designers
Structure Engineers:	Severud Associates Consulting Engineers, P.C.
Mechanical Consultants:	AltieriSeborWieber LLC
Construction Manager:	Turner Construction Company
Civil Engineer / Landscape Architect:	Tighe & Bond
Acoustics, Audio Visual and Sound System:	Cavanaugh Tocci Associates, Incorporated

General Building Statistics

Construction

The David S Ingalls Rink at Yale University is an extraordinary building designed by architect Eero Saarinen and originally completed in 1958. The multi-million renovation taken in year 2008-2010 restored the previous architectural appearance of the building and added an underground training room and locker room addition. Turner Construction Company was the primary construction management firm for this project.

Electrical

The building power of David S. Ingalls Rink is served by Yale's Central Power Plant. The building electrical system has a utilization voltage of 480Y/277V. Main service and distribution equipment includes metal enclosed NEMA 1 enclosure switchboards and 480Y/277V panelboards to serve motors and lightings. Automated Transfer Switch (ATS) was used to switch the emergency panels to emergency power in the case of main power failure. A step-down transformer with a secondary end of 208Y/120V was installed to provide lower voltage for the emergency receptacle panel. The equipment that are connected to the emergency power systems include emergency lighting, low air compressor and fire alarm control panels.

Lighting

High-bay luminaire mounted with slight changes following the ceiling curves were used to provide recommended light levels for athletic competition for the rink area. Fluorescent lighting fixtures were used in the rest of the space inside the building including concourse, Schley Memorial Club Room, and the lower level new addition. The system utilizes Lutron lighting control system which is designed to provide two-level output: full output for varsity practice and games, then 50% output for recreational skating to save further energy.

Mechanical

Two Air Handling Units each with 10,800 CFM and 3,000 CFM are located in the lower level renovation addition to serve for building ventilation and exhaust. Two air condition systems each with 10,000 CFM capacity located in the ice arena were the full replacement for the existing heating ventilation units. Each unit has two supply fans operation continually when building is occupied. Two Desiccant Dehumidification systems located in the rink area were used to remove moisture from the air at low temperature and increase the cooling coil capacity. Run-around Heat Recovery Coils were placed throughout the lower level to transfer sensible and latent heat carried by airflow via liquid medium.

Structure

The David S. Ingalls Rink has a structural system which consists of reinforcing steel frames and cast-in-place concrete slab on grade. All concrete works are class I normal weight with a minimum ultimate compressive strength of 4000 PSI. The building has a slab on grade Caisson-pile supported foundation, reinforced CMU bearing exterior walls and oak wood roof hung from the central concrete spine and held in place by grid of

aluminum cables running perpendicular to the spine. Because of the innovative roof structure, the ground level interior of David S. Ingalls Rink is free of columns.

|Additional Engineering Support Systems

Fire Protection

The fire alarm system receives 120 VAC emergency power via circuit breakers with handle locking devices. The system incorporates one-way voice communication and tone generating capabilities.

Audio/Video System

The rink video and support systems include video and audio monitoring, video distribution of game cameras to support spaces, sound playback, television production tie lines and cable pathways, production intercom, an assistive listening system, and digital signage. The rink sound system was designed to provide high quality audio performance while maintaining a low visual profile and controlling acoustic wastes in a highly reverberant rink space.

Special Systems

- Acoustical panels and exposed suspension systems at rink area.
- Camera video distribution system and instant replay system are provided in the rink area. Additional audio system was added to the Team Lounge, Strength and Conditioning Room, Locker Room during renovation.
- Electric Frost Prevention: Cables are mineral insulated type with two conductors with a single cold splice at one end. Each system is controlled by a combination time clock and temperature sensing probe. 3 wire temperature sensing probes were used for automatic operation of the system.

Lighting Depth

Introduction

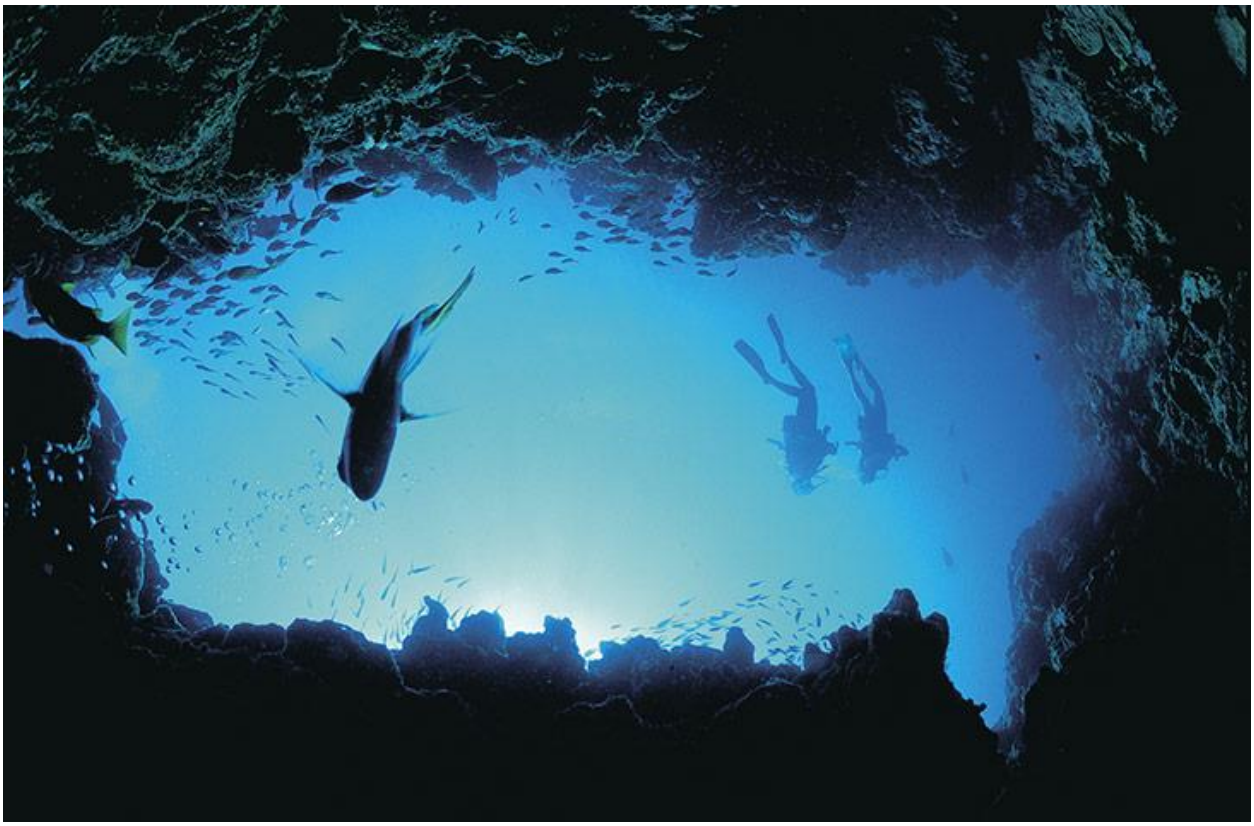


Figure 1| Concept Image - Habitation

Le Corbusier once said: "*Light creates ambiance and feel of a place, as well as the expression of a structure."* Good lighting design illuminates the mind by polarize both sensibility and accessibility. The underlying story of this building was observed by seeing the unchangingness of the beauty of building architecture, and reacting to the activities and senses. With an overall concept of ***Habitation***, the lighting design of David S. Ingalls rink strives to create a living environment for the beloved "Yale Whale", as well as the people who "habitats" inside the building. On one hand light for building by connecting and embracing separate architectural features into a whole; on the other hand light for people by enabling them to experience and react to each illuminated scenes.

Lighting | Building Exterior

|Architectural Description

The exterior of David S. Ingalls Rink establishes its visual identity – "the Yale Whale" with the dramatic sweeping roof. The elliptical shaped building has its main structure of 290 foot long reinforced concrete spine for cable net to hang from to support the iconic roof. The side walls are the same shape in plan as the arch is in section, acting as a counter part of the arch. The exterior walls are also sloped to increase the structural integrity, in the meantime enhance the visual expression of the arch. The rink sits in a quiet neighborhood of residential houses inside Yale Old campus, with several educational buildings on its south side. The parking lot is a place of socialization on the game day with food stands around the arena.

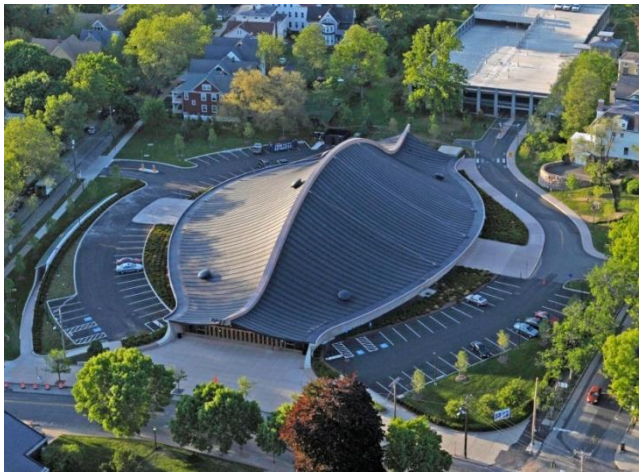


Figure 2| Building Exterior Arial View

Figure 3 | Building Facade

Geometry

Maximum Length: 335'
Maximum Width: 196'
Maximum Height: 66'
Building Footprint: 47,983 SF

Material Finish

Surface	Material	Description	Reflectance	Transmittance
Roof	Oak Wood	Existing oak wood roof in dark finish	0.2	-
	Aluminum	Metal framing to help resist snow load	0.6	-
Formwork	CMU	Unfinished concrete with wood texture	0.4	-
Façade	Wood Framing	Existing wood frame in light finish	0.7	-
	Glass	Insulated Opaque Spandrel Glass	0.51	0.28

Table 1 | Building Exterior Material Properties

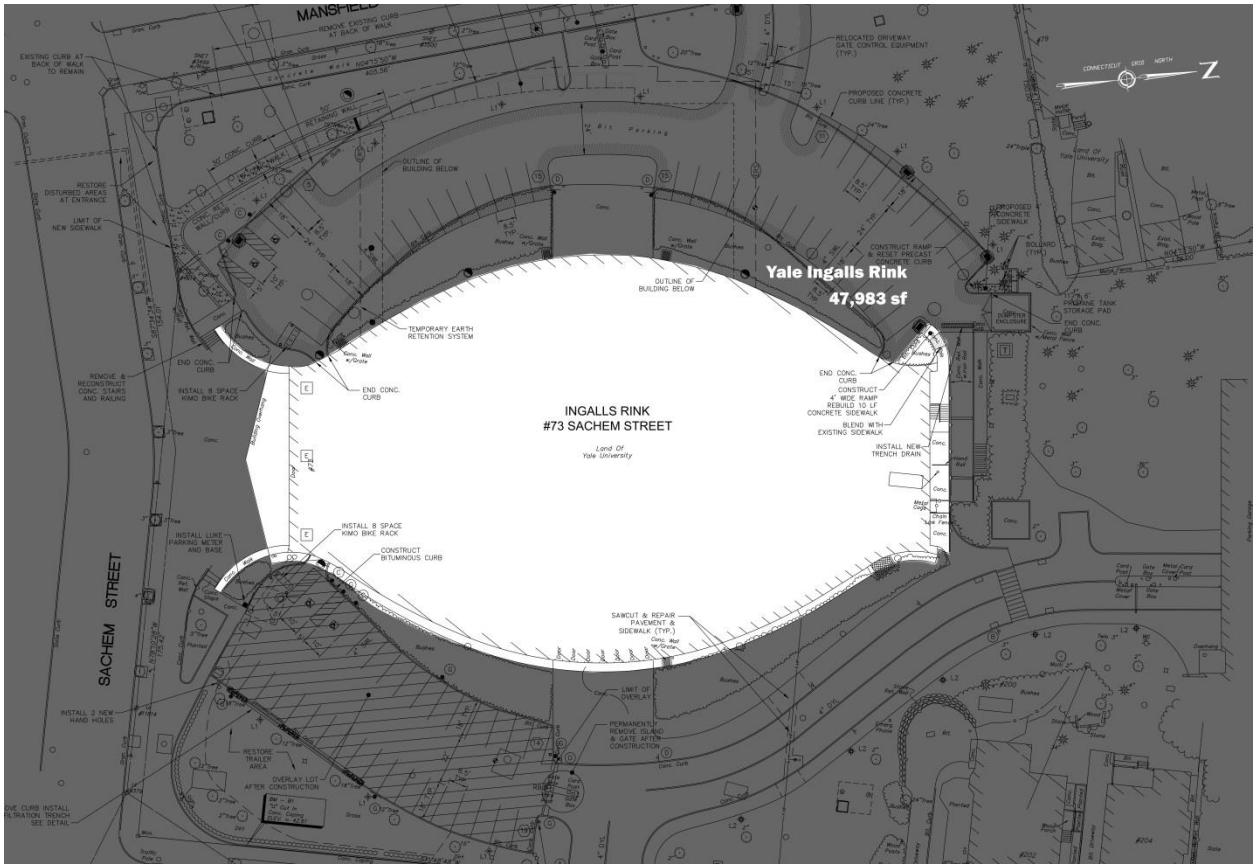


Figure 4 | *Site Plan*

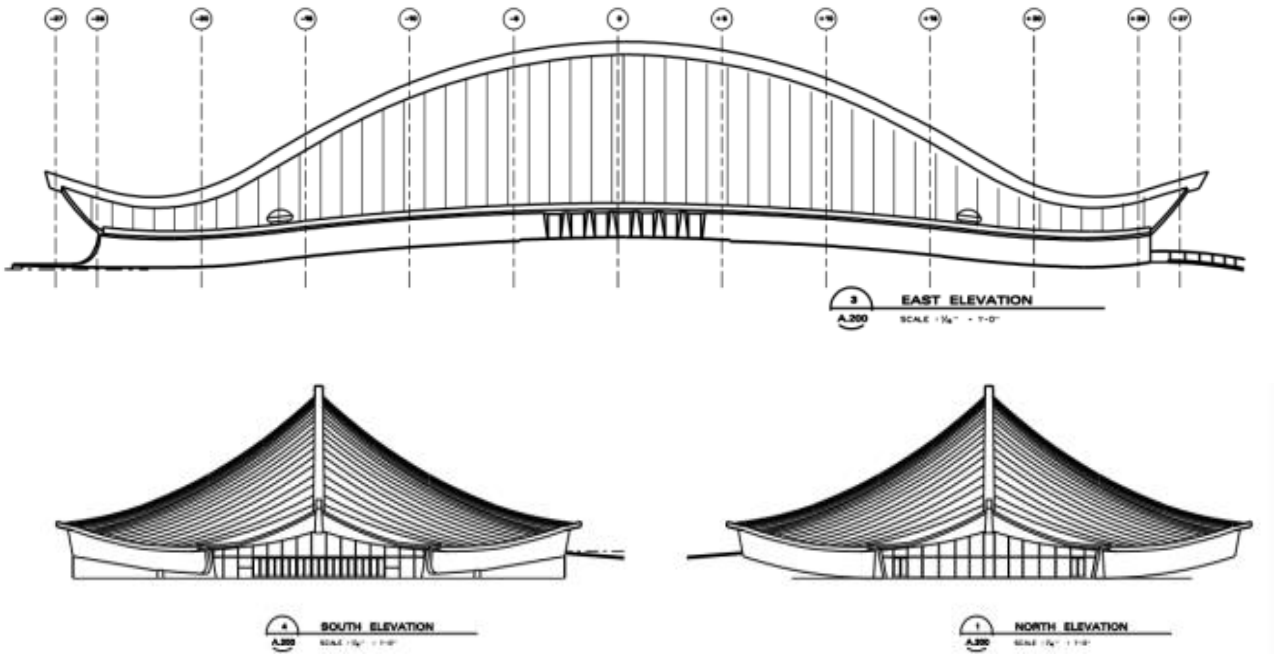


Figure 5| *Building Elevations*

|Design Consideration and Criteria

David S. Ingalls Rink is the home of numerous national championship collegiate hockey teams, and is recognized as the rink with the "best design" across all of America by *New York Times*. As such, it has an admired history and reputation for the university. The architect Eero Saarinen was very enthusiastic about three common principles of the architecture of his time: function, structure, and being a part of his time. In relation to the neighborhood, the mass and scale of Ingalls Rink together with the dramatic structural elements harmoniously enhanced the surrounding environment.

The lighting design of the building exterior needs to respect the historically significant architecture of Ingalls Rink. Installation of lighting fixtures should have minimum impact of the day-time building appearance. In the meantime, lighting should act to structurally and visually integrate the building with existing landscape such as trees and street poles. With the consideration of respecting neighborhoods and wildlife, the exterior lighting should provide enough light level to give sense of security. The design also has to follow city codes, and be able to resist strong winds and snow.

Illuminance Recommendation

Space Type	E_v
Facades Activity Level [Medium][Low] Lighting Zone[LZ3]	200lux high activity/100lux low activity for darker toned surface materials (reflectance <0.5); 100 lux high activity/50lux low activity for lighter-toned façade materials (reflectance ≥0.5)

IES Lighting Handbook 10th Edition (Table 26.2, 26.4, 22.4)

Energy Allowance

Space Type(zone3)	Power Density (W/sqf)
Main Entries	30W/linear foot of door width
Entry Canopies	$0.4W/ft^2$
Building Façade	$0.15W/ft^2$ for each illuminated wall or surface or 3.75 W/linear foot for each illuminated wall or surface length
Building Grounds	0.8W/linear foot for walkways less than 10 ft wide. $0.16W/ft^2$for walkway 10 ft wide or greater, plaza areas, and special feature areas.

ASHRAE standard 90.1 – 2010 (Table 9.4.3A, 9.4.3B)

Exemptions – lighting used to highlight features of public monuments and registered historical landmarks structures or buildings.

Sky Glow

Luminaires should be aimed to minimize the upward spread of light near to and above the horizontal.

|Concept Statement

The design of exterior lighting is intended to create the motion of a **Whale Dive**. David S. Ingalls Rink was given the amiable nick name – "the Yale Whale" because of its beloved dramatic soaring roof. The main spine structural component will be highlighted by linear fixtures to recreate the beauty of back spine curvature in the dark. In response to the smooth and strong spine ribbon, linear flood light will be used to light up the roof perimeter, which has the same curved shape in plan as the structural spine in section. The bright ribbon on center and the graceful grazing coming up from the side will act together to create the "lifting" motion of the sweeping roof and float the whole building, bringing the whale to life. The continuous flow and motion will be highlighted with a strong finish by the high illuminance fixtures mounted inside the light sculpture on the roof end, give dramatic impression of a whale tail, and throw ambient and uniform light pool to the front plaza.

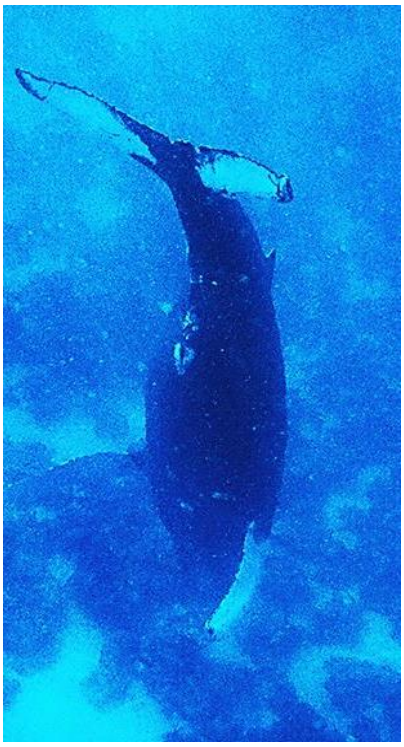


Figure 6 | Whale Dive

|System Implementation

Description

The designed lighting system combines four different types of linear LED fixtures, each with different lumen output and light distribution to bring motion and dynamic to the building exterior nighttime appearance. *Lumen Pulse* surface mounted adjustable linear grazing fixture with six inches arm will be mounted on both sides of the spine. The fixture has a narrow 10° by 60° light distribution, together with the 30° aiming angle allowing just enough light to brighten up the spine with limited spilled illuminance to the sky. *Phillips* linear exterior flood light are mounted along the curved perimeter of the roof with three different light output to coordinate with projection distance on the sloped roof. The top half of the roof is intentionally left dark in order to further bring out the structural form using the contrast between light and shadow. Four 100 watts *Lumen Pulse* LED fixtures are placed inside the light sculpture. High lumen output gives highlight to the end of the spine curvature, and provides additional security lighting for the front plaza.

Original façade lighting and rink lighting penetrating through the glass curtain walls will add more illumination to the front plaza. The existing street poles provide required 1fc light level on the parking plaza.

Lighting Plan

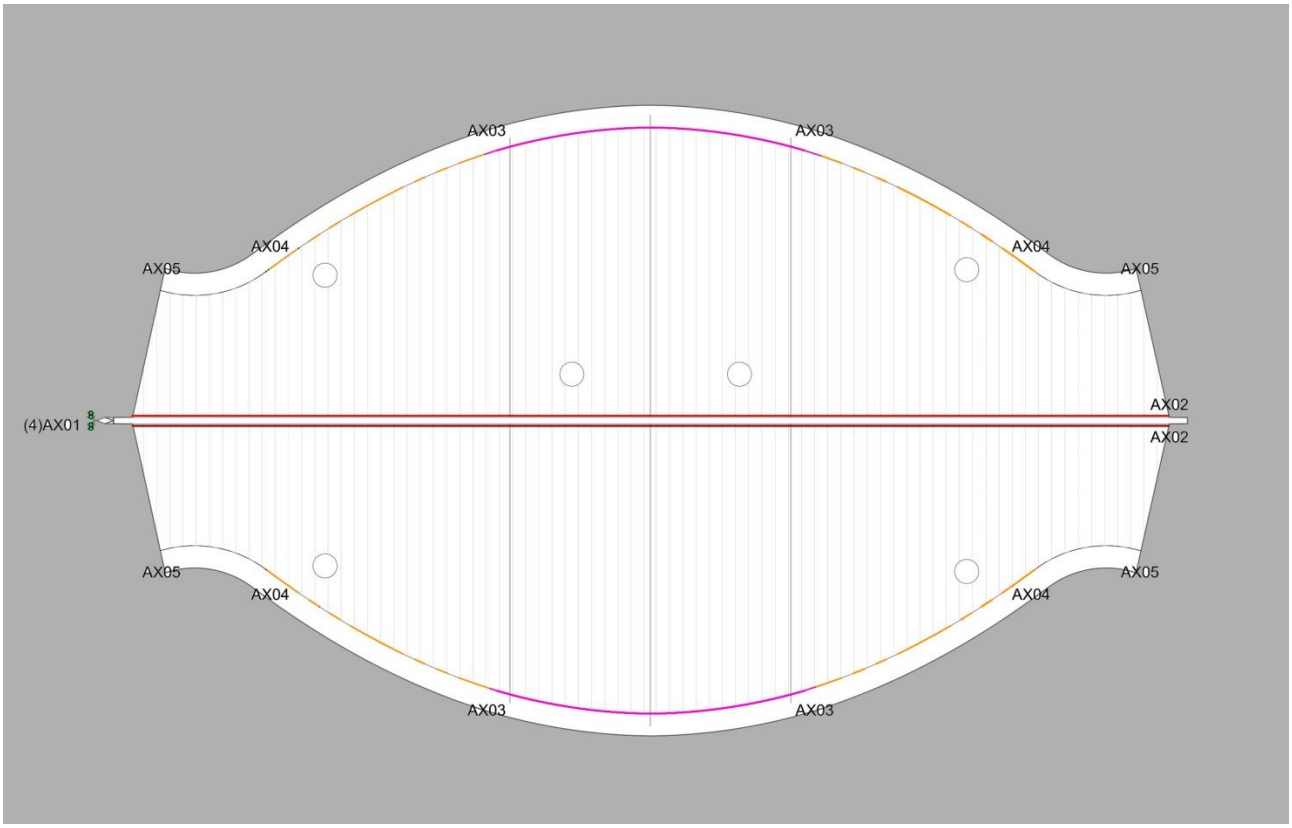


Figure 7 | Exterior Roof Lighting Plan

Fixture Schedule

Type	Luminaire	Mounting	Description	Lamps	Power	Model	Remarks
●**AX01**	Exterior Downlight	Surface	Nominal 13 3/8" D x 5 3/4"H Housing: Die-cast aluminum Lens: Clear tempered glass CRI: 78+ CCT: 4000K	LED	100W	*Lumen Pulse* LBG-277-40K-WFL-LSLH-BK-NO-TBD	UL Wet Location Listed
●**AX02**	Exterior Linear Grazing Fixture	Surface Adjustable arm 6"	Nominal 4' L x 2 7/16"W x 1 5/16"H Housing: Die-cast aluminum Lens: Clear tempered glass CRI: 78+ CCT: 4000K	LED	5W/ft	*Lumen Pulse* LOGR_ASHRAE-24V-48-40K-60x60-WAMR6-BK-DMX 1FX-CRC	UL Wet Location Listed 'Surface Mounted 20° rotated towards the spine 'DMX 1FX Dimming, Resolution per fixture

●**AX03**	Exterior Linear Floodlight	Surface	Nominal 4' L x 2 4/5"W x 2 7/10"H Housing: Extruded anodized aluminum Lens: Clear Polycarbonate CRI: 81 CCT: 4000K	LED	15W/ft	*Philips* 523-000080-46	UL Wet Location Listed 'reverse phase ELV-type dimmer
●**AX04**	Exterior Linear Floodlight	Surface	Nominal 4' L x 2 4/5"W x 2 7/10"H Housing: Extruded anodized aluminum Lens: Clear polycarbonate CRI: 81 CCT: 4000K	LED	10W/ft	*Philips* 523-000081-46	UL Wet Location Listed 'reverse phase ELV-type dimmer
●**AX05**	Exterior Linear Floodlight	Surface	Nominal 4' L x 2 4/5"W x 2 7/10"H Housing: Extruded anodized aluminum Lens: Clear Polycarbonate CRI: 81 CCT: 4000K	LED	5W/ft	*Philips* 523-000086-46	UL Wet Location Listed 'reverse phase ELV-type dimmer

|Performance Analysis

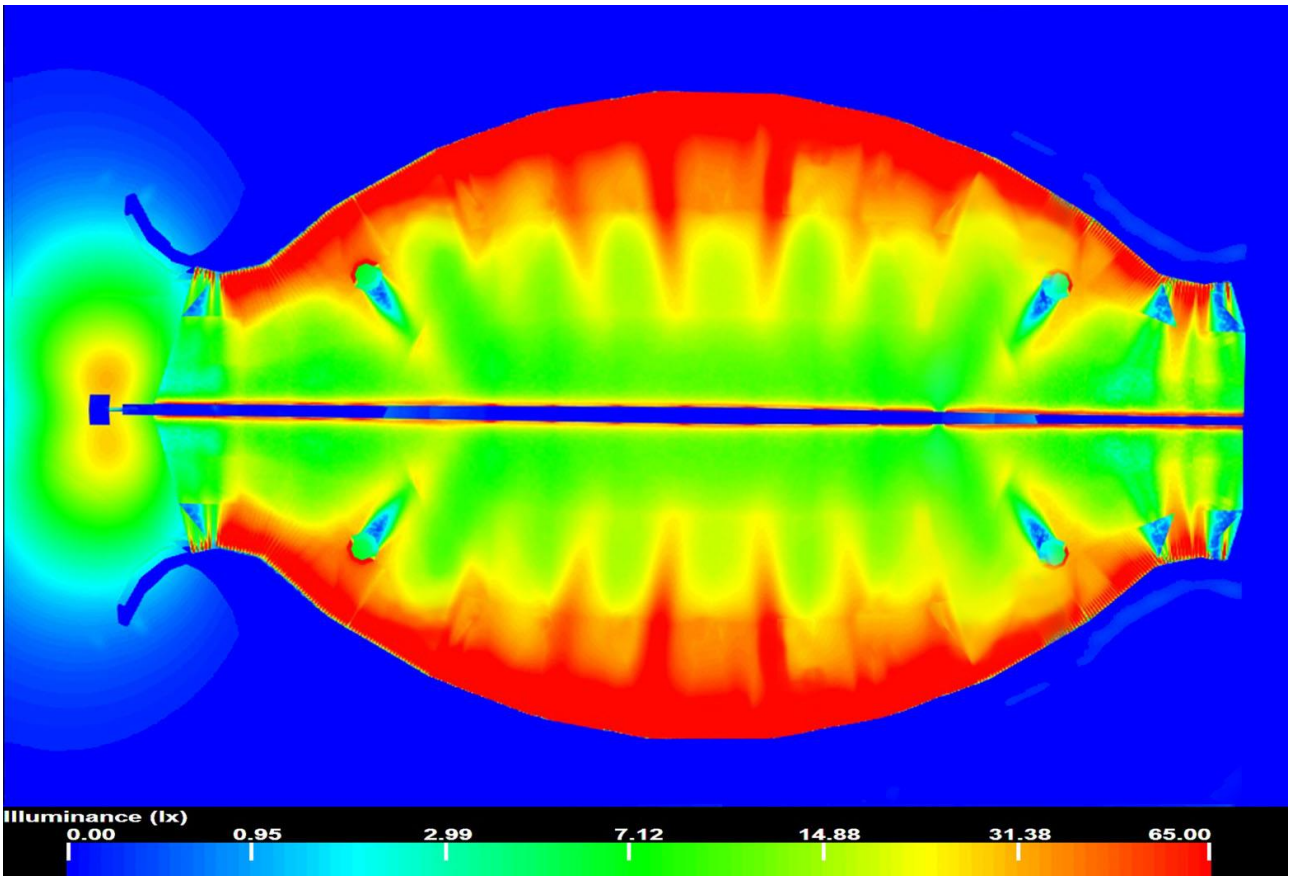


Figure 8 | Exterior Roof Pseudo Color

Illuminance Levels

Location	Avg	Max	Min	Avg/Min	Max/Min
Roof Surface	4	110	0	NA	NA
Roof Spine	50	68	26	1.92	2.62
Front Plaza	2.5	3.6	.4	6.25	9

Light Loss Factor

All light loss factors for LED fixtures are assumed to be 0.7.

Lighting Power Density

Location	Fixture	#of fixtures	$Power_{total}$(W)	Area(ft^2)	$LPD_{designed}$	$LPD_{allowed}$
Façade/Exterior	*Lumen Pulse* 5W LED	646	3230	65660	0.156	0.15
	Philips 15W LED	192	2880			
	Philips 10W LED	344	3440			
	Philips 5W LED	136	680			
		TOTAL	10230			
Front Plaza	100W LED	4	400	6667	0.060	0.16

System Evaluation

For an iconic building with long history and reputation, it is necessary to have a lighting system which emphasizes the building architecture, as well as adapt to the surrounding environment. To respect the historical importance of the building, the designed lighting system has a minimal touch to the building exterior structure. The main spine curvature is effectively highlighted by linear grazers, employing narrow beam and adjusted aiming angle to control light pollution. The dramatic curvature is again echoed on the edge of the roof, with linear flood light shining up towards half way of the sloped roof. With this design, the dramatic appearance of David S. Ingalls rink is recreated with a powerful lifting and floating effect. In the end, the curvatures are ended with a strong highlight created by high output flood light mounted inside the lighting sculpture on the building front. The historical appearance of the building in daytime is well preserved with unnoticeable fixture mounting locations.

The lighting power density is slightly above the ASHRAE Standard recommended value. This is reasonable considering the area used for lighting power density calculation is the measured area on the site plan instead of the actual curved roof surface area which would be larger. With only LED flood light fixtures located in the lighting sculpture, the front plaza is dimly lit with an average of 2.5 foot candles. The overall light level will be raised with existing façade lighting providing adequate amount of illuminance for security purposes. The retrofit LED fixture has a higher lumen output when comparing to the original induction lamp, resulting a stronger sparkle at the “whale tail”. Through appropriate lighting practices, Ingalls Rink is celebrated with natural and harmonious sense suitable to the historic site; with soft yet prominent glow and highlight to establish its prominent role as an important landmark.

|Renders

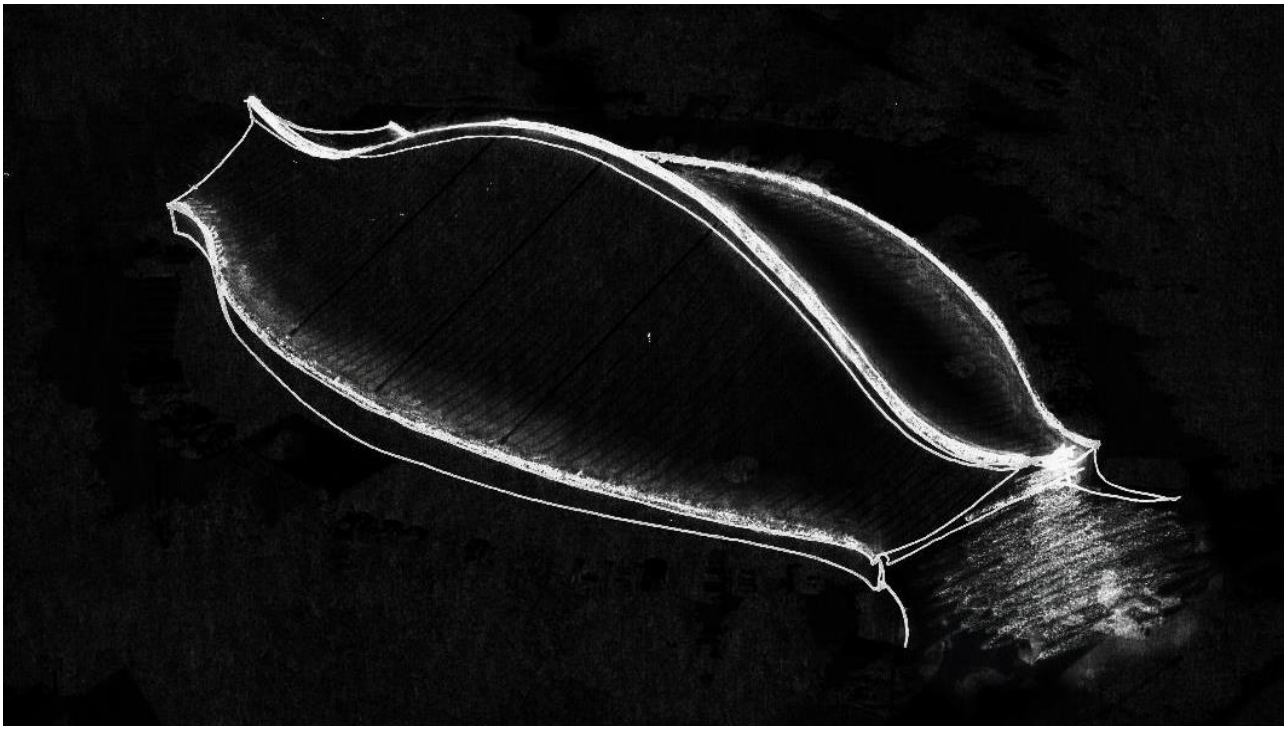


Figure 9 | Building Exterior - Initial Lighting Sketch

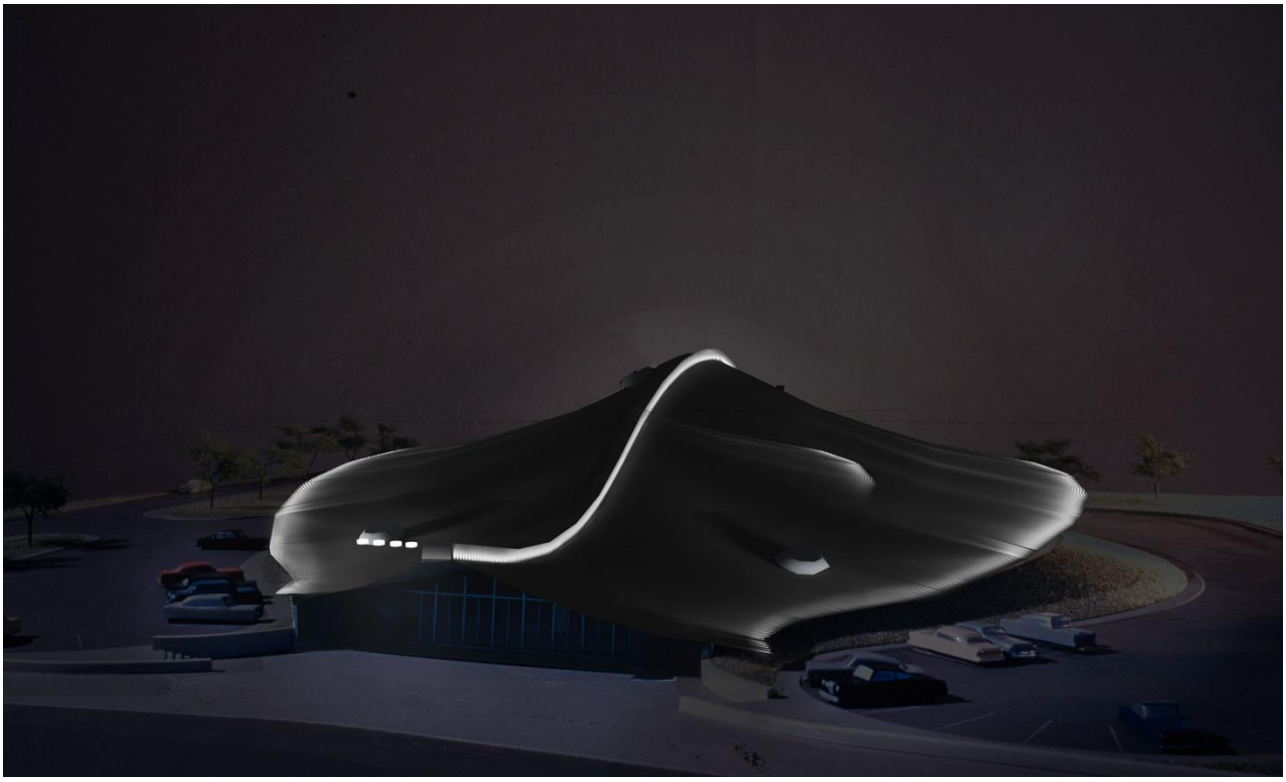


Figure 10 | Building Exterior – Perspective Rendering

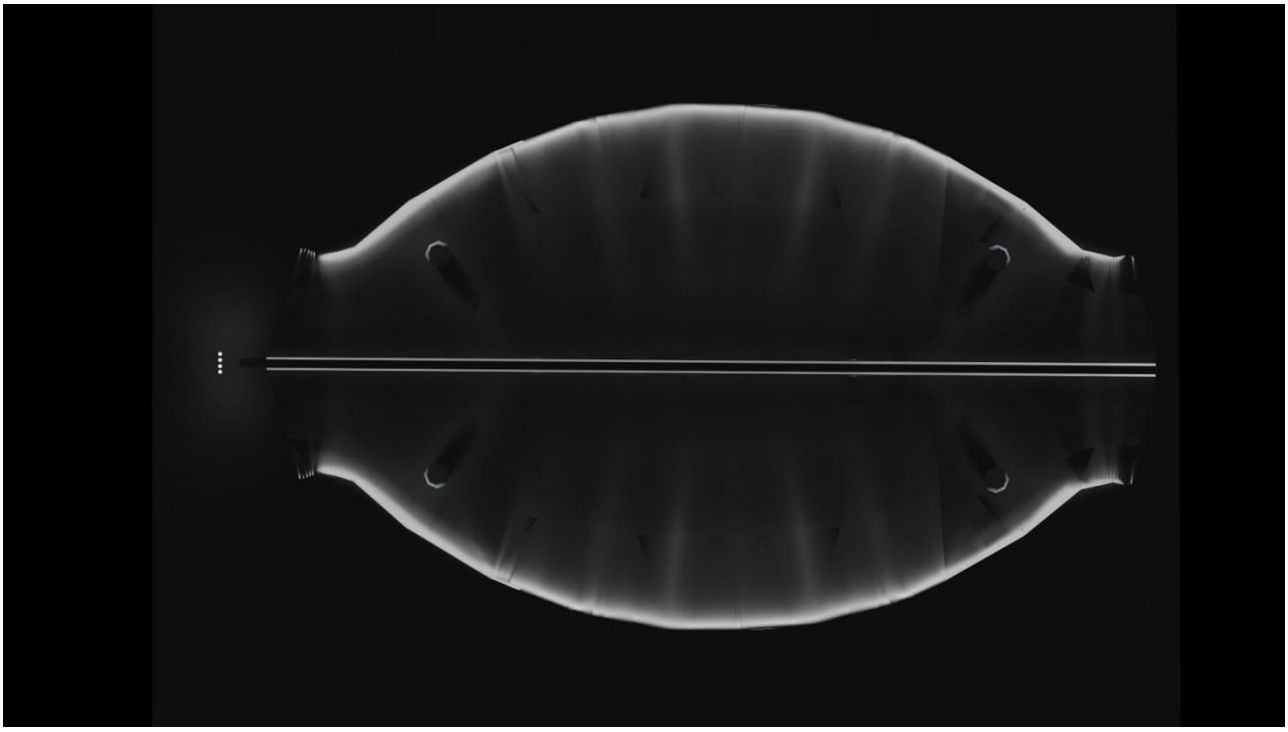


Figure 11 | *Building Exterior – Top View*

Lighting | Circulation Corridor

|Architectural Description

The concourse surrounds the rink and provides main circulation to the public. Building entrances are located on the east and west end, whereas seven exit doors are located on the north and south. There are a total of fifteen rows of benches, with press box located on the back row of north and south side. There are four isles each lead to the seating on the north and south and two on the east and west. During any event, public enter through the main entrance, then follow the concourse corridor to individual seats.

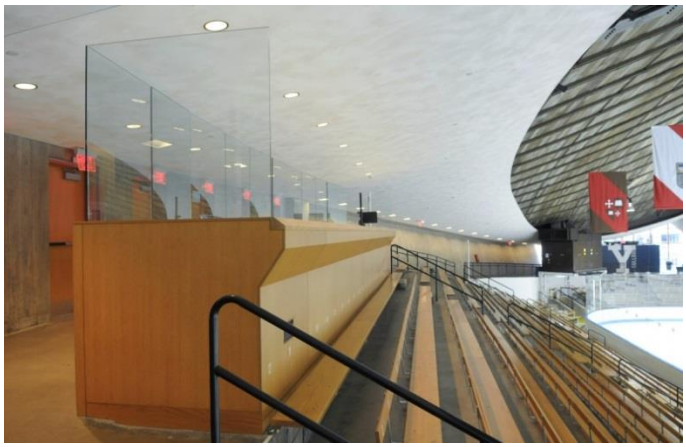


Figure 12| Press Box

Figure 13| Concourse

Geometry

Concourse Width: 8’
Isle Width: 4’
Sloped Ceiling: 10’ max
Concourse Area: 8274 SF

Material Finish

- Perimeter Corridor

Surface	Material	Reflectance
Floor	Sealed Concrete	0.2
Walls	Concrete	0.5
Ceiling	Plaster	0.8

Table 5 | Perimeter Corridor Material Properties

- Press Box

Surface	Material	Reflectance
Floor	Resilient Flooring	0.2
Walls	CMU Paint Type B	0.5
Ceiling	Painted gyp board	0.6

Table 6 | Press Box Material Properties

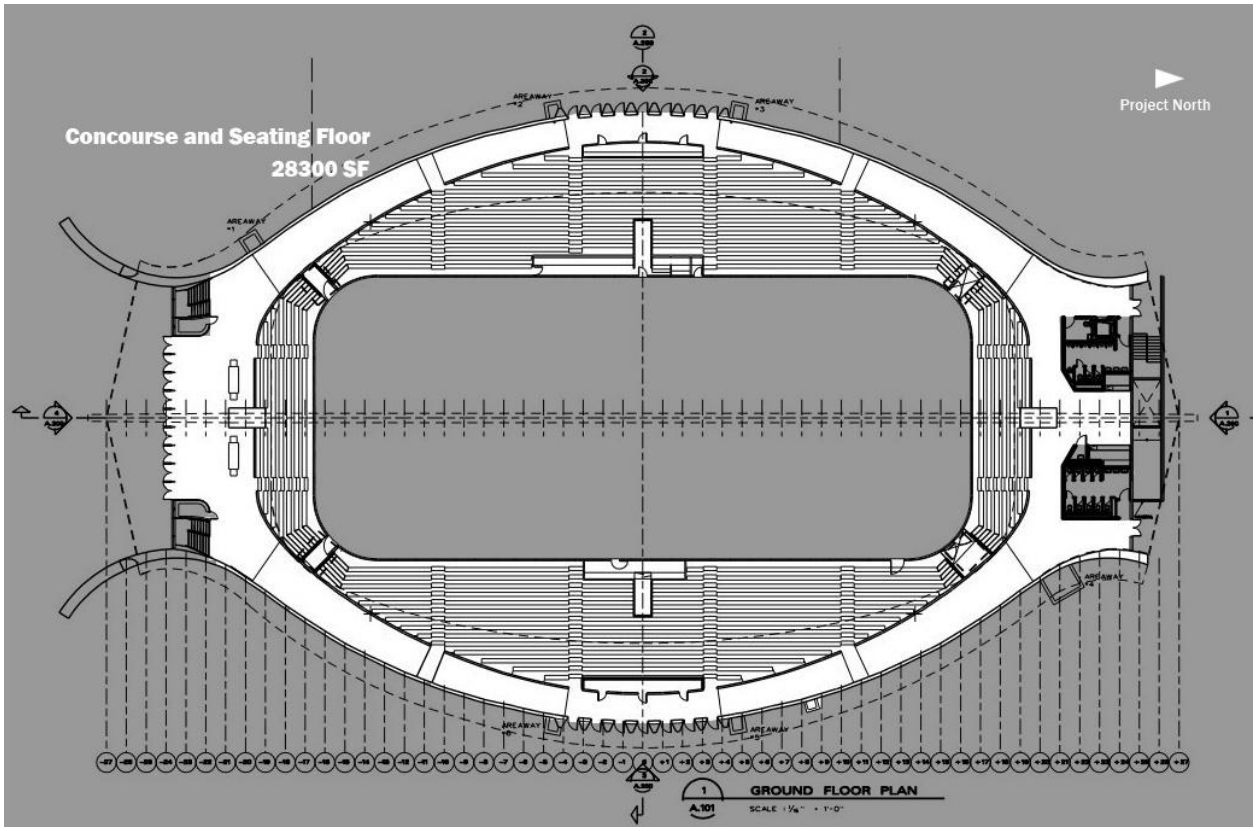


Figure 14| Ground Floor Plan – Concourse and Seating Floor

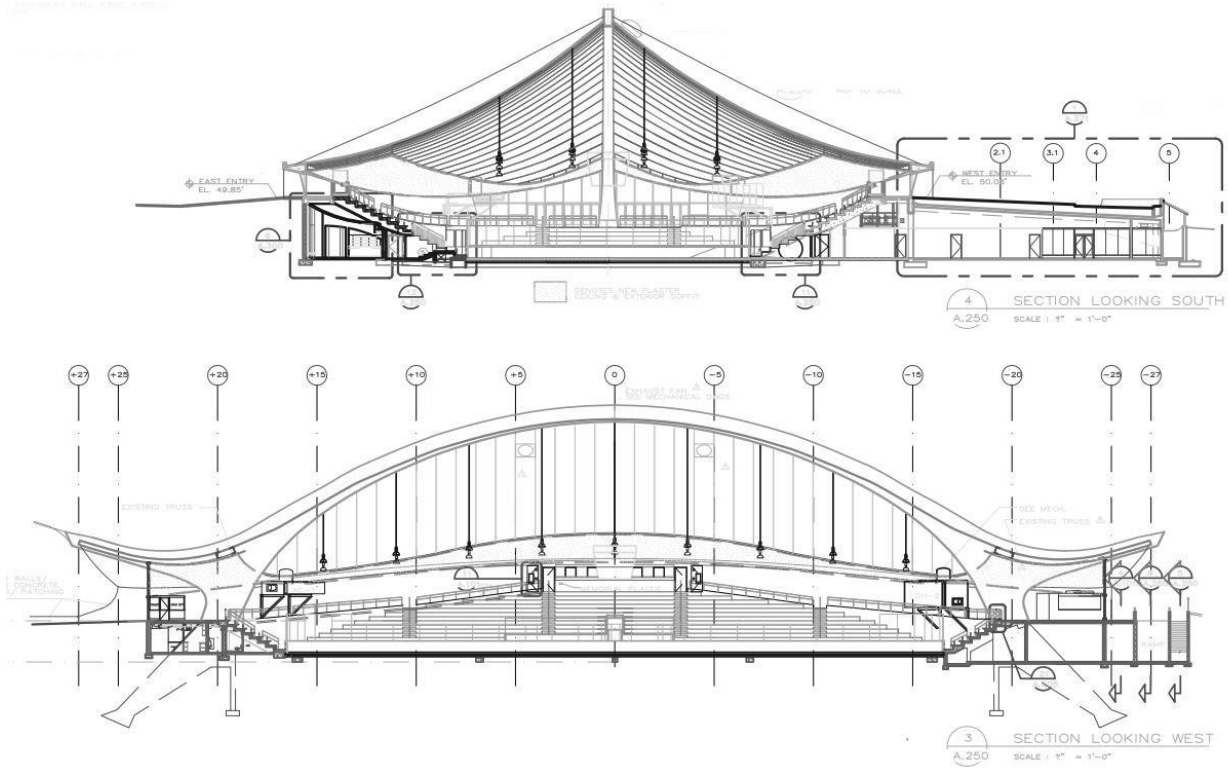


Figure 15| Building Section- Concourse and Seating Floor

|Design Consideration and Criteria

Once entering into the building, people flow into the circulation corridor. It surrounds the rink and seating area and serves its main purpose as a circulation space to direct and guide pedestrians to their point of interest. Although the whole ground floor can be considered as an open space, dropped plaster ceiling above the circulation area separates it from the rink and seating area and gives the space its own definition. The slightly sloped unfinished concrete interior walls with vertical wood patterns bring a clean and somber impression.

The circulation lighting should illuminate the walkways, defines the boundaries and provide a clean and simple rendering to the architectural concrete wall. In an effort of avoiding busy visual appearance for a narrow space, the fixture around the perimeter should provide just enough illuminance to guide audience to individual isles. Excessive light levels may lead to confusion and inconvenience since it lowers the contrast between seating floor and playfield. For a functional space as this, the lighting fixture is to disappear and unnoticeable. An evenly lit solution will serve its purpose by creating a comforting environment and embrace the slightly sloped architecture wall. Appropriate amount of illuminance should be provided on the work plane height for press box area to support reading, writing, and computer usage.

Illuminance Recommendation

- Circulation Corridors

Space Type	E_h	E_v	Avg:Min
Public adjacency passageway	avg ≥0.2 times task E_h of adjacent space or as cameras require, but with min≥10lx	avg ≥0.2 times task E_h of adjacent space or as cameras require	3:01

IES Lighting Handbook 10th Edition (Table 22.2)

- Reading and Writing

Space Type	E_h	E_v	Avg:Min
CSA/ISO types I and II Positive Polarity	300 lx	150 lx	1.5:1

IES Lighting Handbook 10th Edition (Table 22.2)

Energy Allowance

Space Type	Power Density (W/sqf)
Corridor/Transition	0.66

ASHRAE standard 90.1 – 2010 (Table 9.6.1)

|Concept Statement

The rink and seating area is harmoniously surrounded by the circulation corridor which acts as an adjoining border of the whole ground floor. If we unfold the space and look at the architectural elements individually, one eye-catching feature of this space is the vertical unfinished concrete wood pattern, just like **coral reefs**. To engage the architecture to a sense of verticality, light stripes will be projected to the floor to lead the direction for pedestrians. Linear patterns are continually carried on to the sloped concrete wall from ground up at correspond step light locations. The upwards projection of light pattern will emotionally expand the sense of dimension and increase the feeling of accessibility. By implementing one pattern on two different surfaces, the space appears connected and engaged. The moment you start to move, the light starts to move, the reef starts to move, and the space become alive and reachable.

Figure 16| Coral Reef

|System Implementation

Description

The circulation space implements step lights and in ground uplights to create vertical linear patterns on the floor and walls. *Bega* wall recessed step light are mounted to the railing base, 6’ apart from each other to project bright linear stripes on the circulation floor. This pattern functions to direct and guide the pedestrians. The reflector of the fixture is adjustable 0° to 30° in 5° increments. After the angle is adjusted to the mounting position, it can be locked in place with an internal fastener. The square shape of the fixture acts to pair with the architectural spatial dynamics. *Bega* 1.5’ in-ground uplights are mounted in the projected position of step light pattern on the contrary side of the floor. The upwards linear patterns extend the verticality of linear stripes on the floor and function to engage the functionality with architectural structure. In addition, the in-ground fixtures project a smooth halo on the ceiling perimeter, enhancing the overall brightness of the space. Both fixtures have a correlated color temperature of 4000K with intention of bringing up the somber and formal characteristic of concrete material.

Cree 13W LED ceiling recessed fixtures are mounted on top of the press box area. The fixture provides soft and uniform illumination to the task surface to support reading, writing and computer usage.

Lighting Plan

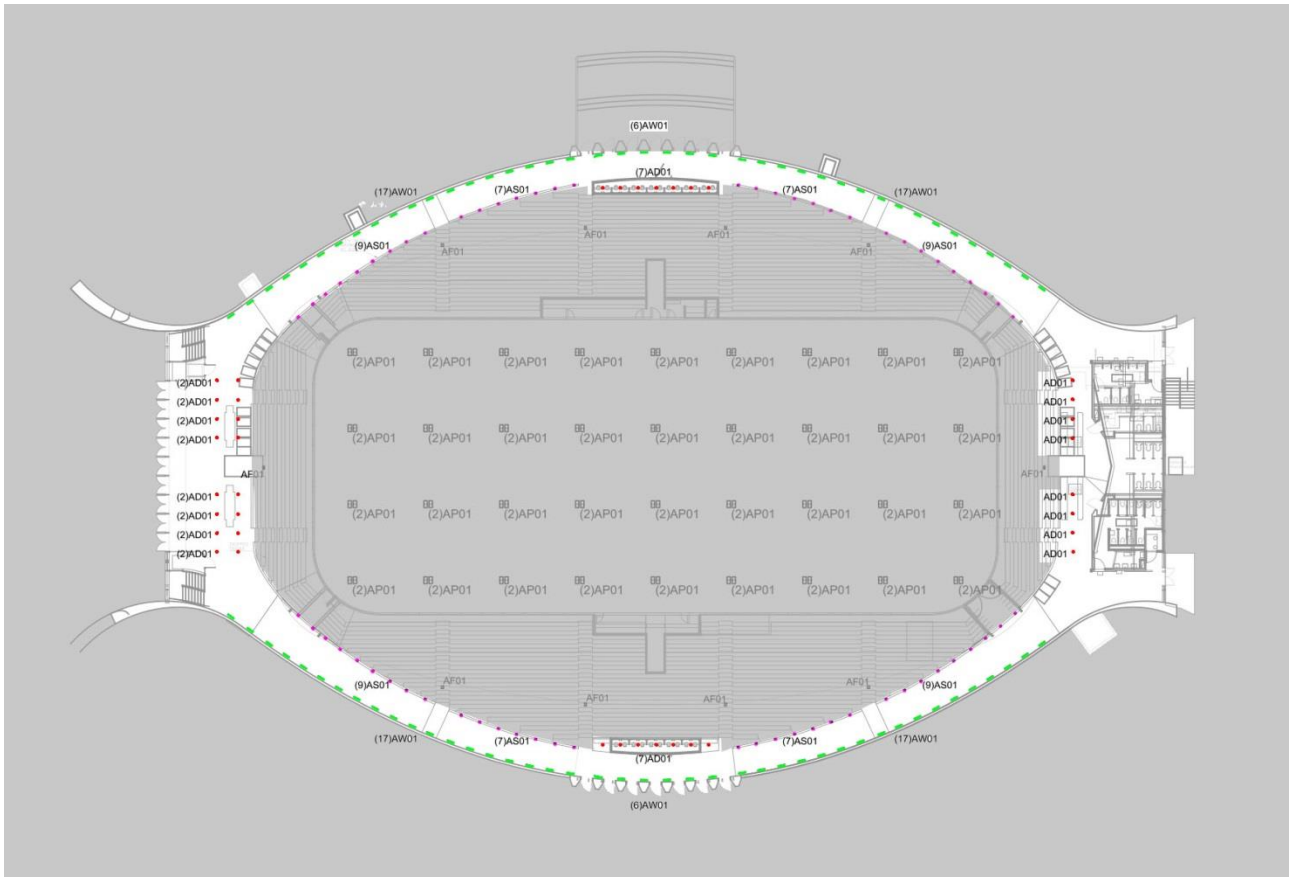


Figure 16| Circulation Lighting Plan

Fixture Schedule

Type	Luminaire	Mounting	Description	Lamps	Power	Model	Remarks
●**AS01**	Steplight	Wall Recessed	Nominal 7 1/2" L x 7 1/2"W x 5 1/2"H Housing: Die-cast aluminum Lens: Clear tempered glass CRI: 80+ CCT: 4000K	T4 GU6.5MH	20W	*BEGA* 2198 MH	adjustable optical assembly
●**AW01**	Asymmetrical Wall washer	In-ground	Nominal 20 7/8" L x 3 1/2"W x 5"H Housing: Extruded stainless steel Lens: matte tempered safety glass CRI: 80+ CCT: 4000K	LED	22W	*BEGA* 7917LED	UL Wet Location Listed

●**AD01**	Downlight	Ceiling Recessed	Nominal 5 1/4" D x 7 1/4"H Housing: Extruded anodized aluminum Lens: Clear tempered glass CRI: 78+ CCT: 3500K	LED	18W	*Cree* KR-4-9L-35-277V-10V	0-10V dimming

|Performance Analysis

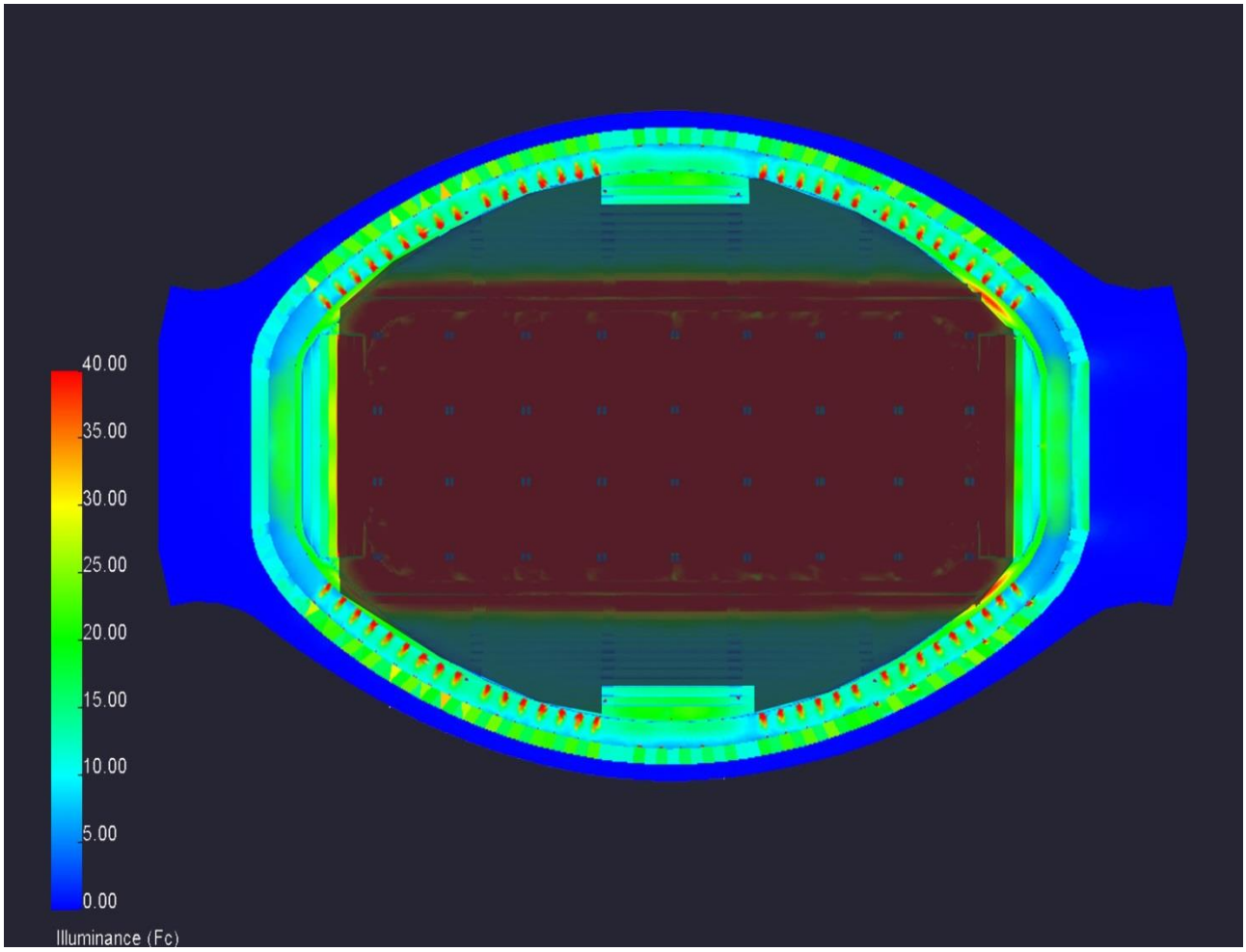


Figure 17 | Circulation Corridor Pseudo Color

Illuminance Levels

Location	Avg(fc)	Max(fc)	Min(fc)	Avg/Min	Max/Min
Circulation Floor	27.68	335	7.5	3.5	42.46
Circulation @ 5'6	10.50	12.50	5.80	1.86	2.16
Press Box	17.69	19.00	14.80	1.20	1.28
Wall (vertical)	16.9	37.70	12.80	1.32	2.95
Seating	18.72	53.80	9.50	1.97	5.66

Illuminance Levels - Emergency

Location	Avg(fc)	Max(fc)	Min(fc)	Avg/Min	Max/Min
Circulation Floor	7.53	324	1	7.53	324.4
Circulation @ 5'6	1.71	2.4	1.2	1.43	2
Press Box	1.24	1.4	1.1	1.13	1.27
Wall (vertical)	1.13	1.3	0.8	1.41	1.63
Seating	3.56	16.7	0.9	3.96	18.56

Light Loss Factor

All light loss factors for LED fixtures are assumed to be 0.7.

LLF_{MH} = LDD X LLD X BF = 0.9 X 0.95 X 1 = 0.855

Lighting Power Density

Location	Fixture	#of fixtures	$Power_{total}$(W)	Area(ft^2)	$LPD_{designed}$	$LPD_{allowed}$
Circulation Corridor	*Bega* 20W MH	70	1400	8274	0.44	0.66
	Bega 22W LED	85	1870			
	Cree 13W LED	14	182			
Press Box	*Cree* 13W LED	24	312	332		
		TOTAL	3764	8606		

System Evaluation

Overall, the lighting system in circulation corridor has successfully achieved the design goals. Step lights with adjustable optical system act as direction leaders by creating strong stripes of light on the circulation floor. The vertical pattern is then carried on from the horizontal floor to the vertical wall by use of linear in-ground uplights. The smooth vertical wash on the wall allows light to integrate with the architectural material, reinforce the formal and calm appearance of concrete. The two fixtures functioned together to give the space a new verticality expression, with adequate light levels for way finding and security camera usage. The overall uniform wash on the wall and ceiling also enhanced the overall spatial dimension. Press box and entrance area are effctively lit with LED downlights with sufficient amount of light for task performances.

The average to minimum illuminance level on the floor surface is the one design parameter that was not met to compromise the strong light stripe visual appearance. Due to the mounting height of step lights, the readings on the floor level slightly exceed the IES recommended values; however the light level at eye level appears to be uniform and achieves a visual comfortable level. The seating area adjacent to the corridor has light level of 10 fc, which is close to that of corridor to establish a smooth boundary between two spaces.

|Renders

Figure 18| Circulation Corridor – Initial Sketch

Figure 19| Circulation Corridor – Perspective Rendering

Figure 20| Circulation Corridor – Emergency Mode

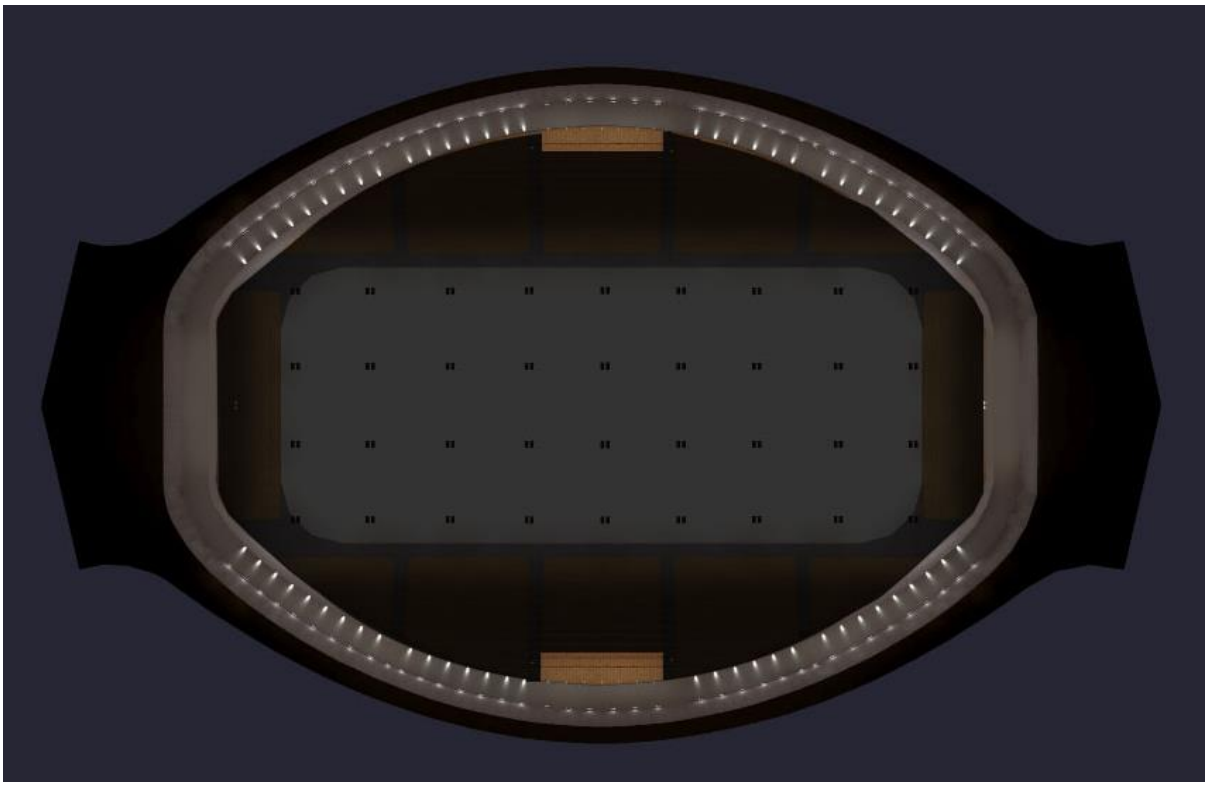


Figure 21| Circulation Corridor – Top View

Lighting | Ice Rink

|Architectural Description

With 290 feet spine and cables to support the iconic roof, the interior of the rink does not have any columns inside. The curved ceiling looks like the bottom of a boat, giving an open impression with a maximum ceiling height at 76 feet. The materials used for exterior of the building got carried inside, combined together to give a remarkable visual appearance. The arena can be used for purpose of hockey, figure skating and recreational use.

Figure 20 | Ice Rink

Geometry

Length: 200’
Width: 85’
Maximum Height: 76’
Area: 17,000 SF

Task:

- Hockey
- Recreational skating
- Figure skating
- broadcasting

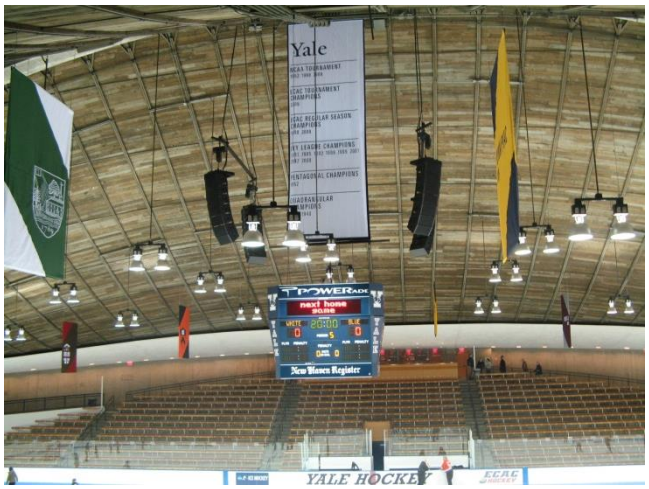


Figure 21 | Ice Rink – Ceiling Detail

Material Finish

Surface	Material	Description	Reflectance
Rink Floor	Concrete	Concrete floor base with ice sheet on top	0.79
Ceiling	Oak Wood	Existing oak wood roof in dark finish	0.2
Hockey Boards	Plexi-Glass	-	0.3

Table 3 | Ice Rink Material Properties

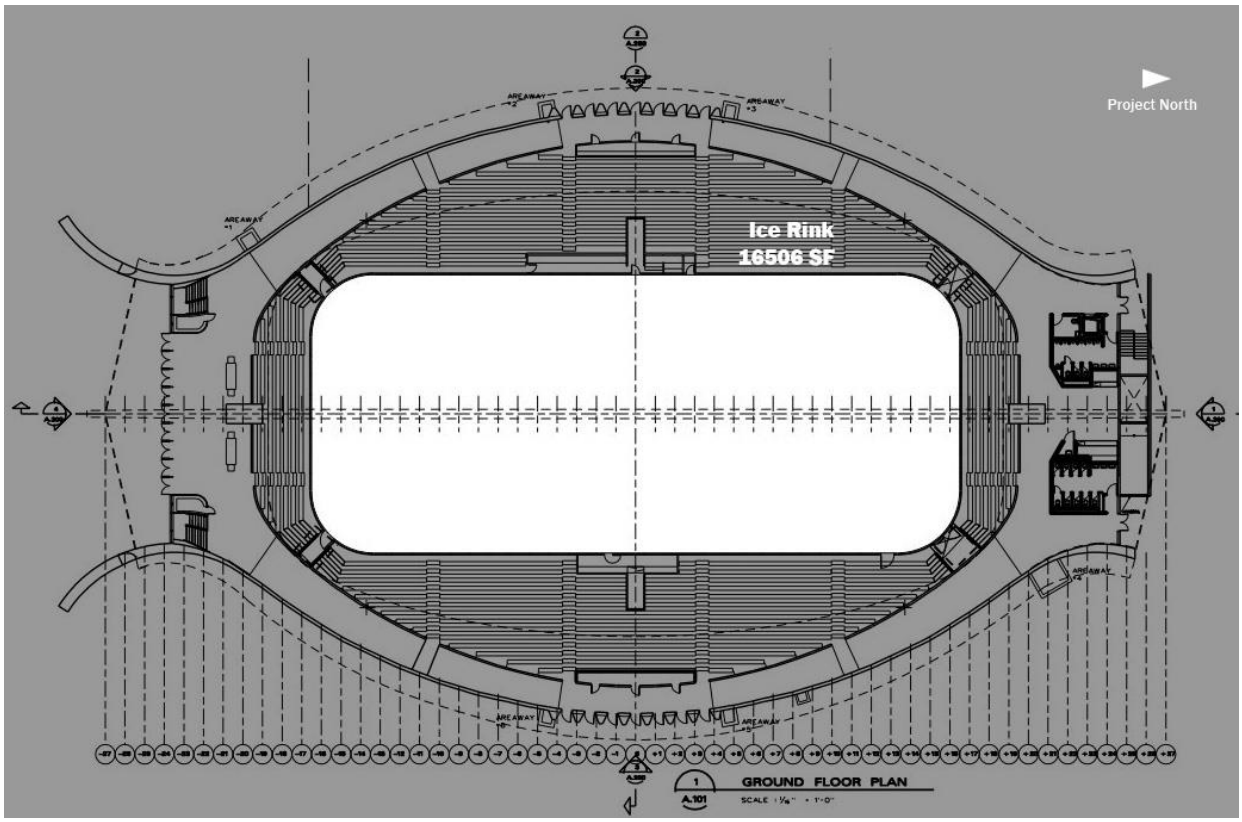


Figure 22 | Ground Floor Plan - Ice Rink

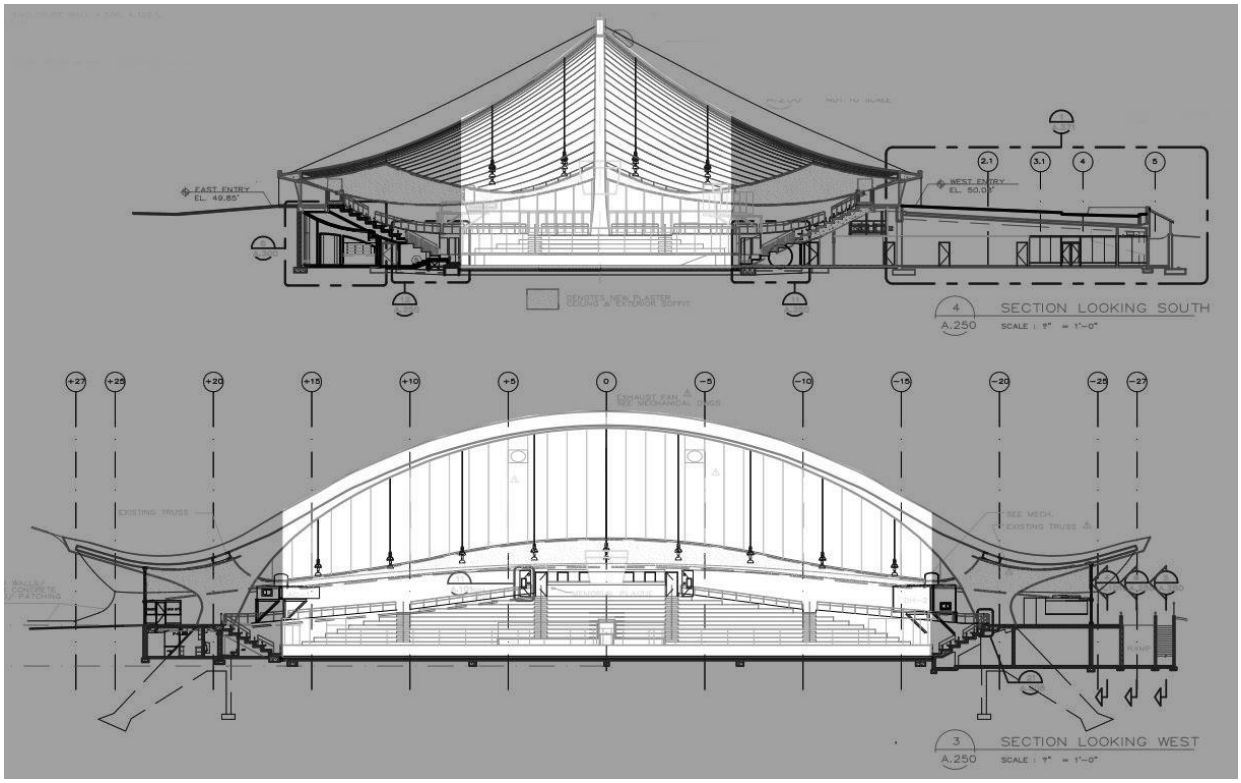


Figure 23 | Building Section - Ice Rink

|Design Consideration and Criteria

Once inside, public will immediately experience the same dramatic and harmonious design of the interior space which got carried in from outside. The two by eight oak wood ceiling with a maximum ceiling height of 70 feet provides an open impression. To enhance the visual appearance, an appropriate amount of uplight should be provided to accentuate the ceiling. Along with the aesthetic goals, lighting fixtures mounted above the ice also needs to be energy efficient since it generates large portion of radiation heat which can add to the refrigeration load. High-bay sports fixture should be specified with proper spacing and mounting height in order to achieve the desired light level and uniformity with control of direct and reflected glare issue. Typically, the ice arenas are used 18 hours per day on weekends and 12 hours per day during weekdays. Long durability is critical to efficiency and sustainability since resurfacing is required if a lamp accidentally exploded. In addition to that, the fixtures need to be impact resistant for safety consideration.

National Collegiate Athletic Association indicates that with a horizontal light level of 100 fc and uniformity of 2.5:1, the level of facility will provide standard intercollegiate play with no requirements for television broadcasts. Minimum lamp color temperature must be 3600 degrees Kelvin. Minimum color rendering index must be 65. Following the recommended best practices will help ensure quality of light needed for the safety of participants and the enjoyment of spectators.

Illuminance Recommendation

Space Type	E_h	E_v	CV_{max}	Max:Min
Ice Hockey Class II	1000 lux	300 lux	0.21	2.5:1

College Sports Facility: Class II – Competition play with facilities for up to 5000 spectators.

IES Lighting Handbook 10th Edition (Table 35.3)

Energy Allowance

Space Type	Power Density (W/sqf)
Sports Arena - Class II	1.92

ASHRAE standard 90.1 – 2010 (Table 9.6.1)

Broadcast

Facility Type	E_h	Horizontal Uniformity	Typical Seating	Pole Position
Intercollegiate Play (no broadcast)	1000 lx	2.5:1	N/A	N/A

Note: New Lighting System designs are recommended to use 0.7 recoverable Light Loss Factor.

NCAA Best Lighting Practices

|Concept Statement

Inspiration of the rink area comes from the overall lighting concept and skaters. Considering figure skaters with flowing movements like beautiful fish, or hockey players with speed like sharks, the design of rink lighting is intended to create a playground for the those who habitat inside the building. Since the rink is sorrounded by the circulation corridor, it is like the **Ocean** area that is sorrounded by coral reefs. Uniform illumination will be provided to sports function for hockey players, whereas more romance will be created on the ice surface for figure skaters during performance events. Strong vertical stripes will be projected upwards towards the ceiling, like sun strokes shining through the water surface, adding the sense of dimension by playing with the sense of space.

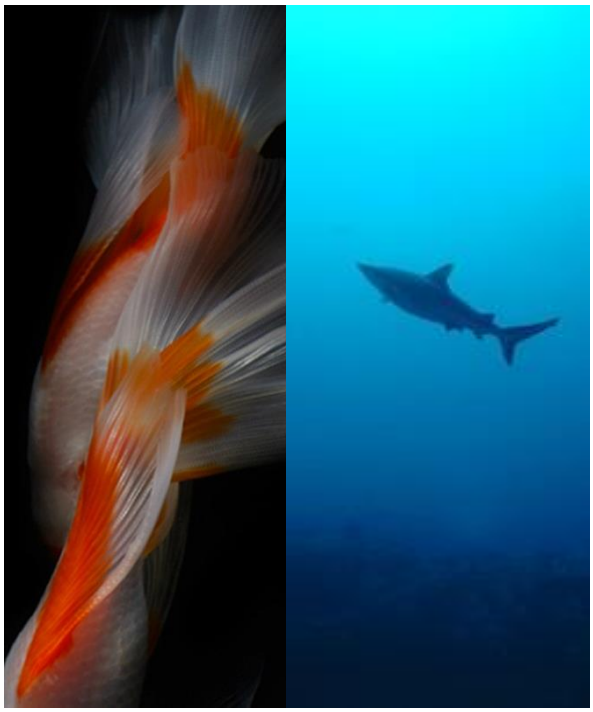


Figure 24 | fish + shark

|System Implementation

Description

The rink lighting design consists of a series of high performance LED pendants and narrow beam spread flood light. The new LED pendant system are suspended from building ceiling with steady Gripple Y-fit hangers. With a 22’ spacing in both x and y cartetian directions, pairs of *Philips GentleSpace* 267W high bay LED fixtures provide uniform distribution on the ice surface for sports purpose. The mounting height varies in 3 feet with the purpose of reducing the variance of light level between center and edge of the ice surface ; on the other hand, ,the variance in mounting height complements the flow of ceiling curvature. *LumenPulse* 50W LED floodlight with narrow beam will be used to create linear patterns to further engage the sense of dimension and accentuatue architectural wooden ceiling with minimum distractions to the activities. By directing the view with the direction of light flow, floodlights mounted on ceiling perimeter further expand the ceiling towards the sky, enhancing the volume of the whole arena.

Temporary theater fixtures with colored gels and gobos will be used to accentuate the ice surface for figure skating performances and special events. Chain motors are installed on the ceiling surface to allow temporary truss lifing. Conventional moving light will be used to project soft wash on the ice surface, whereas profile theater fixtures will be used with adjustable edge and gobo to provide special accents. All fixture wires will run to the temporary dimmer rack located in a secure location.

Lighting Plan

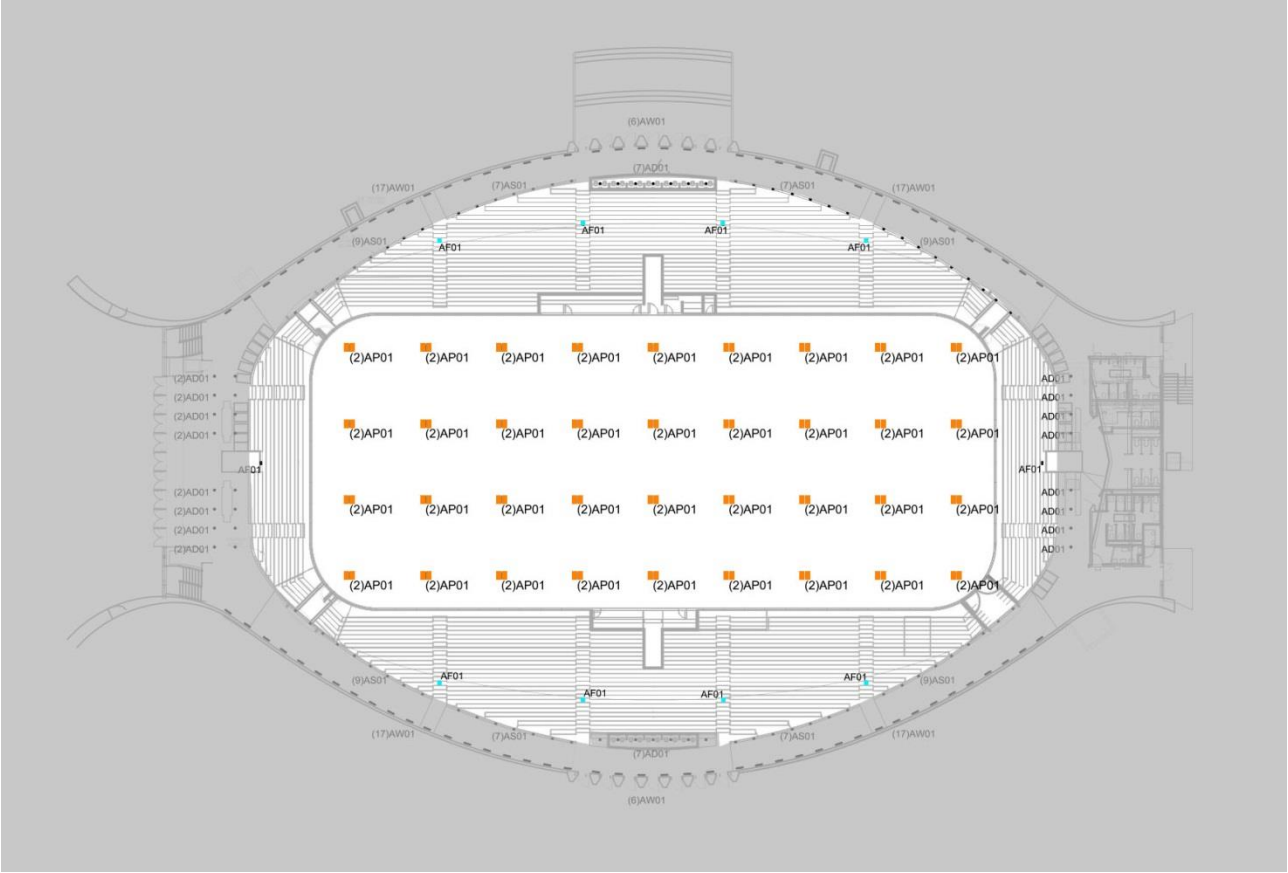


Figure 25 | Building Section - Ice Rink

Fixture Schedule

Type	Luminaire	Mounting	Description	Lamps	Power	Model	Remarks
●**AP01**	Downlight	Pendant	Nominal 2' L x 1'W x 4"H Housing: aluminum Lens: Polymethyl methacrylate CRI: 76 CCT: 4000K	LED	267W	*Philips* BY461P LED240S/740 PSD WB GC SI MB	Suspension accessory: Mounting bracket
●**AF01**	Floodlight	Surface	Nominal 10 1/8" D x 4 3/4"H Housing: Die-cast aluminum Lens: Clear tempered glass CRI: 78+ CCT: 4000K	LED	50W	*Lumen Pulse* LBL-120/277-40K-VN-SI-DIM-SY	adjust aiming angle to match the ceiling slope

|Performance Analysis

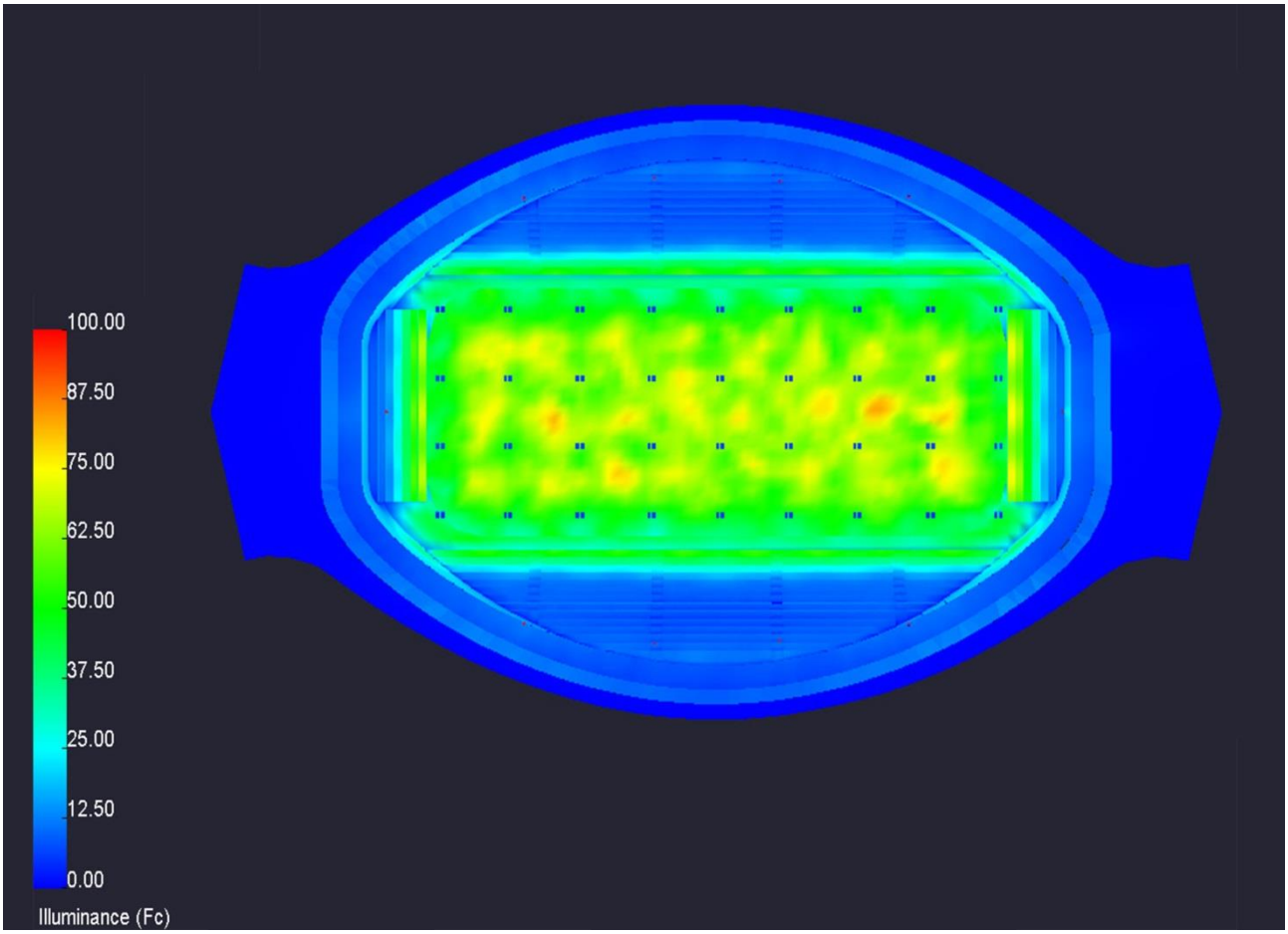


Figure 25 | Ice Rink Pseudo Color

Illuminance Levels

Location	Avg	Max	Min	Avg/Min	Max/Min
Rink	95.85	125	61.90	1.55	2.01
Seating	18.72	53.80	9.50	1.97	5.66
Ceiling	19.34	60.50	9.50	2.04	6.37

Light Loss Factor

All light loss factors for LED fixtures are assumed to be 0.7.

Lighting Power Density

Location	Fixture	#of fixtures	$Power_{total}$(W)	Area(ft^2)	$LPD_{designed}$	$LPD_{allowed}$
Rink	*Philips* 267W LED	72	19224			
	Lumen Pulse 56W LED	10	560	17000	1.16	1.92
		TOTAL	19784			

System Evaluation

The designed rink lighting system with (72) 267W *Philips* High Bay LED fixture paired in 36 locations effectively creates a uniform distribution of illuminance on the playing surface. Besides the extraordinary lamp performance characteristics such as effective heat dissipation, lamp efficiency and long life span, the new LED system also provides equivalent light level with **30%** lower power output comparing to the original Metal Halide. At a decreased lumen output, the LED light may remain operational for a long time, in the meantime generates less heat to the surrounding atmosphere, which can make a great difference to the system refrigeration load. According to NCAA lighting performance checklist for Collegiate Ice Hockey Arena, the calculation grid are created with a size of 14' by 14' in the simulation tool to allow accurate readings. The design met both illuminance and power density criteria from IES and ASHRAE Standard, providing adequate amount of illuminance to support the activities such as hockey games, figure skating and recreational usage. Reflected light from ice surface successfully brightens up the curved wood ceiling with average light level of **20 fc.** *Lumen Pulse* dimmable spotlight are positioned on top of audience walking isles, projecting vertical linear patterns on the roof to further accentuate the ceiling. All fixtures are dimmable to accommodate the variety of events.

Permanent chain motors are installed at different locations on the ceiling to allow theatrical truss mounting for the figure skating performance and special event purposes. Since the overall ceiling height reaches 76 feet on the zenith, the size of chain motors is negligible considering overall clean ceiling appearance.

|Renders

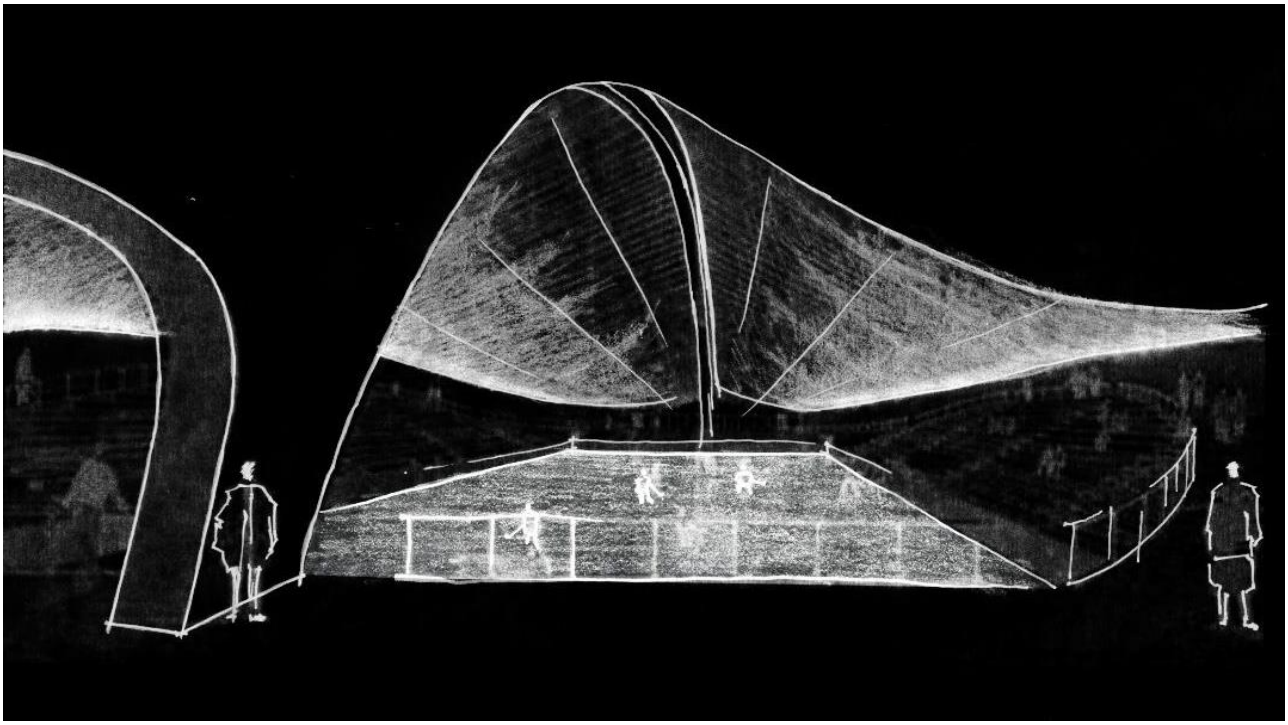


Figure 25 | Ice Rink – Initial Sketch

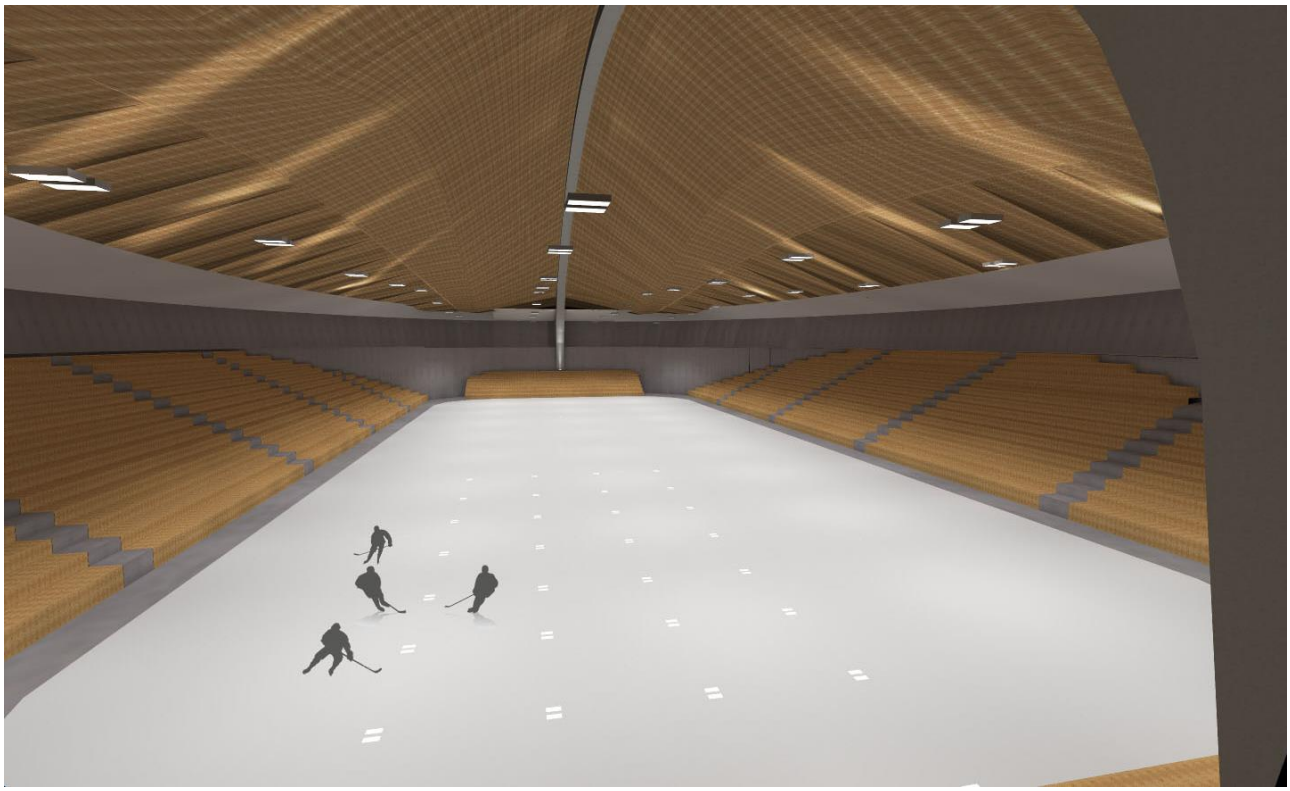


Figure 26 | Ice Rink – Perspective Rendering

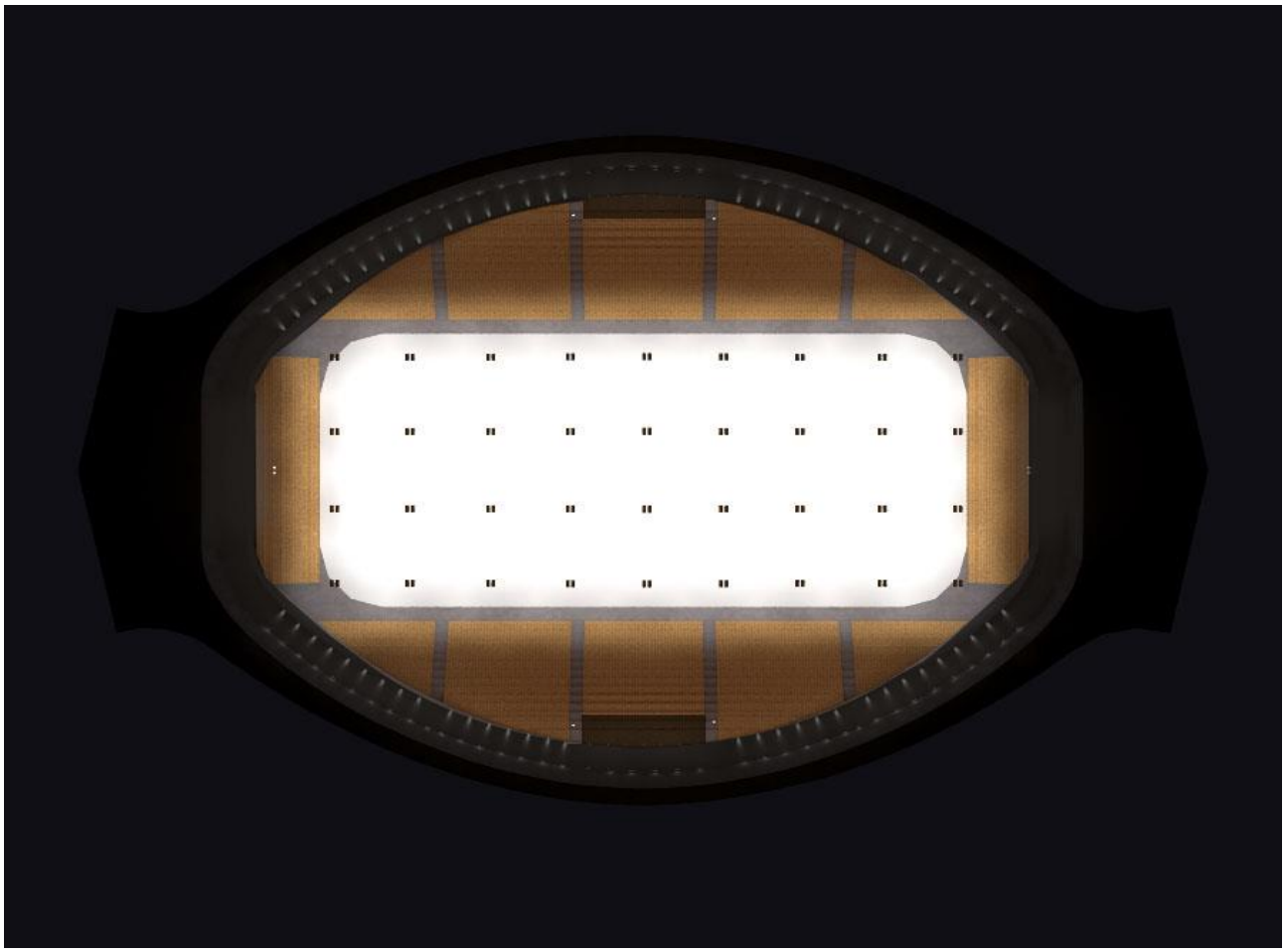


Figure 27| Ice Rink Rendering – Top View

Figure 28| Ice Rink – Spine Detail

Lighting | Schley Memorial Club Room

|Architectural Description

The Schley Memorial Club Room provides an intimate atmosphere for visitors to sit and rest. There are display cases and timeline photos spanned across the entire wall highlighted by wall mounted accent fixtures, telling the story of Yale hockey history dated back to 1895. This space will be designed to give a lighting solution with unique psychological reinforcement. The room locates directly below the seating area on building south. The original room had an exposed ceiling, whereas the renovation added a new customized wood ceiling to enhance the welcome environment and adds warmth to the room.

Figure 29 | Schley Memorial Club Room Original

Figure 30| Schley Memorial Club Room

Geometry

Length: 77’
Width: 22’
Height: 14’ max

Material Finish

Surface	Material	Reflectance
Floor	Carpet Type B1&B2	0.2
Walls	Painted Gyp Board	0.6
Ceiling	Plaster	0.8
	Custom Wood Panels	0.4

Table 8| Schley Memorial Club Room Material Properties

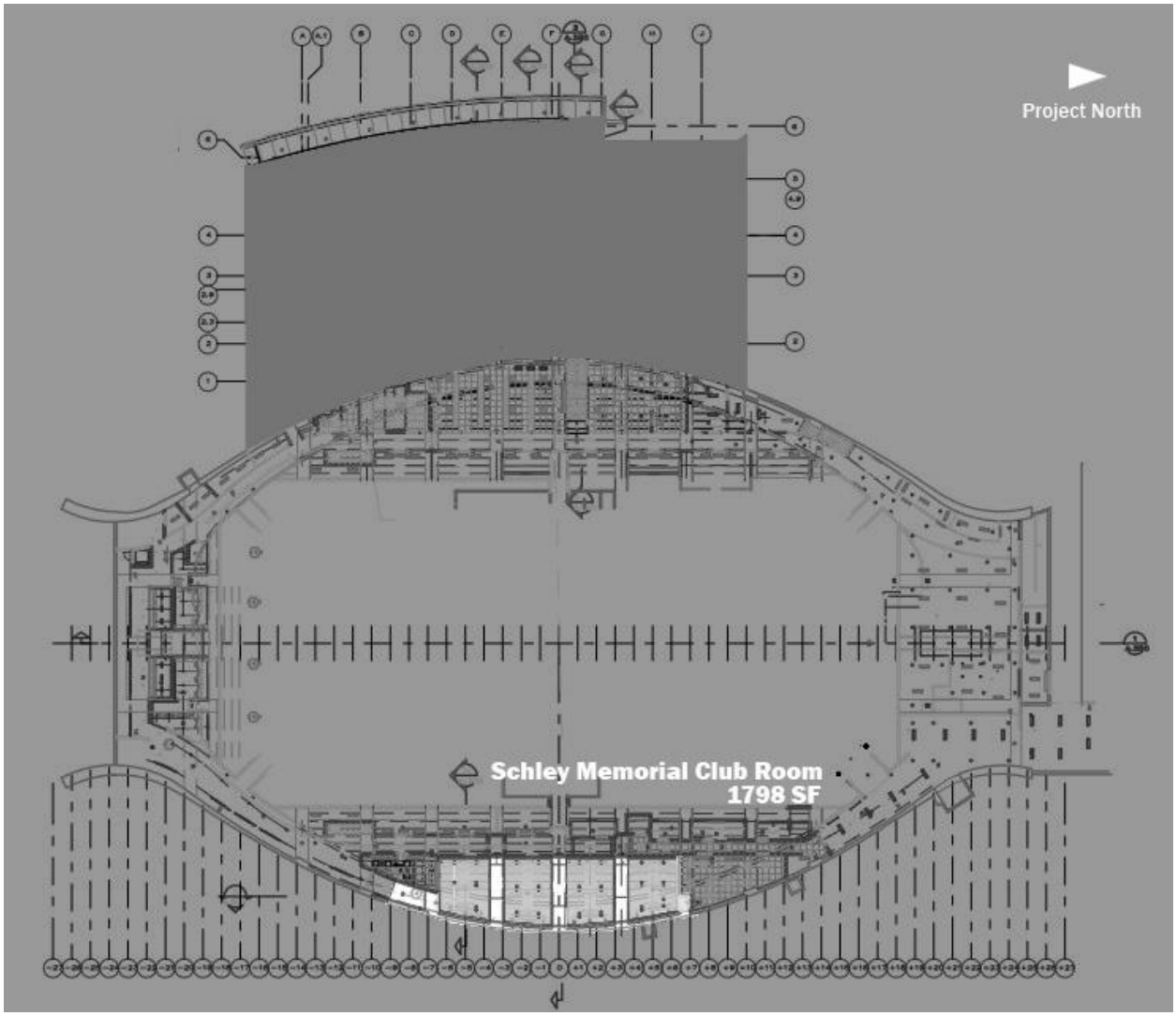


Figure 31 | Basement Floor Plan – Schley Memorial Club Rom

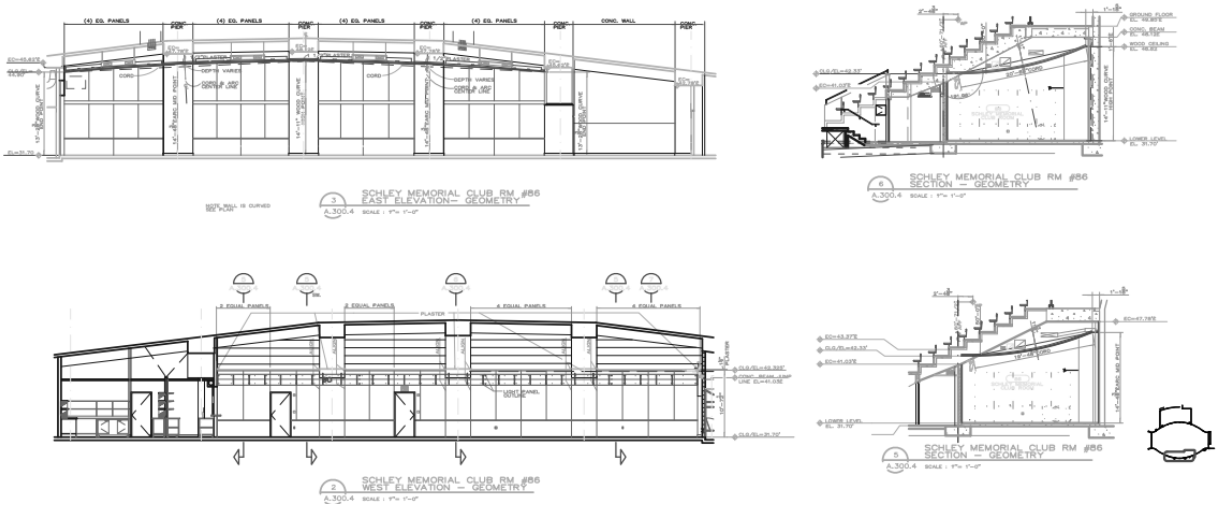


Figure 32| Building Section- Schley Memorial Club Room

|Design Consideration and Criteria

The multi-functional Club Room is used for socialization and display. It is important to create focal point on art works and timelines with aiming strategy on each side of north and south to emphasis the significance of the historical building. The general seating area should have a lower illuminance compared to the timeline/art display in order for it to appear dramatically lit. The light levels should also appear balanced for seating area to create a comforting atmosphere. Across the space, ambient illumination can be added to the sloped customized wood ceiling panel, which helps creating a comforting atmosphere and resembles an upscale lounge. This space is designed and studied with progress based off from John Flynn's psychological mode. A private impression will be achieved with contrast in light levels and the use of brightness and shadows.

Illuminance Recommendation

- Club Room

Space Type	E_h	E_v	Avg:Min
Social/Waiting Areas	100	30	3:1

IES Lighting Handbook 10th Edition (Table 22.2)

- Timeline Display

Attraction	Role	Illuminance Ratio	Application Notes
Moderate	Feature	5:1 focal point to task	Used on focal points or features for visual interest. Long-term exposure may fade-degrade focal. Focal plane may be different from takes plane.

IES Lighting Handbook 10th Edition (Table 15.2)

Energy Allowance

Space Type	Power Density (W/sqf)
Multipurpose	1.23

ASHRAE standard 90.1 – 2010 (Table 9.6.1)

-Accent lighting

Accent lighting is necessary in many situations.it can address some spatial and psychological factors and establish boundaries of space without the visual monotony and equipment.

-Display

The circulation/general purpose space lighting should have a lower light level compared to the display to establish the strong contrast, dramatically illuminate the space.

|Concept Statement

After **diving** through the ocean surface, swimming past the **coral reefs** in the **ocean**, you get to the **deep ocean floor**, which is the Schley Club Room located in the lower level. To impement the private psychological impression, the ligthing design of this space tends to use the contrast between light and shadow and layers of light to contribute to the overall quiet and enclosed sense of deep ocean. Recessed downlight will be mounted on the ceiling to give a uniform distribution of light on the floor, whereras adjustable spotlight will be used to give highlight on the wall mounted timline artworks. Curved ceiling will be grazed up in the direction of the elevated slope, giving a sense of extention.

Figure 33| Deep Ocean Floor

|System Implementation

Description

Schley Club Room implements three different types of fixtures to create layers of light. *Cree* 4'' ceilling recessed downlights are used to provide smooth and ambient light level on the floor. In contrast, *WAC Lighting* 6" x 6" adjustable ceiling recessed spot light mounted 4 feet away from the wall creates bright scallop patterns on timeline photos. The sloped wooden ceiling panels are accentuated using the same lighting approach as the concrete walls in circulaiton areas – with linear *Lumen Pulse* adjustable linear fixtures to graze it up. This approach allows an extention of eyesight, which leads to an expansion of the space dimension. These grazer fixtures will be concealed to prevent direct glare which may lead to visual discomfort. All fixtures are dimmable in order to cordinate with the presentation, special event and social interaction purposes.

The overall private psychological impresseion is achieved by layers of light with different brightness. Upon entering into the space, the bright spots on the wall surface directly attracts attention to the most important historical timeline feature. Inaddition, the wooden architectural ceiling is smoothly grazed by the linear fixtures towards the slope top. Lastly, ambient illuminacce on the fllor surface provides the overall comfattable and calm atomosphere.

Lighting Plan

Figure 34 | Schley Club Room Lighting Plan

Fixture Schedule

Type	Luminaire	Mounting	Description	Lamps	Power	Model	Remarks	Location
●AD01	Downlight	Ceiling Recessed	Nominal 5 1/4" D x 7 1/4"H Housing: Extruded anodized aluminum Lens: Clear tempered glass CRI: 78+ CCT: 3500K	LED	13W	*Cree* KR-4-9L-35-277V-10V	0-10V dimming	Schley Club Room
●AD02	Spotlight	Ceiling Recessed	Nominal 6 3/4" L x 6 3/4"W x 6"H Housing: Die-cast aluminum Lens: TBA CRI: 85 CCT: 3500K	LED	11W	*Wac Lighting* MT-LED118-S-35HS-WT	ELV dimmer	Schley Club Room

●AG01	Linear Grazing Fixture	Surface	Nominal 48 3/4" L x 6 3/4"W x 6"H Housing: Extruded aluminum Lens: Clear tempered glass CRI: 85 CCT: 3500K	LED	6W/ft	*Lumen Pulse* LCSRO-277-48-35K-CL-RF-WH-DIM	0-10V dimming	Schley Club Room
●AG01 (a)	Linear Grazing Fixture	Surface	Nominal 12 3/4" L x 6 3/4"W x 6"H Housing: Extruded aluminum Lens: Clear tempered glass CRI: 85 CCT: 3500K	LED	6W/ft	*Lumen Pulse* LCSRO-277-48-35K-CL-RF-WH-DIM	0-10V dimming	Schley Club Room

|Performance Analysis

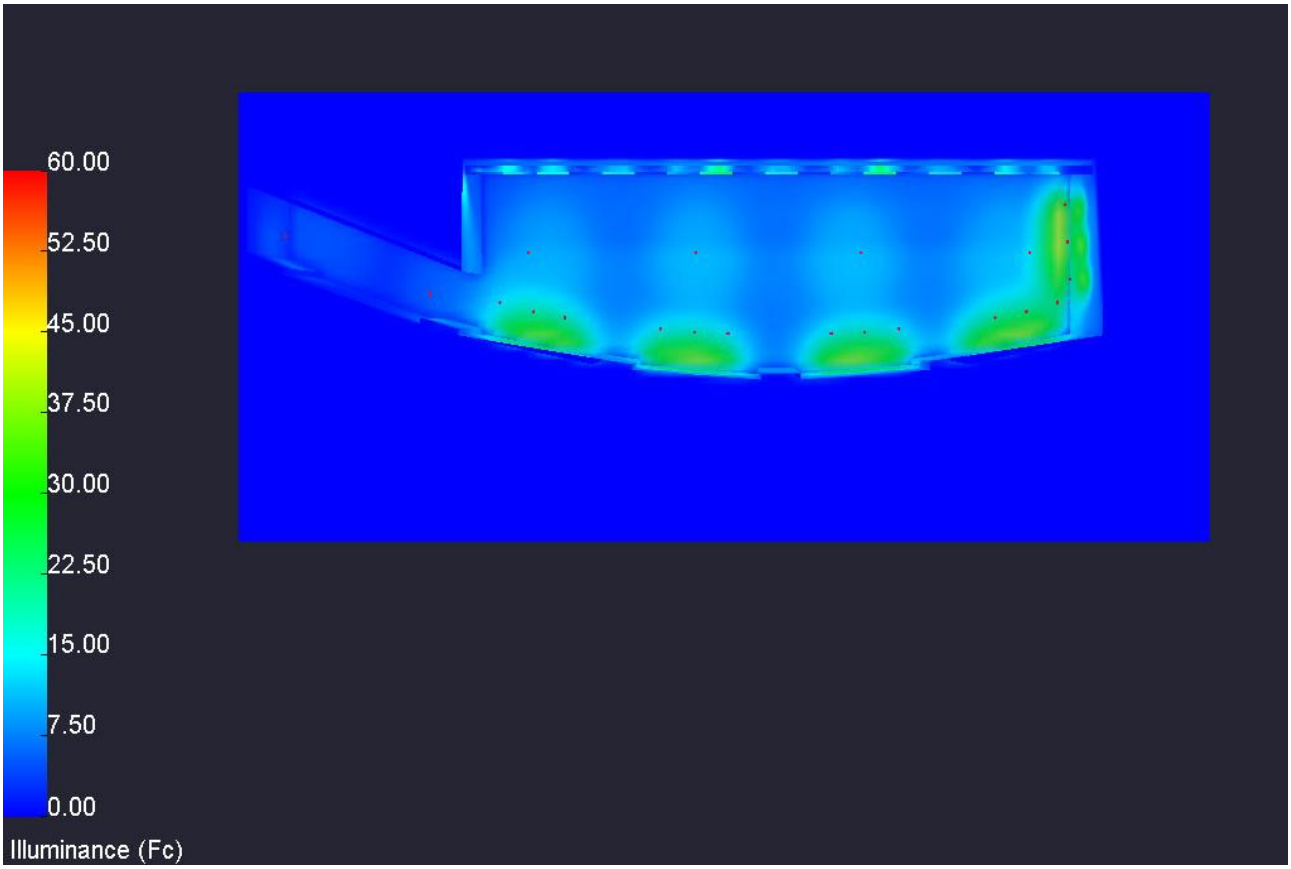


Figure 35 | Schley Club Room Pseudo Color

Illuminance Levels

Location	Avg	Max	Min	Avg/Min	Max/Min
Floor	95.85	39.70	4.90	2.60	8.10
Wall	11.84	26.60	2.70	4.39	9.85
Ceiling	20.96	150	1.5	13.97	100

Light Loss Factor

All light loss factors for LED fixtures are assumed to be 0.7.

Lighting Power Density

Location	Fixture	#of fixtures	$Power_{total}$(W)	Area(ft^2)	$LPD_{designed}$	$LPD_{allowed}$
Schley Memorial Club Room	*Cree* 13W LED	6	48	1754	0.38	1.23
	Wac Lighting 11W LED	15	165			
	Lumen Pulse 6W LED	77	462			
		TOTAL	675			

|System Evaluation

The designed lighting system for schley club room successfully establish the private impression through strong contrast betwee light and shadow while providing adequate amount of light for social interaction. Adjustable spot light cast storng scallop patterns on the timeline artworks with 26fc on the focal point center. The linear grazer mounted on the lower side of the sloped ceiling panel projects a smooth gradient of light on the wood to extend the spacial dimension with a light level slightly lower than the timeline focal point.

Size and shape of ceiling recessed downlights are carefully selected to ensure minimal apperance on the wooden panels. When entering into the space, occupants are able to distinguish the importance between each feature in the room, without noticing the exsitance of lighting fixtures. In the meantime, overall space will be illuminated uniformly with recommended light levels for social interaction to create a comforting environment.

|Renders

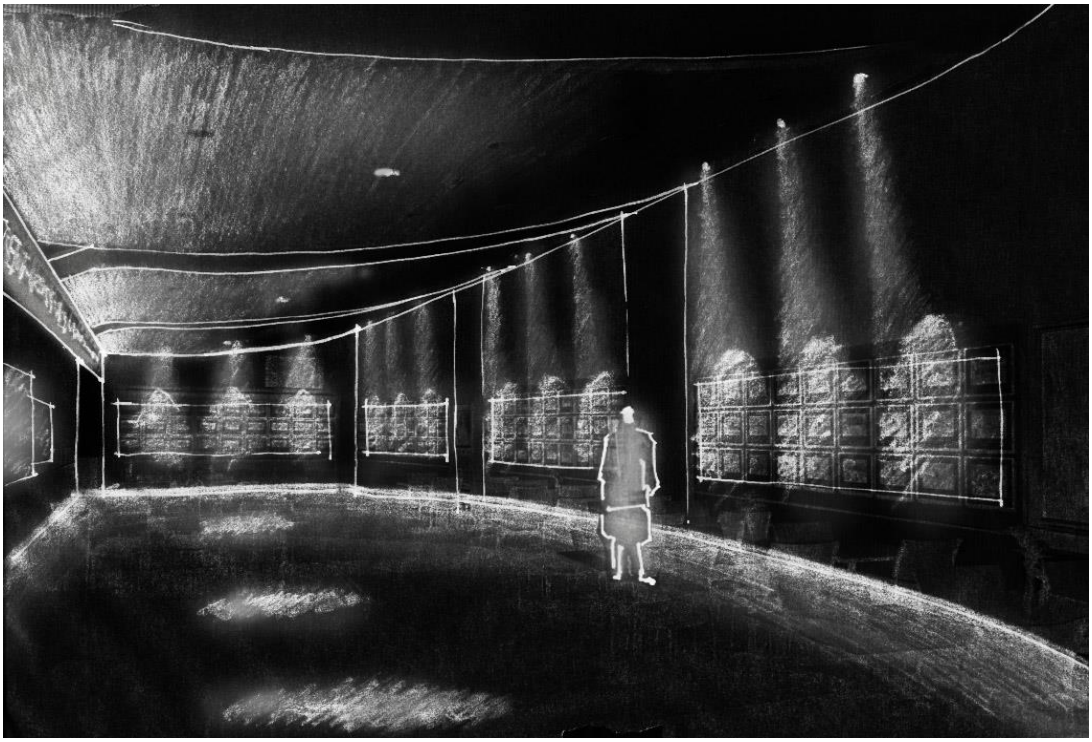


Figure 36 | Schley Club Room – Initial Sketch

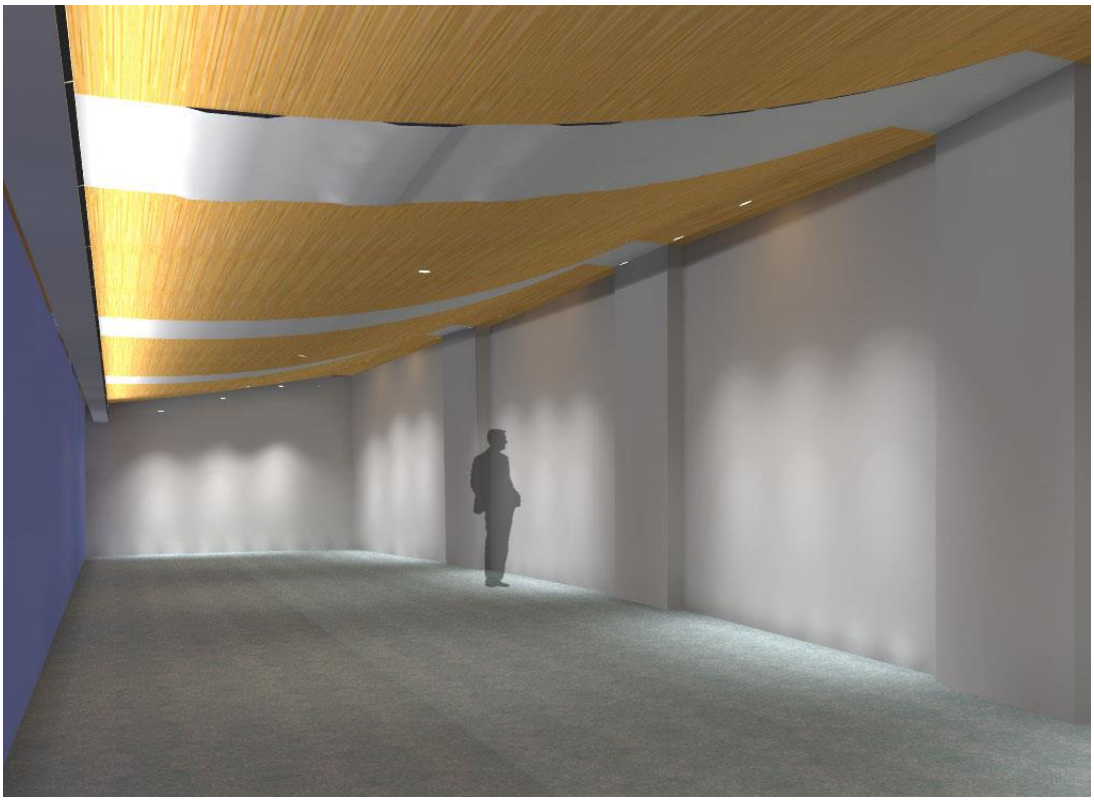


Figure 37 | Schley Club Room – Perspective Rendering

Electrical Depth

|Introduction

Three topics were selected for analyzing the exisitn g building electrical system. Branch circuit analysis was performed by replacing new designed lighting fixtures with the original fixutres on the panel board schedule. The overall voltamps for each new panelboard was calculated to evaluate the possibilities of feeder upsizing. The second analysis contains short circuit analysis between primary/secondary transformers and switchboards. Following procedures of Cooper Bussman short circuit analysis, fault current protection of selected five points in the electrical diagram was calculated and compared to the existing switchboards Amperes Interuption Current rating. Lastly, a cost estimation was performed to evaluate the benefit of replacing copper wires with aluminum regarding construction and material budget.

Electrical I | Branch Circuit Analysis

Existing Panelboard Schedule

Highlighted in red are lighting loads that are taken out based on the adjustments made to the original lighting design. Adjusted spaces include Rink, Circulation, exterior, and team lounge.

480 Y/277V — **LP-N** — BUS: 100 AMP

42K AIC — 3Ø-4W — MAIN: 100 AMP CB

	LOAD SERVED	WIRE SIZE	TRIP	POLE	LOAD IN kVA ØA		ØB		ØC		POLE	TRIP	WIRE SIZE	LOAD SERVED	
1	Lower Level Lighting	2#12+G- 3/4"C	20	1	1.52	0.69					1	20	2#12+G- 3/4"C	Upper Level Bathrooms	2
3	SPARE	2#12+G- 3/4"C	20	1			0.00	0.30			1	20	2#12+G- 3/4"C	North Entrance Lighting	4
5	Exterior South Lighting	2#12+G- 3/4"C	20	1					0.50	0.50	1	20	2#12+G- 3/4"C	Interior South Lighting	6
7	Pole Lighting	2#12+G- 3/4"C	20	1	2.03	1.58					1	20	2#12+G- 3/4"C	Pole Lighting	8
9	Ramp Lighting	2#12+G- 3/4"C	20	1			0.50	0.47			1	20	2#12+G- 3/4"C	South Lower Lighting	10
11	South Lower Lighting	2#12+G- 3/4"C	20	1					2.49	3.33	1	20	2#12+G- 3/4"C	West Lighting	12
13	West Lighting	2#12+G- 3/4"C	20	1	2.99	1.47					1	20	2#12+G- 3/4"C	Team Lounge	14
15	Time Clock	2#12+G- 3/4"C	20	1			0.50	4.14			1	20	2#12+G- 3/4"C	Schley Room	16
17	SPARE		20	1					0.00	0.00	1	20		SPARE	18
19	SPARE		20	1	0.00	0.00					1	20		SPARE	20
21	SPARE		20	1			0.00	0.00			1	20		SPARE	22
23	SPARE		20	1					0.00	0.00	1	20		SPARE	24
25	SPARE		20	1	0.00	0.00					1	20		SPARE	26
27	SPARE		20	1			0.00	0.00			1	20		SPARE	28
29	SPARE		20	1					0.00	0.00	1	20		SPARE	30
31	SPARE		20	1	0.00	0.00					1	20		SPARE	32
33	SPARE		20	1			0.00	0.00			1	20		SPARE	34
35	SPARE		20	1					0.00	0.00	1	20		SPARE	36
		LOAD PER PHASE			10.27		5.91		6.82						

TOTAL = 23.00 kVA — 28 AMPS — A = AFI BREAKER

NOTES: ☐ FEED THROUGH LUGS ☐ FLUSH ☐ 600KCM LUGS ☐ ISOLATED GROUND BUS G = GFI BREAKER

480Y/277 VOLT, 14,000 A.I.C. (1), 3 PHASE – 4 WIRE

DIMMER PANEL EDR – SEC1 (3)

REFER TO DETAIL #3/E.404 FOR DETAILS

ROOM/AREA	CONTROLS	CIRCUIT # NORM.	CIRCUIT # EMERG.	ZONE	DESCRIPTION	# OF LAMPS	TOTAL WATTS	I	HID	ND	F	WIRE & CONDUIT	REMARKS
RINK	–	–	1	2b	A01	1	750		X			4#12+G-3/4"C.	0-10 VOLTS
RINK	–	–	2	3b	A01	1	750		X			4#12+G-3/4"C.	0-10 VOLTS
RINK	–	–	3	4c	A01	1	750		X			4#12+G-3/4"C.	0-10 VOLTS
RINK	–	–	4	4d	A01	1	750		X			4#12+G-3/4"C.	0-10 VOLTS
RINK	–	–	5	4e	A01	1	750		X			4#12+G-3/4"C.	0-10 VOLTS
RINK	–	–	6	4f	A01	1	750		X			4#12+G-3/4"C.	0-10 VOLTS
RINK	–	–	7	4g	A01	2	1500		X			4#12+G-3/4"C.	0-10 VOLTS
UPPER EAST CORNER	–	–	8	5	A02	13	416			X		2#12+G-3/4"C.	–
UPPER WEST CORNER	–	–	9	6	A02	13	416			X		2#12+G-3/4"C.	–
UPPER NORTH/SOUTH ENTRIES	–	–	10	7	A03	8	256			X		2#12+G-3/4"C.	–
UPPER EAST ENTRY	–	–	11	8	A03	3	96			X		2#12+G-3/4"C.	–
UPPER WEST ENTRY	–	–	12	9	A03	3	96			X		2#12+G-3/4"C.	–

SEE NOTE #2

SEC1 + SEC2 TOTAL LOAD =9,666 VA – 11.6 AMPS — TOTAL LOAD = 7,280 VA – 8.8 AMPS

480Y/277 VOLT.
14,000 A.I.C. (1)
3 PHASE – 4 WIRE

DIMMER PANEL EDR – SEC2

REFER TO DETAIL #3/E.404 FOR DETAILS

ROOM/AREA	CONTROLS	CIRCUIT # NORM.	CIRCUIT # EMERG.	ZONE	DESCRIPTION	# OF LAMPS	TOTAL WATTS	I	LV	ND	F	WIRE & CONDUIT	REMARKS
UPPER NORTH CONCESSION	–	–	13	10	A03	2	64			X		2#12+G–3/4"C.	–
RMS 80,95,95A	–	–	14	11	A21A,ASW1	4,2	336			X		2#12+G–3/4"C.	–
CORRIDOR 81E	–	–	15	12 (12)	A13	3	318			X		2#12+G–3/4"C.	–
RMS 94,94B,94C,94D, 73	–	–	16	13	A21	8	448			X		2#12+G–3/4"C.	–
RMS 93,93A,60	–	–	17	14	A14,A17	6,4	324			X		2#12+G–3/4"C.	–
RM 96	–	–	18	15	A21	5	280			X		2#12+G–3/4"C.	–
RMS 91, 92	–	–	19	16	A14,A21	4,2	280			X		2#12+G–3/4"C.	–
RMS 90,90A,90B	–	–	20	17	A24	12	336			X		2#12+G–3/4"C.	–
SPARE	–	–	21	–	–	–	–					–	–
SPARE	–	–	22	–	–	–	–					–	–
SPARE	–	–	23	–	–	–	–					–	–
SPARE	–	–	24	–	–	–	–					–	–

TOTAL LOAD = 2,386 VA – 2.9 AMPS

480Y/277 VOLT.
14,000 A.I.C. (1)
3 PHASE – 4 WIRE

DIMMER PANEL DR – SEC1 (3)

REFER TO DETAIL #3/E.404 FOR DETAILS

ROOM/AREA	CONTROLS	CIRCUIT # NORM.	CIRCUIT # EMERG.	ZONE	DESCRIPTION	# OF LAMPS	TOTAL WATTS	I	HID	ND	F	WIRE & CONDUIT	REMARKS
RINK	–	1	–	1a	A01	6	3000		X			4#12+G–3/4"C.	0–10 VOLTS
RINK	–	2	–	1b	A01	6	3000		X			4#12+G–3/4"C.	0–10 VOLTS
RINK	–	3	–	2a	A01	4	2000		X			4#12+G–3/4"C.	0–10 VOLTS
RINK	–	4	–	2b	A01	3	1500		X			4#12+G–3/4"C.	0–10 VOLTS
RINK	–	5	–	3a	A01	4	2000		X			4#12+G–3/4"C.	0–10 VOLTS
RINK	–	6	–	3b	A01	3	1500		X			4#12+G–3/4"C.	0–10 VOLTS
RINK	–	7	–	4a	A01	8	4000		X			4#12+G–3/4"C.	0–10 VOLTS
RINK	–	8	–	4b	A01	8	4000		X			4#12+G–3/4"C.	0–10 VOLTS
RINK	–	9	–	4c	A01	5	2500		X			4#12+G–3/4"C.	0–10 VOLTS
RINK	–	10	–	4d	A01	5	2500		X			4#12+G–3/4"C.	0–10 VOLTS
RINK	–	11	–	4e	A01	5	2500		X			4#12+G–3/4"C.	0–10 VOLTS
RINK	–	12	–	4f	A01	5	2500		X			4#12+G–3/4"C.	0–10 VOLTS
RINK	–	13	–	4g	A01	2	1000		X			4#12+G–3/4"C.	0–10 VOLTS
UPPER EAST CORNER	–	14	–	5	A02	28	896			X		2#12+G–3/4"C.	–
UPPER WEST CORNER	–	15	–	6	A02	28	896			X		2#12+G–3/4"C.	–
UPPER NORTH/SOUTH ENTRIES	–	16	–	7	A03	15	480			X		2#12+G–3/4"C.	–

SEC1 + SEC2 TOTAL LOAD =38,284 VA – 46.0 AMPS

TOTAL LOAD = 34,272 VA – 41.2 AMPS

SEE NOTE #2

480Y/277 VOLT, 14,000 A.I.C. (1) 3 PHASE – 4 WIRE

DIMMER PANEL DR – SEC2

REFER TO DETAIL #3/E.404 FOR DETAILS

ROOM/AREA	CONTROLS	CIRCUIT # NORM.	CIRCUIT # EMERG.	ZONE	DESCRIPTION	# OF LAMPS	TOTAL WATTS	I	LV	ND	F	WIRE & CONDUIT	REMARKS
UPPER EAST ENTRY	–	17	–	8	A03	9	288			X		2#12+G–3/4"C.	–
UPPER WEST ENTRY	–	18	–	9	A03	9	288			X		2#12+G–3/4"C.	–
UPPER NORTH CONCESSION	–	19	–	10	A03	4	128			X		2#12+G–3/4"C.	–
RMS 80,95,95A	–	20	–	11	A21A,ASW1	4,4	448			X		2#12+G–3/4"C.	–
CORRIDOR 81E	–	21	–	12 (12)	A13	3	468			X		2#12+G–3/4"C.	–
RMS 94,94B,94C,94D, 73	–	22	–	13	A21	12	672			X		2#12+G–3/4"C.	–
RMS 93,93A,60	–	23	–	14	A14, A17	12,3	438			X		2#12+G–3/4"C.	–
RM 96	–	24	–	15	A21	5	280			X		2#12+G–3/4"C.	–
RMS 91, 92	–	25	–	16	A17,A21	3,3	294			X		2#12+G–3/4"C.	–
RMS 90,90A,90B	–	26	–	17	A24	11	308			X		2#12+G–3/4"C.	–
UPPER SOUTH	–	27	–	18	AX15	8	400			X		2#12+G–3/4"C.	–
SPARE	–	28	–	–	–	–	–					–	–
SPARE	–	29	–	–	–	–	–					–	–
SPARE	–	30	–	–	–	–	–					–	–
SPARE	–	31	–	–	–	–	–					–	–
SPARE	–	32	–	–	–	–	–					–	–

TOTAL LOAD = 4,012 VA – 4.8 AMPS

Adjusted Panelboard Schedule

Total volt amps of new lighting equipment are employed in the panel board schedules in replacement of the original lighting. With a primary utilization voltage of 480Y/277V, the maximum volt-amps for each circuit equals: **277V x 20A x 0.8(Continuous load) x 0.8(spare) = 3.5 KVA.**

480Y/277VOLT
144,000 A.I.C.
3 PHASE - 4 WIRE

DIMMER PANEL EDR - SEC 1

ROOM/AREA	CIRCUIT # NORM.	CIRCUIT # EMERG.	DESCRIPTION	# OF FIXTURES	LAMP TYPE	TOTAL VA	WIRE & CONDUIT	REMARKS
RINK	-	1	AP01	2	LED	534	4#12+G - 3/4"C.	0-10V
RINK	-	2	AP01	2	LED	534	4#12+G - 3/4"C.	0-10V
RINK	-	3	AP01	2	LED	534	4#12+G - 3/4"C.	0-10V
RINK	-	4	AP01	2	LED	534	4#12+G - 3/4"C.	0-10V
CORRIDOR SOUTHEAST	-	5	AS01	5	T4 GU6.5MH	100	2#12+G - 3/4"C.	-
CORRIDOR SOUTHWEST	-	6	AS01	5	T4 GU6.5MH	100	2#12+G - 3/4"C.	-
CORRIDOR NORTHEAST	-	7	AS01	5	T4 GU6.5MH	100	2#12+G - 3/4"C.	-
CORRIDOR NORTHWEST	-	8	AS01	5	T4 GU6.5MH	100	2#12+G - 3/4"C.	-
CORRIDOR SOUTHEAST	-	9	AW01	5	LED	135	2#12+G - 3/4"C.	-
CORRIDOR SOUTHWEST	-	10	AW01	5	LED	135	2#12+G - 3/4"C.	-
CORRIDOR NORTHEAST	-	11	AW01	5	LED	135	2#12+G - 3/4"C.	-
CORRIDOR NORTHWEST	-	12	AW01	5	LED	135	2#12+G - 3/4"C.	-
NORTH ENTRY	-	13	AW01	2	LED	54	2#12+G - 3/4"C.	-
SOUTH ENTRY	-	14	AW01	2	LED	54	2#12+G - 3/4"C.	-
					TOTAL LOAD	= **3184**	VA - **3.8 AMPS**	

480Y/277VOLT 144,000 A.I.C. 3 PHASE - 4 WIRE			DIMMER PANEL DR - SEC 1					
ROOM/AREA	CIRCUIT #		DESCRIPTION	# OF FIXTURES	LAMP TYPE	TOTAL VA	WIRE & CONDUIT	REMARKS
	NORM	EMERG						
RINK	1	-	AP01	12	LED	3204	4#12+G - 3/4"C.	0-10V
RINK	2	-	AP01	12	LED	3204	4#12+G - 3/4"C.	0-10V
RINK	3	-	AP01	12	LED	3204	4#12+G - 3/4"C.	0-10V
RINK	4	-	AP01	12	LED	3204	4#12+G - 3/4"C.	0-10V
RINK	5	-	AP01	8	LED	2136	4#12+G - 3/4"C.	0-10V
RINK	6	-	AP01	8	LED	2136	4#12+G - 3/4"C.	0-10V
CIRCULATION CORRIDOR	7	-	AS01	50	LED	1000	2#12+G - 3/4"C.	-
CIRCULATION CORRIDOR	8	-	AW01	61	LED	1647	2#12+G - 3/4"C.	-
RINK	9	-	AF01	10	LED	500	-	-
RINK	10	-	AD01	7	LED	91	-	-
RINK	11	-	AD01	7	LED	91	-	-
CIRCULATION CORRIDOR	12	-	AD01	16	-	208	-	-
CIRCULATION CORRIDOR	13	-	AD01	8		104		
					TOTAL LOAD	= 20729	VA - 23.7 AMPS	

480 Y/277V 42K AIC 3Ø-4W					LP-N							BUS: 100 AMP MAIN: 100 AMP CB				
	LOAD SERVED	WIRE SIZE	TRIP	POLE	LOAD IN kVA						POLE	TRIP	WIRE SIZE	LOAD SERVED	
					ØA		ØB		ØC						
1	Lower Level Lighting	2#12+G- 3/4"C	20	1	1.52	0.69					1	20	2#12+G- 3/4"C	Upper Level Bathrooms	2
3	SPARE	2#12+G- 3/4"C	20	1			0.00	0.30			1	20	2#12+G- 3/4"C	North Entrance Lighting	4
5	Exterior South Lighting	2#12+G- 3/4"C	20	1					0.50	0.50	1	20	2#12+G- 3/4"C	Interior South Lighting	6
7	Pole Lighting	2#12+G- 3/4"C	20	1	2.03	1.58					1	20	2#12+G- 3/4"C	Pole Lighting	8
9	Ramp Lighting	2#12+G- 3/4"C	20	1			0.50	0.47			1	20	2#12+G- 3/4"C	South Lower Lighting	10
11	South Lower Lighting	2#12+G- 3/4"C	20	1					2.49	3.33	1	20	2#12+G- 3/4"C	West Lighting	12
13	West Lighting	2#12+G- 3/4"C	20	1	2.99	1.47					1	20	2#12+G- 3/4"C	Team Lounge	14
15	Time Clock	2#12+G- 3/4"C	20	1			0.50	0.627			1	20	2#12+G- 3/4"C	Schley Room	16
17	SPARE		20	1					0.00	0.00	1	20		SPARE	18
19	SPARE		20	1	0.00	0.00					1	20		SPARE	20
21	SPARE		20	1			0.00	0.00			1	20		SPARE	22
23	SPARE		20	1					0.00	0.00	1	20		SPARE	24
25	SPARE		20	1	0.00	0.00					1	20		SPARE	26
27	SPARE		20	1			0.00	0.00			1	20		SPARE	28
29	SPARE		20	1					0.00	0.00	1	20		SPARE	30
31	SPARE		20	1	0.00	0.00					1	20		SPARE	32
33	SPARE		20	1			0.00	0.00			1	20		SPARE	34
35	SPARE		20	1					0.00	0.00	1	20		SPARE	36
		LOAD PER PHASE			10.27		5.91		6.82						
		TOTAL =			23.00 kVA						28 AMPS			A = AFI BREAKER	
NOTES: ☐ FEED THROUGH LUGS ☐ FLUSH ☐ 600KCM LUGS ☐ ISOLATED GROUND BUS G = GFI BREAKER															

480Y/277VOLT
42k A.I.C.
3 PHASE - 4 WIRE

LP-N

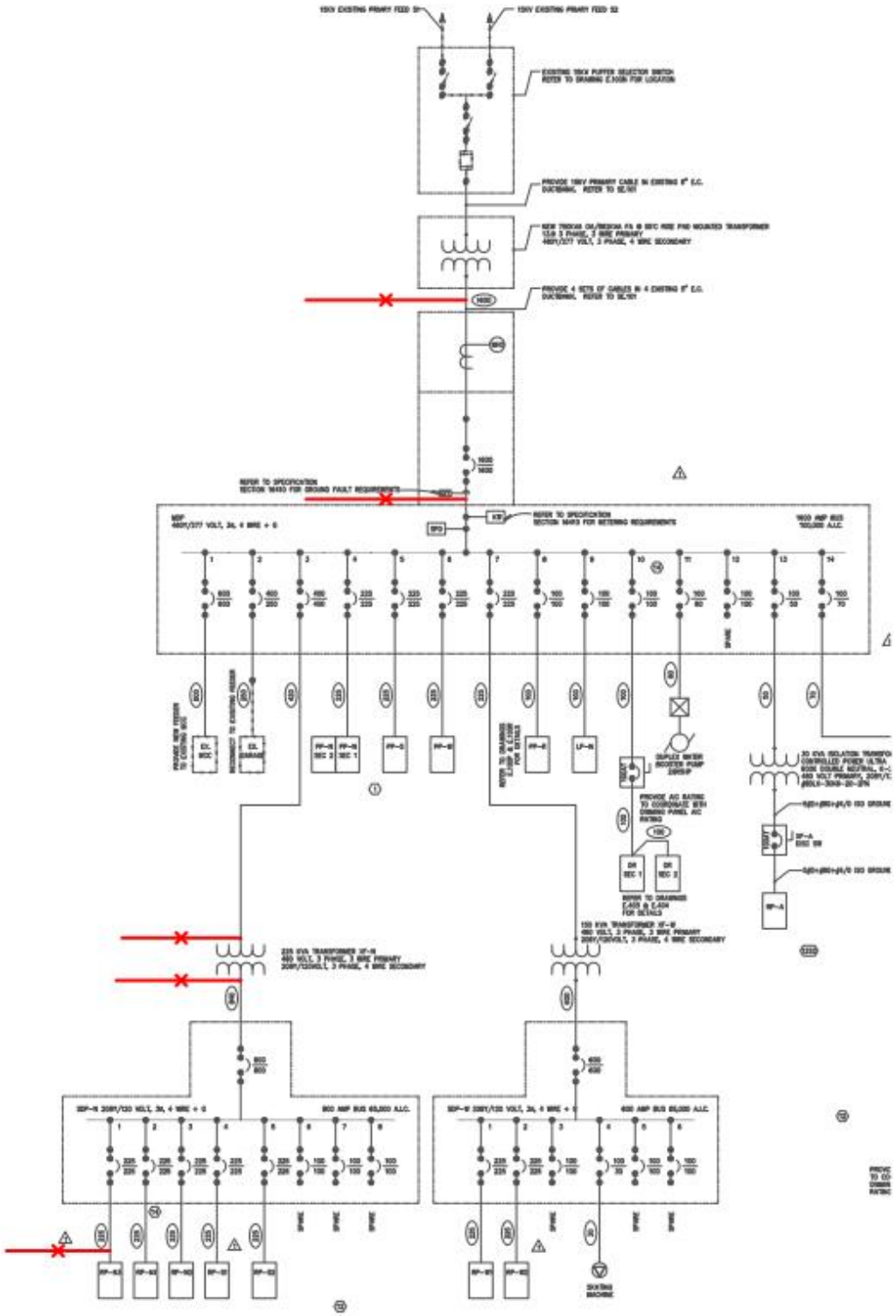
BUS: 100 AMP
MAIN: 100 AMP CB

	LOAD SERVED	WIRE SIZE	TRIP	LOAD IN KVA ΘA		ΘB		ΘC		TRIP	WIRE SIZE	LOAD SERVED	
1	Lower Level Lighting	2#12+G - 3/4"C.	20	1.52	0.69					20	2#12+G - 3/4"C.	Upper Level Bathrooms	2
3	SPARE	2#12+G - 3/4"C.	20			0.00	0.30			20	2#12+G - 3/4"C.	North Entrance Lighting	4
5	Exterior South Lighting	2#12+G - 3/4"C.	20					0.50	0.50	20	2#12+G - 3/4"C.	Interior South Lighting	6
7	Pole Lighting	2#12+G - 3/4"C.	20	2.03	1.58					20	2#12+G - 3/4"C.	Pole Lighting	8
9	Ramp Lighting	2#12+G - 3/4"C.	20			0.50	0.47			20	2#12+G - 3/4"C.	South Lower Lighting	10
11	South Lower Lighting	2#12+G - 3/4"C.	20					2.49	3.33	20	2#12+G - 3/4"C.	West Lighting	12
13	West Lighting	2#12+G - 3/4"C.	20	2.99	1.47					20	2#12+G - 3/4"C.	Team Lounge	14
15	Time Clock	2#12+G - 3/4"C.	20			0.50	0.63			20	2#12+G - 3/4"C.	**Schley Room**	16
17	**Exterior Spine**	2#12+G - 3/4"C.	20					3.23	3.23	20	2#12+G - 3/4"C.	**Exterior Spine**	18
19	**Exterior Perimeter**	2#12+G - 3/4"C.	20	1.44	1.44					20	2#12+G - 3/4"C.	**Exterior Perimeter**	20
21	**Exterior Perimeter**	2#12+G - 3/4"C.	20			1.72	1.72			20	2#12+G - 3/4"C.	**Exterior Perimeter**	22
23	**Exterior Perimeter**	2#12+G - 3/4"C.	20					0.34	0.34	20	2#12+G - 3/4"C.	**Exterior Perimeter**	24
25			20							20			26
27			20							20			28
29			20							20			30
31			20							20			32
33			20							20			34
35			20							20			35
		LOAD PER PHASE		13.16		5.84		13.96					
		TOTAL =		**32.96 KVA**							**38AMPS**		

The total load in KVA for each adjusted panelboard is less than the original design. Therefore, resizing the feeder is unnecessary considering the original feeder was sized to the meet the requirements.

Electrical II | Short Circuit Analysis

Fault current is analyzed at five points in building electrical system as shown below.



Following Cooper *Bussmann*'s basic point to point calculation procedure for three-phase short circuits, the level of fault current at primary and secondary transformer is calculated and evaluated. As a result, the fault current protection for MDP and SDP switchboard are effectively rated to prevent overcurrent and short circuit conditions.

Transformer to MDP

Fault X_1

KVA	E_{L-L}	$I_{F.L.A.}$	%Z	Multiplier	$I_{S.C}$
750	480	902.14	3.5	28.57	25775.32

Fault X_2

L	C	n	f	M	$I_{S.C.sym.RMS}$
65	22965	4	0.0658	0.9383	24183.77

MDP to XF-N

L	$I_{3Ø}$	C	n	E_{L-L}	f	M	$I_{S.C.sym.RMS}$	MDP
2	24183.77	22965	1	208	0.0175	0.9828	23766.95	100000 A.I.C

XF-N to RP

Fault X_3

$I_{S.C.primary}$	$V_{primary}$	%Z	$V_{transformer}$	f	M	$I_{S.C.secondary}$
23766.95	480	1.2	225	1.0538	0.4869	26704.94

L	$I_{S.C.secondary}$	C	n	E_{L-L}	f	M	$I_{S.C.sym.RMS}$	SDP
17	26704.94	15082	1	208	0.2506	0.7996	21352.86	65000 A.I.C

Electrical III | Copper vs. Aluminum Feeder Analysis

|Introduction

Copper wires are known as a stable and powerful conductor to the electrical industry. Because of its long life and resistance to damage, the price of it tends to be high. Aluminum wires on the other hand, is significantly less expensive, however are more vulnerable to corrosion. Recent research shows that despite the difference in stability, the performance of aluminum wires is in some way under-rated. The performance of equipment with aluminum conductors, which often times is questioned by clients, is in fact similar to that of copper conductors in commercial buildings. Most importantly, the equipment with aluminum will significantly weigh less than the same equipment with copper. The unit cost of material and labor will be another significant factor when distance between equipment is comparatively long.

This electrical breadth contains detailed cost analysis between the applications of original copper versus proposed aluminum conductors on building electrical systems. According to industry recommendation, all wiring at 1/0 or larger are resized to copper conductors since installing smaller conductors tends to become more expensive. *RS Means Electrical Cost Data 2014* was used as reference for cost of conductors and conduit. Wires are resized based on *NEC 2011*.

|Cost Analysis

Copper

Tag	From	To	Length	No. of sets	Conduit (Per Set)			Conductors								Total Cost
								Phase Conductors				Ground Conductors				
					Size	Type	Cost/LF	No.	Size	Type	Cost/LF	No.	Size	Type	Cost/LF	
1	Service Transformer	MDP	65	4	4"	EMT	26	16	600	XHHW-2	54.25	4	4	THHN/THWN	5.68	64656.8
2	MDP	EX. MCC	27	2	3"	EMT	19.6	8	350	XHHW-2	40.25	2	1	XHHW-2	6.83	10121.22
3		EX. GARAGE	16	1	2 1/2"	EMT	16.65	4	250	XHHW-2	32.15	1	4	THHN/THWN	5.68	2414.88
4		PP - N	12	1	2 1/2"	EMT	16.65	4	4/0	XHHW-2	27.05	1	4	THHN/THWN	5.68	1566.36
5		PP - S	195	1	2 1/2"	EMT	16.65	4	4/0	XHHW-2	27.05	1	4	THHN/THWN	5.68	25453.35
6		PP - W	195	1	2 1/2"	EMT	16.65	5	4/0	XHHW-2	27.05	1	4	THHN/THWN	5.68	30728.1
7	MDP	XF - N	2	1	4"	EMT	26	4	600	XHHW-2	54.25	1	2/0	XHHW-2	7.76	501.52
8	XF-N	SDP - N	2	2	4"	EMT	26	8	600	XHHW-2	54.25	2	2/0	XHHW-2	7.76	1003.04
9	SDP - N	RP - N3	15	1	2 1/2"	EMT	16.65	4	4/0	XHHW-2	27.05	1	4	THHN/THWN	5.68	1957.95
10		RP - N1	129	1	2 1/2"	EMT	16.65	4	4/0	XHHW-2	27.05	1	4	THHN/THWN	5.68	16838.37
11		RP - N2	118	1	2 1/2"	EMT	16.65	4	4/0	XHHW-2	27.05	1	4	THHN/THWN	5.68	15402.54
12		RP - S1	240	1	2 1/2"	EMT	16.65	4	4/0	XHHW-2	27.05	1	4	THHN/THWN	5.68	31327.2
13		RP - S2	188	1	2 1/2"	EMT	16.65	4	4/0	XHHW-2	27.05	1	4	THHN/THWN	5.68	24539.64
14	MDP	XF - W	190	1	2 1/2"	EMT	16.65	4	4/0	XHHW-2	27.05	1	4	THHN/THWN	5.68	24800.7
15	XF - W	SDP - W	9	2	3"	EMT	19.6	8	350	XHHW-2	40.25	2	1	XHHW-2	6.83	3373.74
16	SDP - W	RP - W1	3	1	2 1/2"	EMT	16.65	4	4/0	XHHW-2	27.05	1	4	THHN/THWN	5.68	391.59
17		RP - W2	142	1	2 1/2"	EMT	16.65	4	4/0	XHHW-2	27.05	1	4	THHN/THWN	5.68	18535.26
															Total	273612.3

Aluminum

Tag	From	To	Length	No. of sets	Conduit (Per Set)			Conductors								Total Cost
								Phase Conductors				Ground Conductors				
					Size	Type	Cost/LF	No.	Size	Type	Cost/LF	No.	Size	Type	Cost/LF	
1	Service Transformer	MDP	65	8	4"	EMT	26	32	500	XHHW	26.24	4	4	THHN/THWN	4.82	69352.4
2	MDP	EX. MCC	27	2	2 1/2"	EMT	16.65	8	400	XHHW	19.92	2	2/0	XHHW-2	6.29	5541.48
3		EX. GARAGE	16	1	2 1/2"	EMT	16.65	4	350	XHHW	16.43	1	2	THHN/THWN	5.24	1401.76
4		PP - N	12	1	2 1/2"	EMT	16.65	4	300	XHHW	16.43	1	4	THHN/THWN	4.82	1046.28
5		PP - S	195	1	2 1/2"	EMT	16.65	4	300	XHHW	16.43	1	4	THHN/THWN	4.82	17002.05
6		PP - W	195	1	2 1/2"	EMT	16.65	5	300	XHHW	16.43	1	4	THHN/THWN	4.82	20205.9
7	MDP	XF - N	2	2	4"	EMT	26	8	500	XHHW	26.24	1	2/0	XHHW-2	6.29	536.42
8	XF-N	SDP - N	2	2	4"	EMT	26	8	500	XHHW	26.24	2	2/0	XHHW-2	6.29	549
9	SDP - N	RP - N3	15	1	2 1/2"	EMT	16.65	4	300	XHHW	16.43	1	4	THHN/THWN	4.82	1307.85
10		RP - N1	129	1	2 1/2"	EMT	16.65	4	300	XHHW	16.43	1	4	THHN/THWN	4.82	11247.51
11		RP - N2	118	1	2 1/2"	EMT	16.65	4	300	XHHW	16.43	1	4	THHN/THWN	4.82	10288.42
12		RP - S1	240	1	2 1/2"	EMT	16.65	4	300	XHHW	16.43	1	4	THHN/THWN	4.82	20925.6
13		RP - S2	188	1	2 1/2"	EMT	16.65	4	300	XHHW	16.43	1	4	THHN/THWN	4.82	16391.72
14	MDP	XF - W	190	1	2 1/2"	EMT	16.65	4	300	XHHW	16.43	1	4	THHN/THWN	4.82	16566.1
15	XF - W	SDP - W	9	2	2 1/2"	EMT	16.65	8	400	XHHW	19.92	2	2/0	XHHW-2	6.29	1847.16
16	SDP - W	RP - W1	3	1	2 1/2"	EMT	16.65	4	300	XHHW	16.43	1	4	THHN/THWN	4.82	261.57
17		RP - W2	142	1	2 1/2"	EMT	16.65	4	300	XHHW	16.43	1	4	THHN/THWN	4.82	12380.98
															Total	206852.2

Copper Feeders	$273,612.30
Aluminum Feeders	$206,852.20
Savings	$66,760.10

Conclusion

As shown above, replacing the copper feeders with aluminum feeders can save approximately $66,760 (24%) of the original material and labor cost. Along with lower cost, aluminum also has multiple profits such as higher amperage capability per weight and better flexibility. These characteristics are most beneficial when making connections across long distance. Problems with oxidation and durability can be easily solved today by using the proper installation methods and incorporating special accessories. The alternative copper material is evidently an economical and effective solution to the building electrical system design.

Breadth Topic I | Acoustic – Reverberation Time Study

|Introduction

This acoustic breadth contains the reverberation time calculation for original and proposed changes of ground floor of David S. Ingalls Rink with supporting documents. The reverberation time of the original and proposed acoustical design was calculated based on the ceiling, wall, floor materials and space dimensions. The space is composed of concrete floors and walls, hardwood seating and oak wood ceiling. To improve the acoustical system qualities, a new wood acoustic ceiling material was proposed in replacement of the original oak wood ceiling.

|Background

When a sound wave is produced, it travels in various directions and strikes the surfaces within the space. From which portion of the sound will get absorbed by the surface it reaches, and the rest will get reflected and re-reflected. The total energy of sound will eventually be completely depleted within several bounces. Characteristic of reflection and absorption are measured by degree of sound absorption in a space. Using material sound absorption coefficient and room surface areas, reverberation time of a space can be calculated and evaluated for acoustic analysis.

For ice rinks, the most significant acoustical parameter is the reverberation time, which should be low enough to enable clear understandable speaking for spectators and music for performers. High quality acoustic system performs helps engaging the spectators more closely in the action of the games and figure skaters to keep up with music. Reflective surfaces such as hardwood seating, concrete walls and ice surface can cause sound to bounce around space, creating echoes. Combining this with cheering from the crowd, it can make speech very difficult to be heard. Oftentimes, the rink sound problems are solved by installing powerful hardware with bigger amplifiers at louder sound levels. The problem to this solution is that the system will waste energy and the sound is still delayed. Therefore, one other possibility comes into play where a change in room surface materials can aid the acoustical problem by the time sound wave hits the surface.

|Room Finish

Surface Description	Material Description	Sound Absorption Coefficient, α					
		Frequency (Hz)					
		125	250	500	1000	2000	4000
Wall_Concrete	Unfinished concrete	0.010	0.020	0.040	0.060	0.080	0.100
Wall_Glass	Glass, large panels	0.180	0.060	0.040	0.030	0.020	0.020
Corridor_Floor	Sealed Concrete	0.010	0.010	0.010	0.020	0.020	0.020
Ceiling	Oak wood	0.240	0.190	0.140	0.080	0.130	0.100
Ceiling	Plaster	0.140	0.120	0.080	0.060	0.060	0.060
People - Seats	Seating, empty, wood	0.080	0.110	0.150	0.160	0.180	0.200
Rink_Floor	Sealed Concrete	0.010	0.010	0.010	0.020	0.020	0.020

|Reverberation Time Analysis

Reverberation time can be calculated using the following two equations:

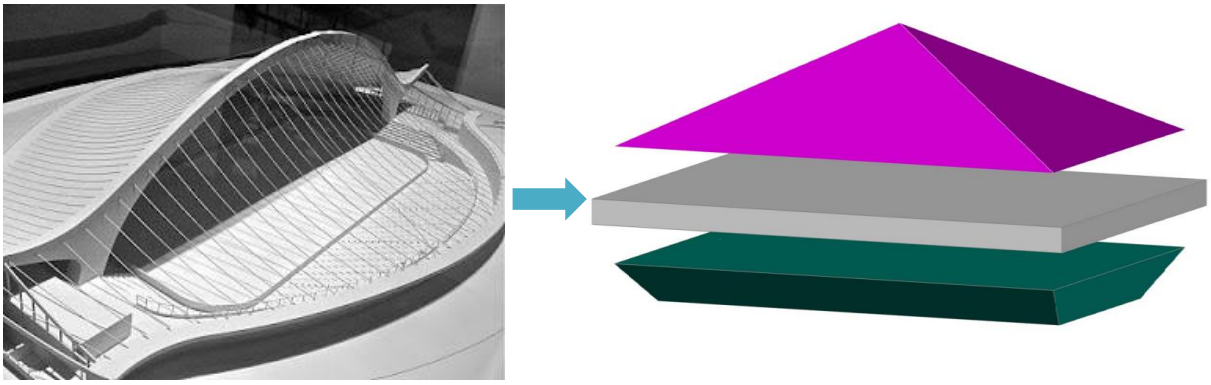
Sabine(Avg.α≤0.2) : $T = \frac{0.161V}{S\bar{\alpha}}$ **Norris Eyring(Avg.α>0.2) :** $T = \frac{0.161V}{-\sum_i S_i \ln(1-\alpha_{Ei})}$

Where V = room volume in ft^3

S= Room surface areas

ā = average absorption coefficients

With simplified geometry, the building overall volume is calculated as V = 1,657,203 ft^3



Original Reverberation Time Calculation:

Surface Description	Surface Area, S (ft^2)	S*α (sabins)					
		Frequency (Hz)					
		125	250	500	1000	2000	4000
Wall_Concrete	6789.50	67.90	135.79	271.58	407.37	543.16	678.95
Wall_Glass	1600.00	288.00	96.00	64.00	48.00	32.00	32.00
Corridor_Floor	8044.00	80.44	80.44	80.44	160.88	160.88	160.88
Ceiling	43317.00	10396.08	8230.23	6064.38	3465.36	5631.21	4331.70
Ceiling	5895.00	825.30	707.40	471.60	353.70	353.70	353.70
People - Seats	20011.17	1600.89	2201.23	3001.68	3201.79	3602.01	4002.23
Rink_Floor	18669.00	186.69	186.69	186.69	373.38	373.38	373.38
	ΣSα=	13445.30	11637.78	10140.37	8010.48	10696.34	9932.84
	Avg. α=	0.13	0.11	0.10	0.08	0.10	0.10
Air absorption constant for 20°C and 40% RH, m		0.00	0.00	0.00	0.00	0.00	0.00
Sabine Reverb Time: (s)	RT=	6.04	6.98	7.15	7.98	5.10	3.02
Norris-Eyring Reverb Time: (s)	RT=	5.64	6.58	6.83	7.74	4.92	2.96
Calculated RT (s)		6.04	6.98	7.15	7.98	5.10	3.02

With the building geometry and its surface finish material, the original reverberation time of ground floor at 500 Hz which sound wave is mostly produced critically exceeds the recommended reverberation time (2-3s) for ice arenas.

Considering the historical importance of the building, the proposed acoustical solution has a minimum effect on the building interior appearance. The original oak wood ceiling is replaced with *Acoustical Solutions* wood plank style wall treatment featuring a series of grooves and slots to achieve the satisfactory acoustic results. The material has NRC ratings up to 0.85`` with overlap edge s to create the original monolithic finished look. There are adequately amount of veneer material to choose from for achieving desirable architectural appearances.

Proposed Reverberation Time Calculation:

Surface Description	Surface Area, S (ft^2)	S*α (sabins)					
		Frequency (Hz)					
		125	250	500	1000	2000	4000
Wall_Concrete	6789.50	67.90	135.79	271.58	407.37	543.16	678.95
Wall_Glass	1600.00	288.00	96.00	64.00	48.00	32.00	32.00
Corridor_Floor	8044.00	80.44	80.44	80.44	160.88	160.88	160.88
Ceiling	43317.00	34220.43	38985.30	35086.77	41151.15	42883.83	42883.83
Ceiling	5895.00	825.30	707.40	471.60	353.70	353.70	353.70
People - Seats	20011.17	1600.89	2201.23	3001.68	3201.79	3602.01	4002.23
Rink_Floor	18669.00	186.69	186.69	186.69	373.38	373.38	373.38
	ΣSα=	12145.79	31130.43	53890.54	53926.50	39285.56	8243.48
	Avg. α=	0.12	0.30	0.52	0.52	0.38	0.08
Air absorption constant for 20°C and 40% RH, m		0.00	0.00	0.00	0.00	0.00	0.00
Sabine Reverb Time: (s)	RT=	2.18	1.92	2.01	1.70	1.53	1.24
Norris-Eyring Reverb Time: (s)	RT=	1.76	1.49	1.61	1.30	1.17	0.99
Calculated RT (s)		1.76	1.49	1.61	1.30	1.17	0.99

|Conclusion

The original reverberation time far exceeded the recommendation values due to the large space volume and high reflective surface material furnish. With proposed change in ceiling material, the rink acoustic performance in reverberation time at low, mid and high frequency is significantly improved while the interior appearance is effectively preserved. The low and high frequency reverberation time are effectively controlled with sealed air space behind the panels. Furthermore, acoustical problem at high frequency can be improved by installing additional insulation such as fiber glass above the wooden acoustic ceiling with openings to further absorb the sound. In addition, the overall acoustic performance of reverberation field will be improved when the rink is occupied since cloth fabrics are also example of sound absorptive material.

Breadth Topic II | Architectural + Structural Façade Study

|Introduction

For this breadth topic, the building façade is studied in both architectural and structural aspect. For architectural topic, detailed research was conducted for information regarding Saarinen's architectural design beliefs and his famous architectural projects. A propose in mullion material was stated regarding material stability and durability. For structural topic, windward and leeward wind analysis is conducted for building front and back entrances. Load resistance is calculated following procedures in ASTM E-1300 for existing glass curtain walls to examine the resistivity of wind load.

|Material

For Saarinen, the hybrid materiality of architectural always takes role as an important and complex part of his design. Throughout his practice, complex material selections has played an essential role in his success – staring from combination of steel and concrete of (*the Gateway Arch in St. Louis*), transitioned into the steel alone (*General Motors Technical Center*), then into the concrete (*the Kresge Auditorium at MIT*), into a combination of wood and concrete with steel cables (*David S. Ingalls Rink*), back to concrete (*the TWA Terminal*), and finally to the most complex hybrid of all materials (*Dulles International Airport*). To him, material, materiality, and materialism are a string of associations that leads people to the nature essence and the soul of the architectural construction.

David S. Ingalls Rink is well-known for her dramatic appearance and structural spine. When Saarinen was designing the building, he wanted it to be a projection of Yale University's contemporary academic pursuits. The concrete and wood material used improvises the stability and elegance to the overall building appearance and sense. The curtain wall façade has a wooden frame which is not common for the New England area due to heavy snow. The wood and glazing façade was replaced and repaired during the renovation taken in 2009. Under the weather circumstance, wood is not the ideal material due to its nature of erosion under humidity. Saarinen is always careful with material selections for his belief in materiality; in this case, wooden frame was chosen to echo the wood roof material. Given that the building has a deep canopy of 14' over the building façade, most of the snow will be prevented from reaching towards the mullion.

|Wind Analysis

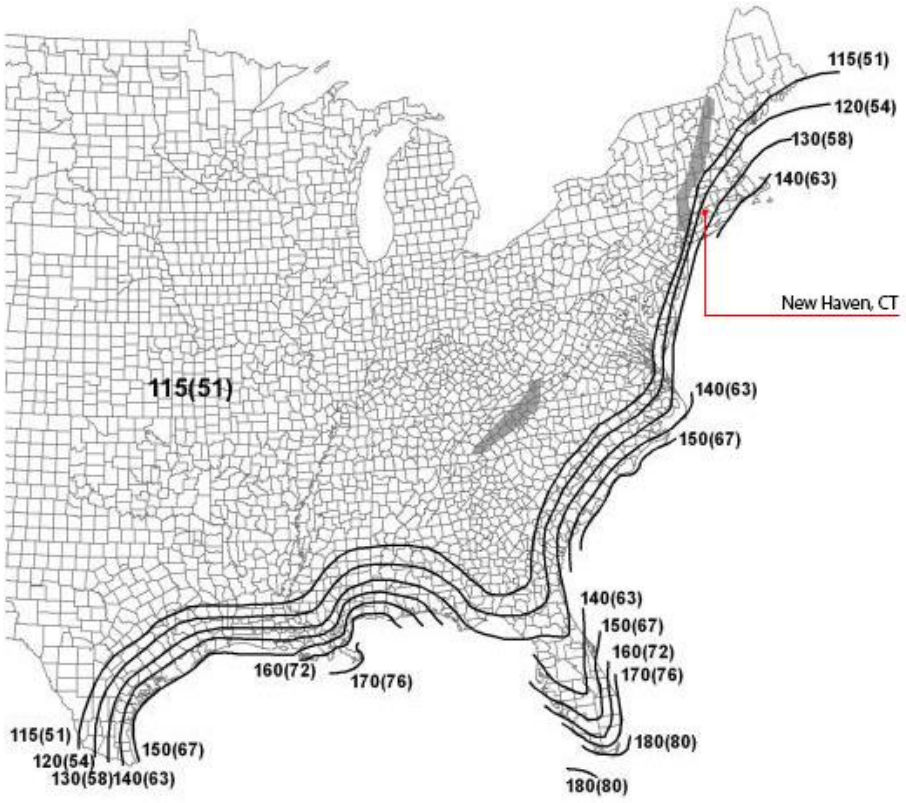
All steps of wind analysis for David S. Ingalls Rink follow procedures from *ASCE 7-10 Table 27.1: Steps to Determine MWDRS Wind Loads for Enclosed, Partially Enclosed and Open Buildings of all Heights.*

Step 1: Determine risk category of building or other structure

Use of Occupancy of Buildings and structures	Risk Category
All Buildings and other structures except those listed in Risk Categories I, III, and IV	II

ASCE 7-10 Table 1.5-1

Step 2: Determine the basic wind speed, V, for the applicable risk Category



ASCE 7-10 Figure 26.5-1

- According to Figure 26.5 – 1A, New Haven, CT has a wind load of 130 Vmph (58 m/s)

Step 3: Determine wind load parameters

K_d	K_{zt}	G	GC_{pi}
0.85	1	0.85	± 0.18

ASCE 7-10 Section 26

Note:

- Considering overall roof geometry, the building roof is assumed to be arched ->Wind Directionality Factor (K_d) = 0.85. (*ASCE 7-10 Table 26.6-1)*
- Considering surrounding neighborhood and mean roof height (65' above grade), David S. Ingalls Rink belongs to Surface Roughness B and Exposure Category B. (*ASCE 7-10 Section 26.7)*
- The Gust Effect Factor(G) = 1 for rigid buildings.
- The internal pressure coefficient (GC_{pi}) = ± 0.18 for fully enclosed buildings.
- Plus and minus signs for internal pressure coefficient signify pressures acting toward and away from the internal surfaces, respectively.

Step 4: Determine velocity pressure exposure coefficient

Height Above	Exposure B

60ft	K_h = 0.89

ASCE 7-10 Table 27.3 -1

Exposure	α	z	z_g	k_z
B	7	65	1200	0.87

ASCE 7-10 Table 26.9- 1

Step 5: Determine velocity pressure

$$q_z = 0.00256 k_z k_{zt} k_d V^2$$

ASCE 7-10 Eq. 27.3 -1

k_h	k_z	K_{zt}	K_d	V	q_h	q_z
0.89	0.87	1	0.85	130	32.73	31.99

Step 6: External pressure coefficient

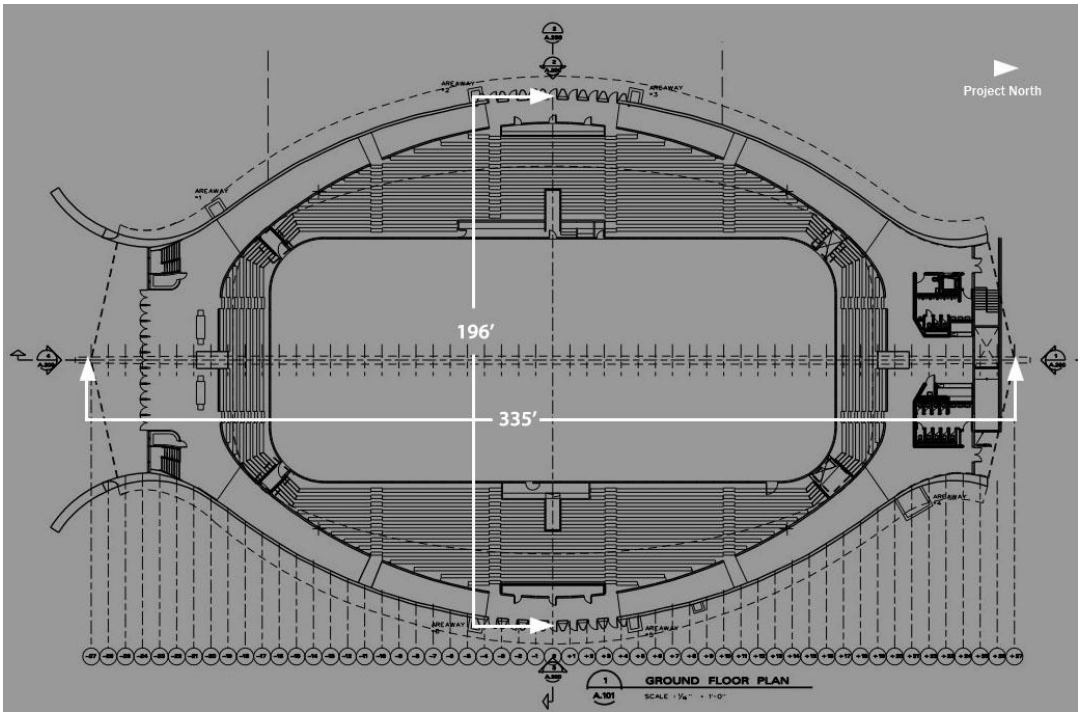
Surface	L/B	C_p	Use With
Windward Wall	All Values	0.8	q_z
Leeward Wall	N-S = 1.7	-0.3	q_h

ASCE 7-10 Table 27.4 -1

Note:

- B: Horizontal dimension of building, in feet, measured normal to wind direction.
- L: Horizontal dimension of building, in feet, measure parallel to wind direction.

- For analyzing building entrances, leeward wind pressure will be analyzed in north – south direction.



Step 7: Calculate wind pressure on building surface

$$P = qGC_p - q_i(GC_{pi}) \ (lb/ft^2)$$

ASCE 7-10 Eq.27.4 -1

Wind pressure on walls for David S. Ingalls Rink in longitudinal direction can be analyzed as indicated below:

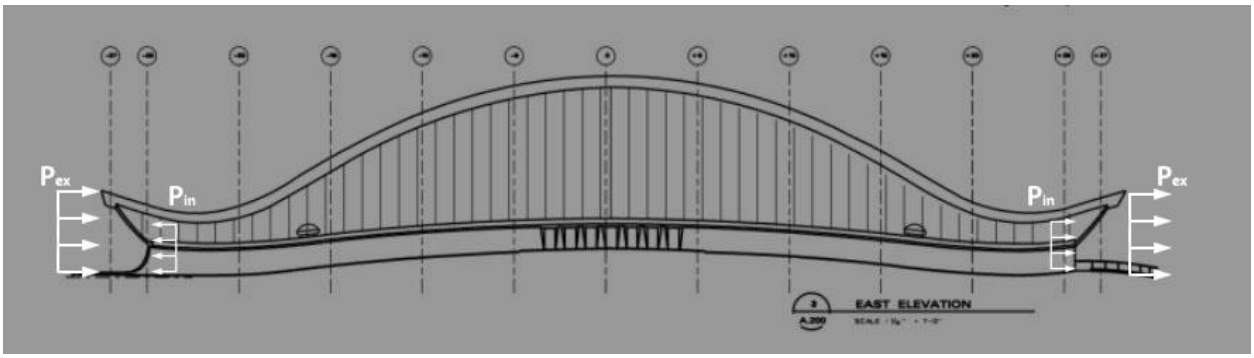


Figure 62 – Wind Pressure Building Section

Windward (Building Façade)

q_z	G	C_p	q_h	GC_{pi}	P(lb/ft^2)
31.99	0.85	0.8	32.73	0.18	15.86

Leeward (Building Façade)

q_h	G	C_p	q_h	GC_{pi}	P(lb/ft^2)

32.73	0.85	-0.3	32.73	0.18	-14.24

| Glazing Study

In order to pick the glazing type with proper thickness, window unit with the largest area will be analyzed for getting the optimum solution.

- Existing Condition

Glass Type	Location	Description	Components
AT	North & South entries - Glazed Walls	Insulating glass unit of nominal 1-1/8" overall thickness	Outer light - 5/16" clear fully tempered glass with low emissivity coating on no.2 surface
			Air Space - 1/2"
			Inner light - 5/16" clear fully tempered glass
BL	North & South entries - Glazed Doors	Laminated glass unit of nominal 5/16" overall thickness	1/8" clear heat strengthened glass
			0.060" clear PVB interlayer
			1/8" clear heat strengthened glass
CL	South entry	Insulating glass unit of nominal 1-1/8" overall thickness	Outer light - 5/16" laminated glass(type BL) with low emissivity coating on no.2 surface
			Air Space - 1/2"
			Inner light - 5/16" laminated glass(type BL)
CLO	North and South Entry	Insulating glass unit of nominal 1-1/8" overall thickness	Outer light - 5/16" laminated glass(type BL)
			Air Space - 1/2"
			Inner light - 5/16" laminated glass(type BL) with ceramic frit opacifer on no. 3 surface

Table xxx– Glass Type Schedule

Geometry

Glass Type	Length	Width
AT	10'	5'2
BL	5'9	1'8
CL	7'7	5'2
CLO	7'7	5'2

Table xxx– Building Entrances Glazing Geometry

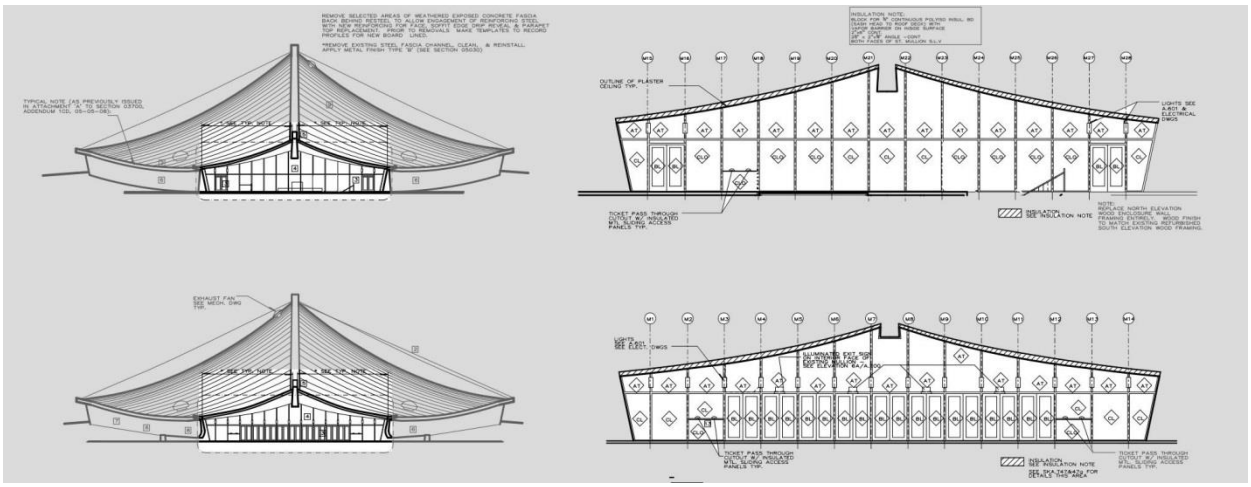


Figure xxx – Building Entrances

Load Resistance Determination

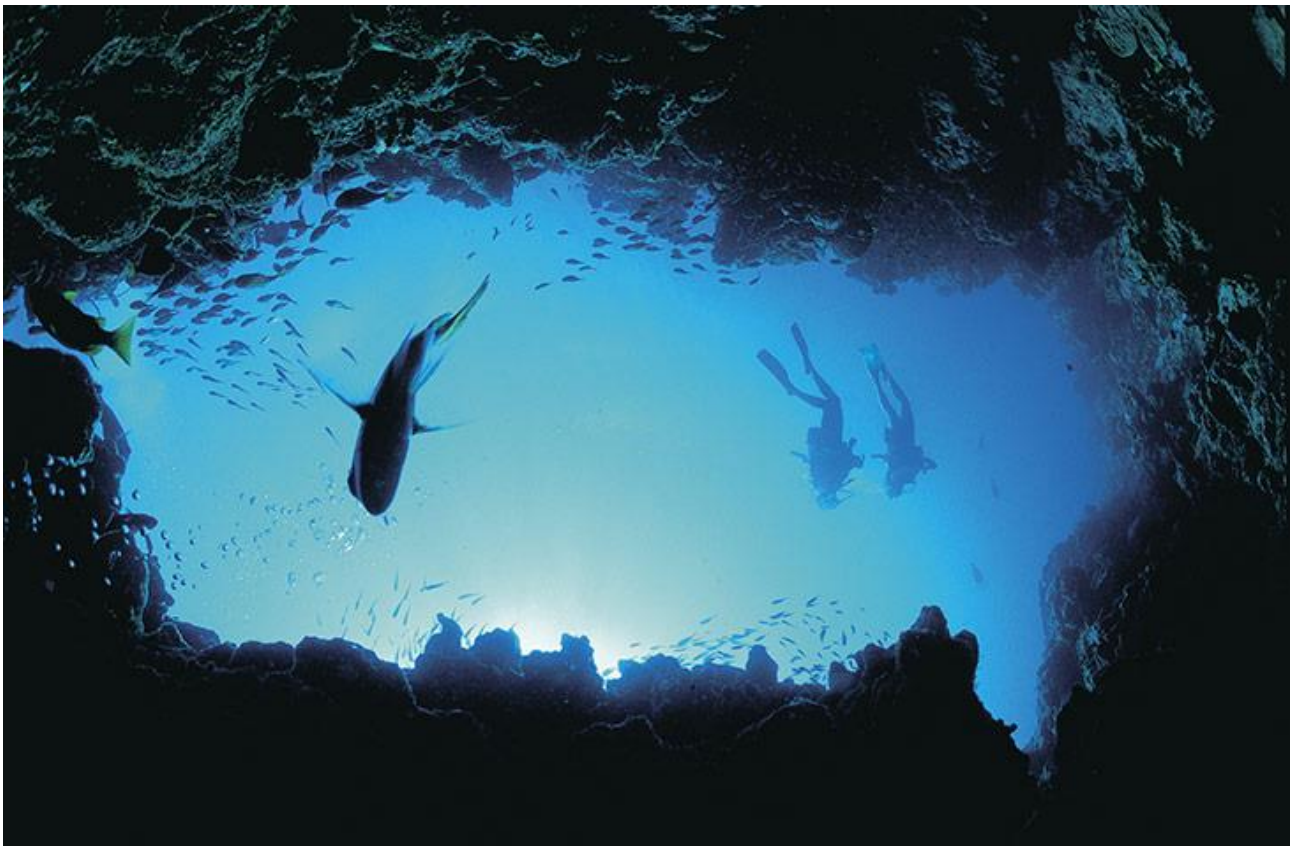
All steps of Glazing LR analysis for David S. Ingalls Rink follow procedures from *ASTM E1300 – 12a: Standard Practice for Determining Load Resistance of Glass in Buildings.*

Glass Type	Type	NFL	Short Duration			Long Duration			lb/ft^2
			GTF	LS	LR	GTF	LS	LR	
AT	5/16" tempered glass	1.4	3.6	2	10.08	2.85	2	7.98	166.6224
BL	1/8" heat strengthened glass	2.5	1.8	2	9	1.25	2	6.25	130.5
CL	5/16" laminated glass	1.7	1.8	2	6.12	1.25	2	4.25	88.74
CLO	5/16" laminated glass	1.7	1.8	2	6.12	1.25	2	4.25	88.74

|Conclusion

The glazing analysis above shows that the glass type used for building façade effectively resists windward and leeward load with building surroundings construction materials.

Conclusion



The works presented in this thesis represents an in-depth study of the overall architecture and engineering systems of David S. Ingalls Rink. The new proposed lighting system enhanced the overall visual appearance and energy usage of each designed space, with an underlying story of journey on the whale back. Building electrical system was analyzed to support changes made in lighting system. The structural and acoustic analysis was performed to analyze and evaluate on aspect of stability and hearing perceptions. By integrating all elements of architecture and egineering within the building, the new proposed design for each building system is engaged together for human body to react and experience, which leads to a sensation of being part of the whole both physically and emotionally.

Reference

Software Used:

AutoCAD 2013

AGI 32

Adobe Photoshop CS6

Microsoft Office

Work Sited

▪Mehta, M., Johnson, J., & Rocafort, J. (2010). *Archietectural Acoustics.* Madan Mehta.

▪Nichols, L. (2009). Improving Efficiency in Ice Hockey Arenas. *ASHRAE*, 17.

▪Charest, Adrian C. *RSMeans Electrical Cost Data 2014*. Norwell, MA: RSMeans, 2013. Print.

▪DiLaura, David L. *The Lighting Handbook: Reference and Application*. New York, NY: Illuminating Engineering Society of North America, 2011. Print.

▪Dykes, Michael. "David S. Ingalls Hockey Arena." *David S*. N.p., n.d. Web. 09 Apr. 2014.

▪Gilson, De Long David, C. Ford. Peatross, and Eero Saarinen. *Eero Saarinen: Buildings from the Balthazar Korab Archive*. New York: W.W. Norton, 2008. 462-63. Print.

▪Margolius, Ivan. "Eero Saarinen, Fred N. Severud, Hannskarl Bandel, Jefferson Memorial Arch." *Architects Engineers = Structures: A Book That Celebrates Well-known Designers Paxton, Torroja, Nervi, Saarinen, Buckminster Fuller, Le Corbusier, Niemeyer, Arup, Hunt and Foster, and the Lesser-known Such as Polivka, Glickman, Kornacker, Cardozo, Zetlin and Strasky*. Chichester, West Sussex: Wiley-Academy, 2002. 45. Print.

▪Mehta, Madan, James Johnson, and Jorge Rocafort. "Sound Absorbing Materials." *Architectural Acoustics: Principles and Design*. Upper Saddle River, NJ: Prentice Hall, 1999. N. pag. Print.

▪*NFPA 70-2011: National Electrical Code, 2011*. Quincy, MA: National Fire Protection Association, 2010. Print.

▪Saarinen, Eero, Eeva-Liisa Pelkonen, and Donald Albrecht. *Eero Saarinen: Shaping the Future*. New Haven: Yale UP, 2006. Print.

▪Simiu, Emil, and Emil Simiu. *Design of Buildings for Wind: A Guide for ASCE 7-10 Standard Users and Designers of Special Structures*. Hoboken, NJ: Wiley, 2011. Print.

▪*Standard Practice for Determining Load Resistance of Glass in Buildings*. West Conshohocken, PA: ASTM International, 2009. Print.

Image Credit

▪**Yale Manuscript and Archives**

▪ **Michael Marsland Photography**

▪ Jodi Frediani Photography

▪ Hiroshi Iwasaki Photography

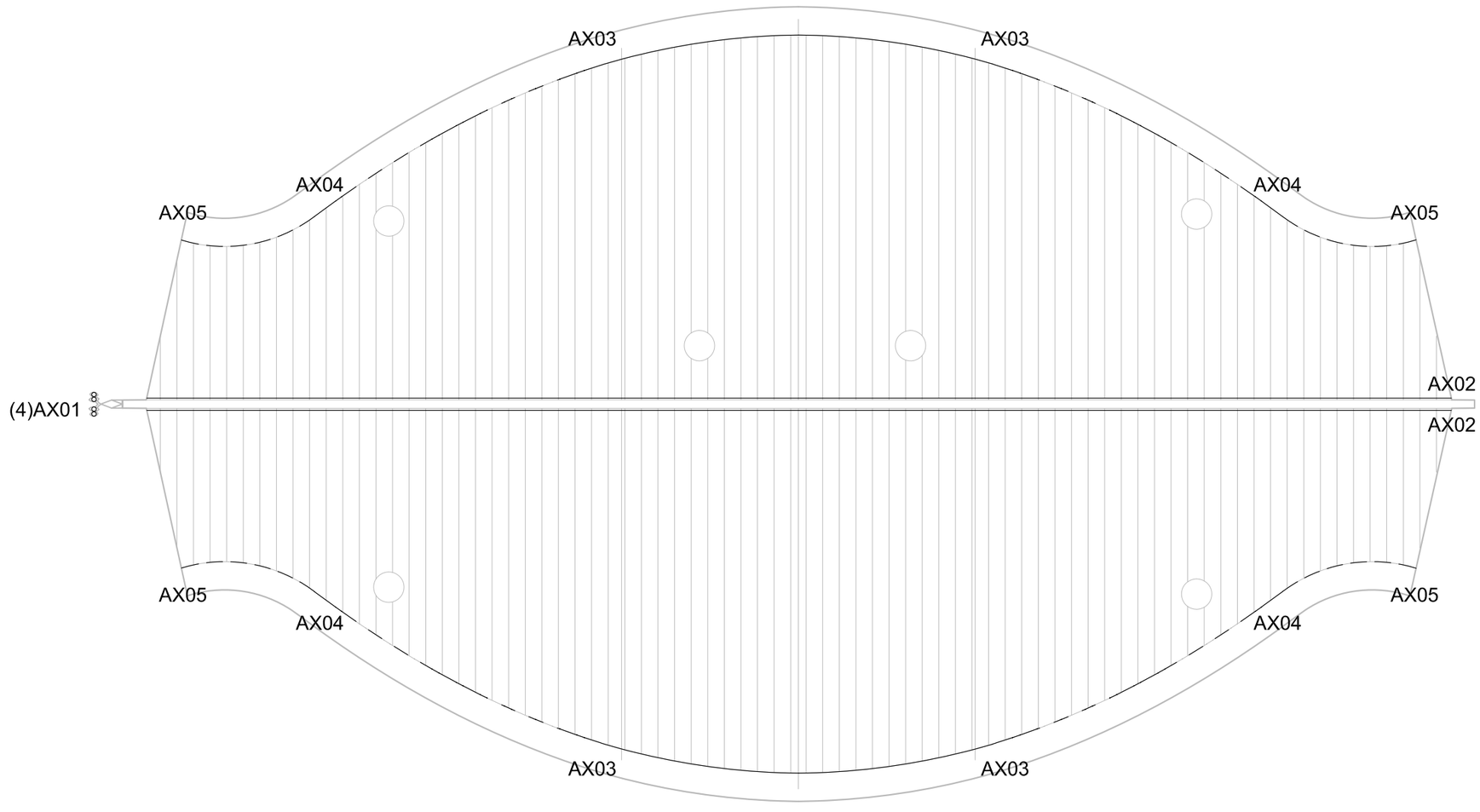
▪ *Ocean Portal*. (n.d.). Retrieved 11 2013, from Seagrass and Seagrass Beds: http://ocean.si.edu/seagrass-and-seagrass-beds

▪ *Photocase*. (2004, 10 18). Retrieved 11 2013, from http://www.photocase.de/foto/32371-stock-photo-meer-blau-fisch-malediven-haifisch

▪ *The Guardian*. (2011, 11 4). Retrieved 11 2013, from Experience Western Australia: http://www.theguardian.com/experience-western-australia/gallery/the-best-of-the-west-in-pictures

Appendix A

Technical Drawings



PENNSYLVANIA STATE UNIVERSITY

DEPARTMENT OF ARCHITECTURAL ENGINEERING
LIGHTING/ELECTRICAL OPTION

SENIOR THESIS
SPRING 2014

KEVIN ROCHE JOHN DINKELOO
AND ASSOCIATES LLC
20 DAVIS STREET HAMDEN, CT

ATELIER TEN CONSULTING ENGINEERS
195 CHURCH STREET, NEW HAVEN, CT

SEVERUD ASSOCIATE
CONSULTING ENGINEERS P.C.
469 7th AVE NEW YORK, NY

ALTIERI SEBOR WIEBER LLC
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TOWERS GOLD
85 WILLOW STREET NEW HAVEN, CT

TIGHE & BOND
1000 BRIDGEPORT AVE, SUITE 320
SHELTON, CT

HENRY J. COUPE ASSOCIATES Inc.
P.O. BOX 9510, WARWICK, RI

PROJECT NAME

David S. Ingalls Rink

BUILDING NAME & ADDRESS

DAVID S. INGALLS RINK

73 SACHEM STREET, NEW HAVEN, CT 06510

DRAWING TITLE

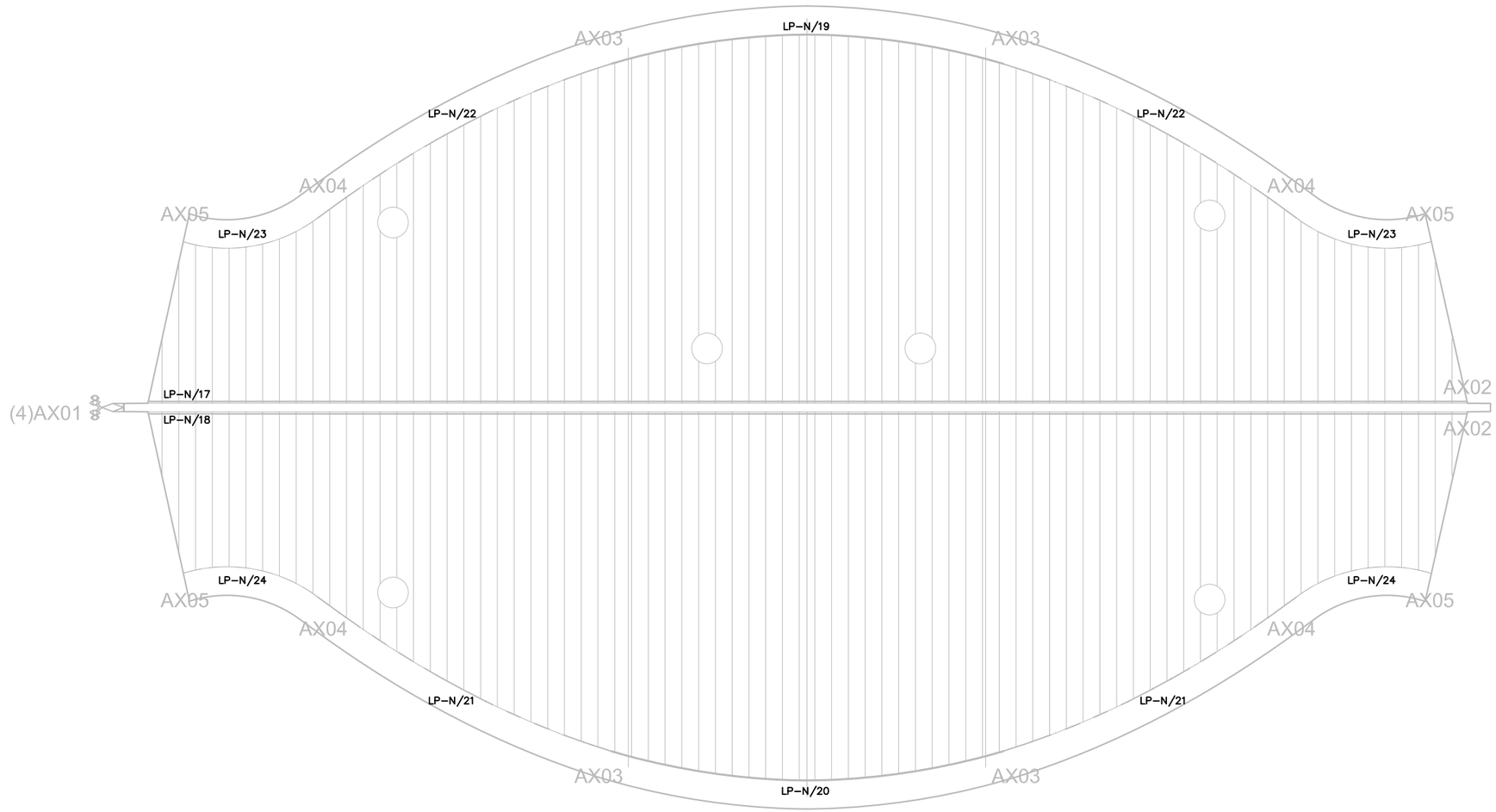
Exterior Roof
LIGHTING PLAN

SCALE	DRAWN BY
1/32" -1'-0"	Amy Huan
CAD FILENAME	DATE
	03/30/2014

DRAWING NUMBER

L01

NUMBER



PENNSYLVANIA STATE UNIVERSITY

DEPARTMENT OF ARCHITECTURAL ENGINEERING
LIGHTING/ELECTRICAL OPTION

SENIOR THESIS
SPRING 2014

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AND ASSOCIATES LLC
20 DAVIS STREET HAMDEN, CT

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195 CHURCH STREET, NEW HAVEN, CT

SEVERUD ASSOCIATE
CONSULTING ENGINEERS P.C.
469 7th AVE NEW YORK, NY

ALTIERI SEBOR WIEBER LLC
91 KNIGHT STREET NORWALK, CT

TOWERS GOLD
85 WILLOW STREET NEW HAVEN, CT

TIGHE & BOND
1000 BRIDGEPORT AVE, SUITE 320
SHELTON, CT

HENRY J. COUPE ASSOCIATES Inc.
P.O. BOX 9510, WARWICK, RI

PROJECT NAME

David S. Ingalls Rink

BUILDING NAME & ADDRESS

DAVID S. INGALLS RINK

73 SACHEM STREET, NEW HAVEN, CT 06510

DRAWING TITLE

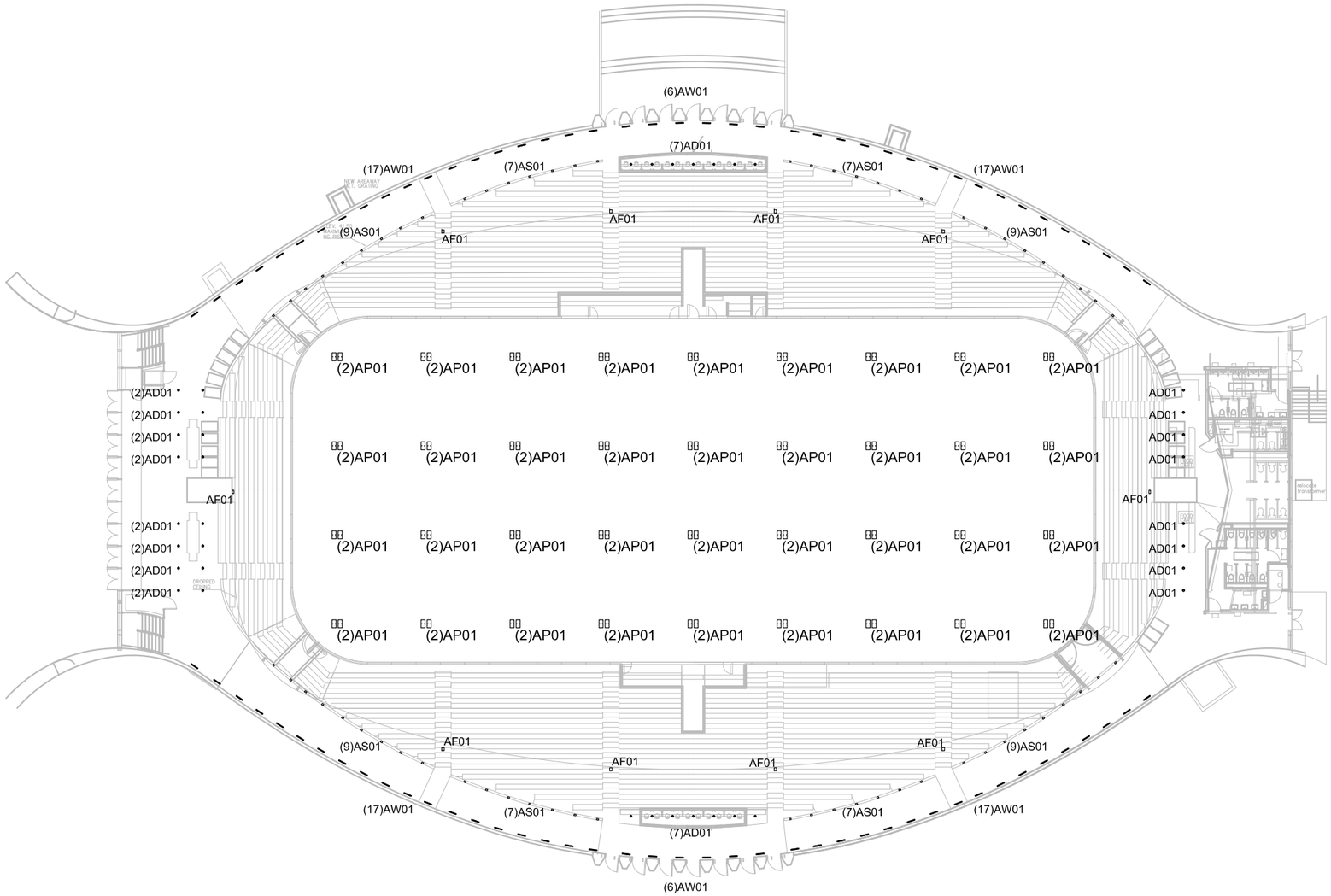
Exterior Roof WIRING DIAGRAM

SCALE	DRAWN BY
1/32" -1'-0"	Amy Huan
CAD FILENAME	DATE
	03/30/2014

DRAWING NUMBER

E01

NUMBER



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73 SACHEM STREET, NEW HAVEN, CT 06510

DRAWING TITLE

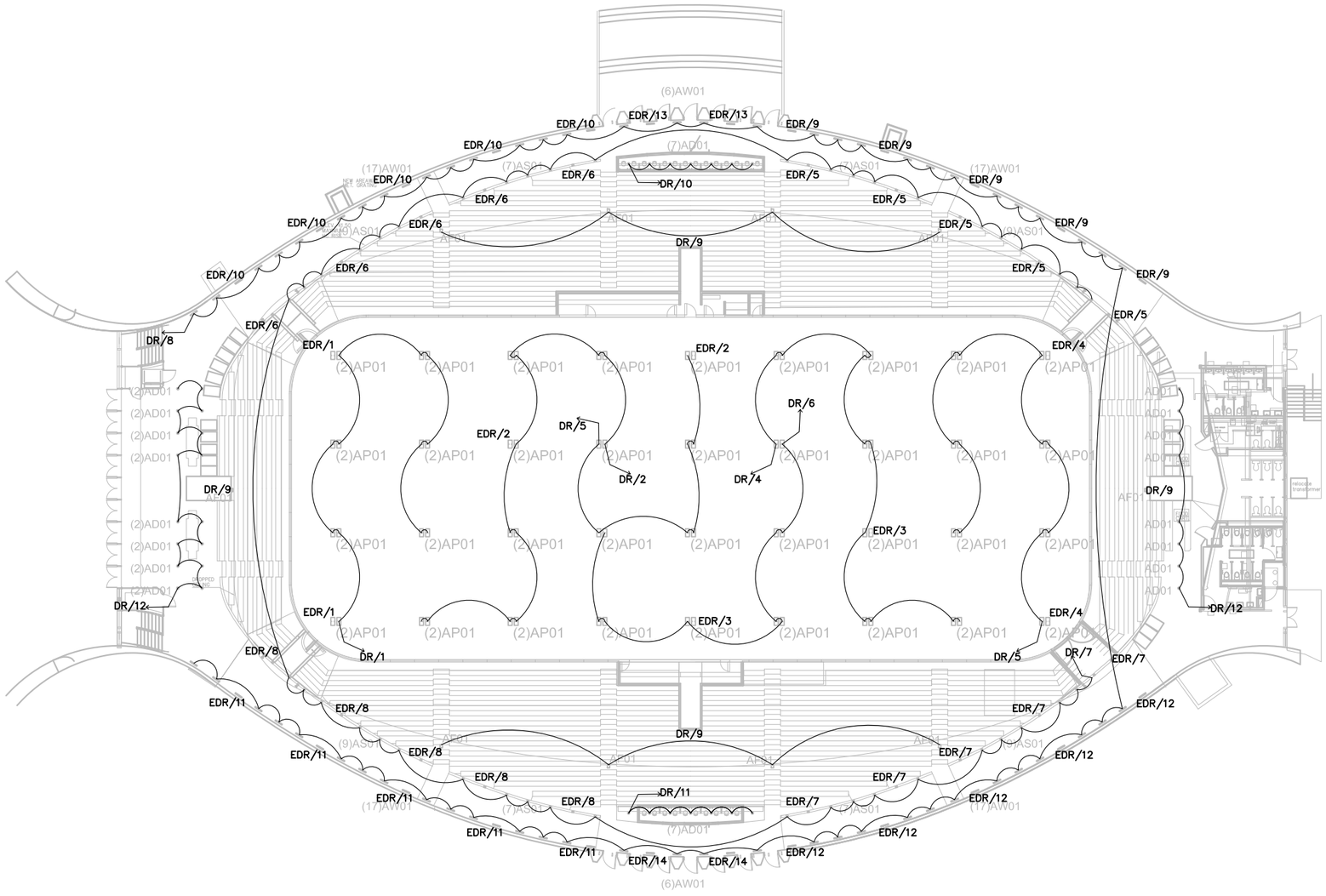
Ground Level LIGHTING PLAN

SCALE	DRAWN BY
1/32" -1'-0"	Amy Huan
CAD FILENAME	DATE
	03/30/2014

DRAWING NUMBER

L02

NUMBER



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BUILDING NAME & ADDRESS

DAVID S. INGALLS RINK

73 SACHEM STREET, NEW HAVEN, CT 06510

DRAWING TITLE

Ground Level WIRING DIAGRAM

SCALE	DRAWN BY
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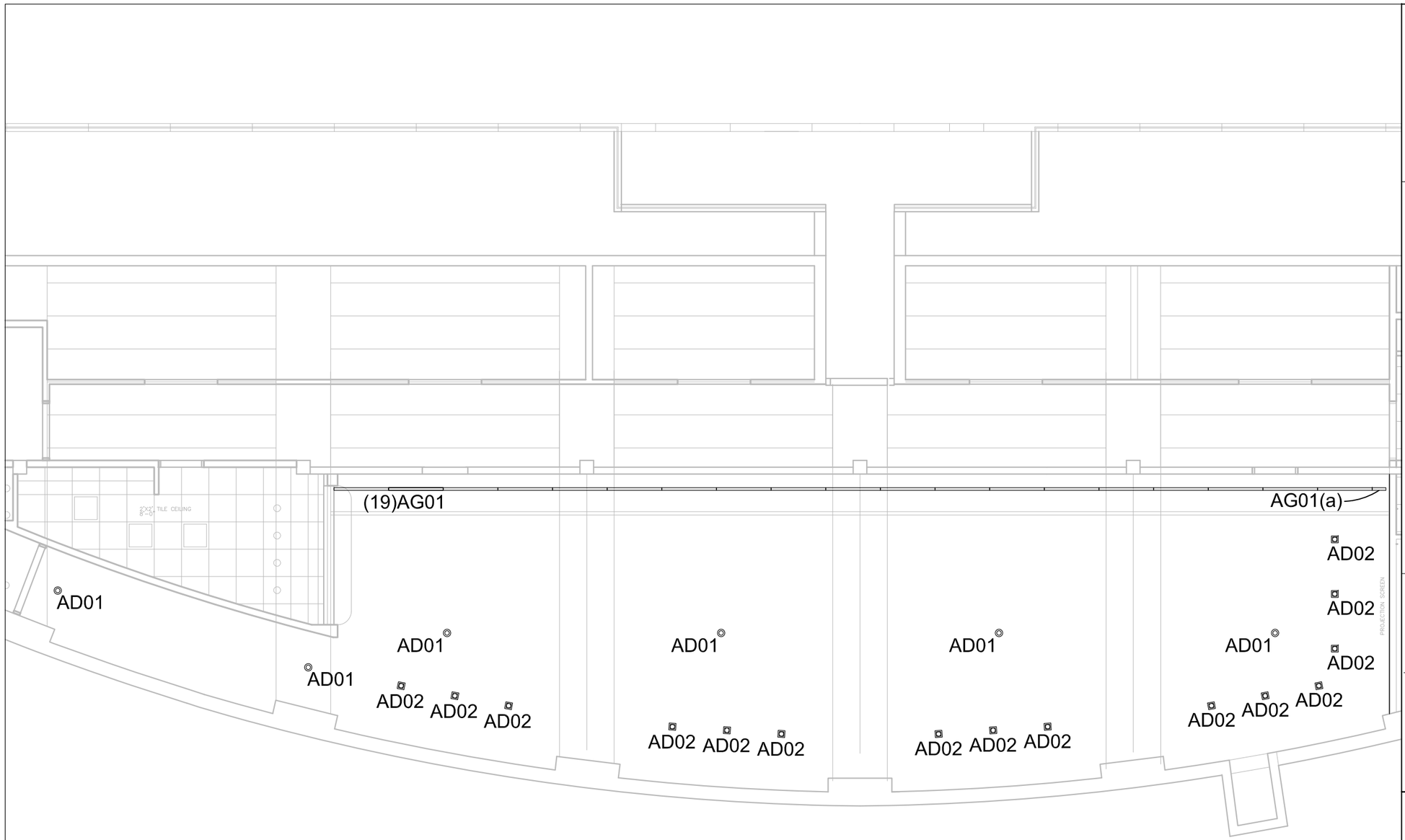
CAD FILENAME	DATE
	04/08/2014

DRAWING NUMBER

E02

NUMBER



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PROJECT NAME

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BUILDING NAME & ADDRESS

DAVID S. INGALLS RINK

73 SACHEM STREET, NEW HAVEN, CT 06510

DRAWING TITLE

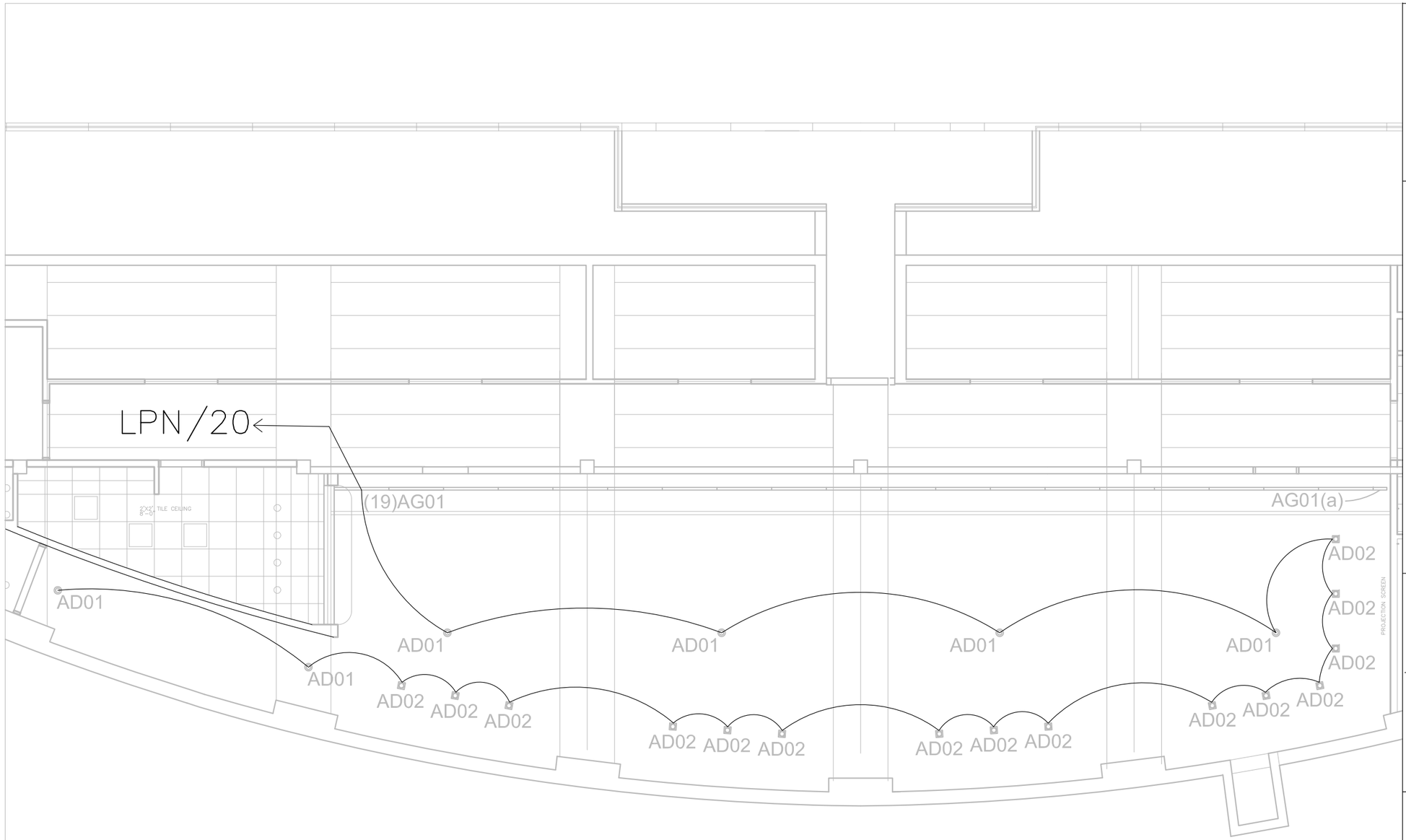
Schley Club Room LIGHTING PLAN

SCALE	DRAWN BY
1/8" -1'-0"	Amy Huan
CAD FILENAME	DATE
	03/30/2014

DRAWING NUMBER

L03

NUMBER



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HENRY J. COUPE ASSOCIATES Inc.
P.O. BOX 9510, WARWICK, RI

PROJECT NAME

David S. Ingalls Rink

BUILDING NAME & ADDRESS

DAVID S. INGALLS RINK

73 SACHEM STREET, NEW HAVEN, CT 06510

DRAWING TITLE

Schley Club Room WIRING DIAGRAM

SCALE	DRAWN BY
1/8" -1'-0"	Amy Huan
CAD FILENAME	DATE
	04/08/2014

DRAWING NUMBER

E03

NUMBER

Appendix B

Fixture Schedule

Type	Luminaire	Mounting	Description	Lamps	Power	Ballast	Model	Remarks	Location
AD01	Downlight	Ceiling Recessed	Nominal 5 1/4" D x 7 1/4"H Housing: Extruded anodized aluminum Lens: Clear tempered glass CRI: 78+ CCT: 3500K	LED	18W	Integral Electronic	*Cree* KR-4-9L-35-277V-10V	0-10V dimming	Pressbox, Schley Club Room
AD02	Spotlight	Ceiling Recessed	Nominal 6 3/4" L x 6 3/4"W x 6"H Housing: Die-cast aluminum Lens: TBA CRI: 85 CCT: 3500K	LED	11W	Integral Electronic	*Wac Lighting* MT-LED118-S-35HS-WT	ELV dimmer	Schley Club Room
AF01	Floodlight	Surface	Nominal 10 1/8" D x 4 3/4"H Housing: Die-cast aluminum Lens: Clear tempered glass CRI: 78+ CCT: 4000K	LED	50W	Integral Electronic	*Lumen Pulse* LBL-120/277-40K-VN-SI-DIM-SY	adjust aiming angle to match the ceiling slope	Rink
AG01	Linear Grazing Fixture	Surface	Nominal 48 3/4" L x 6 3/4"W x 6"H Housing: Extruded aluminum Lens: Clear tempered glass CRI: 85 CCT: 3500K	LED	6W/ft	Integral Electronic	*Lumen Pulse* LCSRO-277-48-35K-CL-RF-WH-DIM	0-10V dimming	Schley Club Room
AG01(a)	Linear Grazing Fixture	Surface	Nominal 12 3/4" L x 6 3/4"W x 6"H Housing: Extruded aluminum Lens: Clear tempered glass CRI: 85 CCT: 3500K	LED	6W/ft	Integral Electronic	*Lumen Pulse* LCSRO-277-48-35K-CL-RF-WH-DIM	0-10V dimming	Schley Club Room
AP01	Downlight	Pendant	Nominal 2' L x 1'W x 4"H Housing: aluminum Lens: Polymethyl methacrylate CRI: 76 CCT: 4000K	LED	267W	Integral Electronic	*Philips* BY461P LED240S/740 PSD WB GC SI MB	Suspension accessory: Mounting bracket	Rink
AS01	Steplight	Wall Recessed	Nominal 7 1/2" L x 7 1/2"W x 5 1/2"H Housing: Die-cast aluminum Lens: Clear tempered glass CRI: 80+ CCT: 4000K	T4 GU6.5MH	20W	Integral Electronic	*BEGA* 2198 MH	adjustable optical assembly	Circulation Corridoor
AW01	Asymmetrical Wall washer	In-ground	Nominal 20 7/8" L x 3 1/2"W x 5"H Housing: Extruded stainless steel Lens: matte tempered safety glass CRI: 80+ CCT: 4000K	LED	22W	Integral Electronic	*BEGA* 7917LED	UL Wet Location Listed	Circulation Corridoor
AX01	Exterior Downlight	Surface	Nominal 13 3/8" D x 5 3/4"H Housing: Die-cast aluminum Lens: Clear tempered glass CRI: 78+ CCT: 4000K	LED	100W	Integral Electronic	*Lumen Pulse* LBG-277-40K-WFL-LSLH-BK-NO-TBD	UL Wet Location Listed	Building Exterior
AX02	Exterior Linear Grazing Fixture	Surface Adjustable arm 6"	Nominal 4' L x 2 7/16"W x 1 5/16"H Housing: Die-cast aluminum Lens: Clear tempered glass CRI: 78+ CCT: 4000K	LED	5W/ft	Remote Driver	*Lumen Pulse* LOGR_ASHRAE-24V-48-40K-60x60-WAMR6-BK-DMX 1FX-CRC	UL Wet Location Listed 'Surface Mounted 20° rotated towards the spine 'DMX 1FX Dimming,resolution per fixture	Building Exterior
AX03	Exterior Linear Floodlight	Surface	Nominal 4' L x 2 4/5"W x 2 7/10"H Housing: Extruded anodized aluminum Lens: Clear Polycarbonate CRI: 81 CCT: 4000K	LED	15W/ft	Integral Electronic	*Philips* 523-000080-46	UL Wet Location Listed 'reverse phase ELV-type dimmer	Building Exterior
AX04	Exterior Linear Floodlight	Surface	Nominal 4' L x 2 4/5"W x 2 7/10"H Housing: Extruded anodized aluminum Lens: Clear polycarbonate CRI: 81 CCT: 4000K	LED	10W/ft	Integral Electronic	*Philips* 523-000081-46	UL Wet Location Listed 'reverse phase ELV-type dimmer	Building Exterior
AX05	Exterior Linear Floodlight	Surface	Nominal 4' L x 2 4/5"W x 2 7/10"H Housing: Extruded anodized aluminum Lens: Clear Polycarbonate CRI: 81 CCT: 4000K	LED	5W/ft	Integral Electronic	*Philips* 523-000086-46	UL Wet Location Listed 'reverse phase ELV-type dimmer	Building Exterior

Appendix C

Cutsheets

KR4™

LED Architectural Downlight – Round 4" Aperture

KR_4_9L_35_120v_10V

Product Description

The KR4™ LED specification downlight features Cree TrueWhite® Technology and delivers beautiful, high-quality light with efficacy up to 57 lumens per watt. Designed for new construction applications, the KR Series is available in variety of color temperatures, with high-quality anodized aluminum reflector finishes, dimmable product options, and sloped ceiling adaptor options, making it suitable for a wide variety of applications.

Performance Summary

Utilizes Cree TrueWhite® Technology

Made in the U.S.A. of U.S. and imported parts

Delivered Light Output*: 9L: 655Lumens(L), **13L:** 956L, **20L:** 1495L, **30L:** 2239L

Input Power: KR4-9L: 13 watts(W), **KR4-13L:** 18W, **KR4-20L:** 30W, **KR4-30L:** 39W

CRI: 90

CCT: 2700K , 3000K , 3500K, 4000K

Dimming: 5% Triac Dimming, 10% 0/1-10V Dimming**, 1% Lutron EcoSystem® Dimming**, 1% Lutron® Forward Phase Dimming**

Lifetime: Designed to last 50,000 hours

Limited Warranty: 10 years†

* Delivered lumen output is typical when using a SSGC type reflector. See Application Performance Chart under Photometry for more detail.

** 0/1-10V for 120V or 277V on 20L and 30L models, Triac for 120V on 9L and 13L models, Lutron dimming for 13L, 20L and 30L models

† See www.cree.com/lighting for warranty terms.

Ordering Information – Housing

Example: KR4-9L-27K-120V

KR4					
Series	**Size**	**Source Lumen Output**	**CCT**	**Voltage**	**Control Options**
KR	**4** 4 inch	**9L** 850 Lumens **13L** 1250 Lumens **20L** 2000 Lumens **30L** 3000 Lumens	**35K** 3500K **30K** 3000K **27K** 2700K **40K** 4000K	**120V** 120 Volts **277V** 277 Volts	Triac DImming* **10V** 0/1-10V Dimming* **LES** Lutron EcoSystem Dimming* **LFP** Lutron Forward Phase Dimming*

*Triac available on 9L and 13L, 10V available on 20L and 30L; LES, LFP available available on 13L, 20L, and 30L

Ordering Information – Reflector

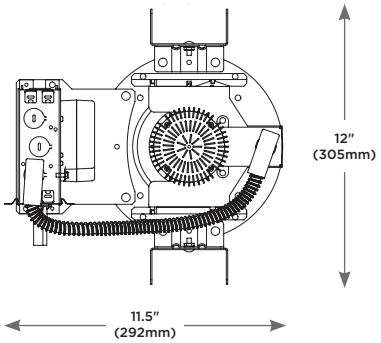
Example: KR4T-SSGC-FF

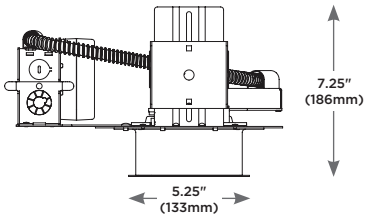
KR4T		
Series	**Reflector Finish**	**Flange Finish**
KR4T	**SSGC** Soft Satin Glow, Clear **SSGCG** Soft Satin Glow, Champagne Gold	**FF** Matching **WF** White Paint

Ordering Information-Sloped Ceiling Adaptor

Example: KRKS405WW

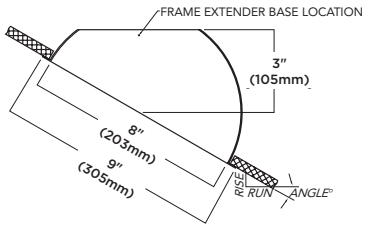
KRKS4		WW
Part	**Adaptor Angle**	**Option**
KRKS4	**05 thru 35** (order in 5 degree increments)	**WW** Required





Accessories:

4" Sloped Ceiling Adaptor



KR4™

Product Specifications

CREE TRUEWHITE® TECHNOLOGY

Cree TrueWhite® technology begins with the highest performing commercially available LEDs. Cree TrueWhite® Technology mixes the light from red and unsaturated yellow LEDs to create beautiful, warm, white light. This patented approach enables color management to preserve high color consistency over the life of the product. Cree TrueWhite® Technology also enables a CRI of at least 90 while maintaining high luminous efficacy — a no compromise solution.

CONSTRUCTION & MATERIALS

- Initial color within a 3-step MacAdam Ellipse.
- Low brightness parabolic spun Alzak aluminum cone, 0.06" (2mm) thick with polished radius and continuous self-flange.
- Soft Satin Glow Clear finish, standard.
- 2" (51mm) aperture throat to accommodate all standard and extra-thick ceilings and provide flexibility in mounting within grid.
- Provided with quick mounting brackets for optional carrying channels.
- Light engine, optics, and driver accessible from below ceiling.

ELECTRICAL SYSTEM

- **Input Voltage:** 120 or 277V
- 5%–100% Triac dimming standard on 120V (9L and 13L models)
- 10% - 100% 0/1-10V dimming standard (20L and 30L models)
- 1% - 100% Lutron EcoSystem and Forward Phase dimming available on 13L, 20L, and 30L models. Consult Lutron for compatible dimmers.
- **Power Factor:** >0.9

REGULATORY & VOLUNTARY QUALIFICATIONS

- cULus Listed® for thru-wiring 8#12AWG-90°C and damp location.
- RoHS compliant.
- Thermally protected.
- Meets Buy American requirements within ARRA. Consult factory for Buy American compliance with Lutron dimming options.
- EnergyStar Qualified with Triac or 0-10V dimming options (except 20L models at 277V). Other models (using LES and LFP) are pending qualification.

Installation

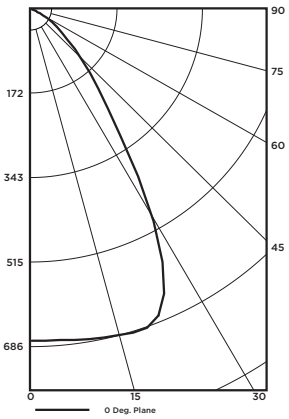
- Recommended ceiling cutout 4.25" (108mm)

Note: 30L versions require marked spacing: 24" (600mm) X 12" (300mm) X ½" (12mm). (24" [600mm] luminaire to luminaire, 12" (300mm) luminaire to side wall, ½" (12mm) above luminaire.

Photometry

All published luminaire photometric testing performed to IESNA LM-79-2008 standards.

Soft Satin Reflector



CESTL Test Report #: 157453
KR4-13L-27K-120V (SSGC-WF)
Initial Delivered Lumens: 956
Efficacy: 55 Lm/W
S/M: 1.2

Intensity (Candlepower) Summary

Angle	Mean CP
0°	664
5°	666
15°	681
25°	639
35°	324
45°	152
55°	65
65°	20
75°	5
85°	0
90°	0

Cone of Light

Distance from Workplane	Footcandles	Beam Diameter
6′	18	7.0′
8′	10	9.2′
10′	7	11.2′
12′	5	13.2′
14′	3	16.8′

Zonal Lumen Summary

Zone	Lumens	% Luminiare
0-30	542	62.4%
0-40	751	89.3%
0-60	929	99.0%
0-90	956	100%

Reflector Finish Multiplier

Reflector Finish	Approximate Multiplier
SSGC	1.0
SSGCG	0.97

Testing represents 13L output models. To estimate performance for other output models, use the Application Performance chart above. For exact photometric data please reference our available IES and LM-79 test results at www.cree.com/lighting/krseries

Application Reference

Open Space					
Spacing	Lumens	Wattage	LPW	w/ft²	Average FC
4 x 4	956	17.6	55	1.04	57
6 x 6				0.49	27
8 x 8				0.26	15
10 x 10				0.17	10

10′ Ceiling, 80/50/20 Reflectances, 2.5 workplane.
LLF: 1.0 Initial. Open Space: 50′ x 40′ x 10′

Corridor					
Spacing	Lumens	Wattage	LPW	w/ft²	Average FC
4′ on Center	956	17.6	55	0.73	24
6′ on Center				0.49	16
8′ on Center				0.35	11
10′ on Center				0.29	9

10′ Ceiling, 80/20/50 Reflectances, Light levels on the ground.
LLF: 1.0 Initial. Corridor: 6′ Wide x 100′ Long

Rev. Date 09/12/2013

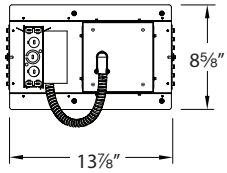
MT-LED118

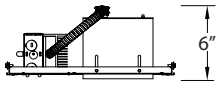
1 Light LEDme™ Multiple Spot

WAC LIGHTING
Responsible Lighting®

6¾" × 6¾"

5⅞" × 5⅞"





Fixture Type: AD02

Catalog Number: MT-LED118S-3-HS-WT

Project:

Location:

PRODUCT DESCRIPTION

Square single light recessed fixture, available with trim or Invisible Trim™. Invisible Trim™ includes spackle ring to permit a stable finished installation with a drywall ceiling. Housing and trim ordered separately.

FEATURES

- Trim version has a ⅛" low profile
- Invisible Trim™ is designed to sit flush with the ceiling for a clean, architectural look
- Spot and Flood beam spreads
- 40° vertical adjustment and 350° horizontal rotation
- ANSI compliant Warm/Neutral LED module
- 50,000 hour rated life
- 5 year WAC Lighting product warranty

FIXTURE PERFORMANCE

Model #	Beam	Color Temp	Watt *IC*	Watt *Non-IC*	Lumens *IC*	Lumens *Non-IC*	Efficacy	CRI
MT-LED118S-27	10°	2700K	11W	17.5W	621	849	56.5 Lm/W	85
MT-LED118F-27	25°				639	870	58.1 Lm/W	
MT-LED118S-WW	10°	3000K	11W	17.5W	621	849	56.5 Lm/W	85
MT-LED118F-WW	25°				639	870	58.1 Lm/W	
MT-LED118S-35	10°	3500K	11W	17.5W	661	904	60.1 Lm/W	80
MT-LED118F-35	25°				680	926	62.0 Lm/W	
MT-LED118S-CW	10°	4500K	11W	17.5W	755	1003	69.0 Lm/W	75
MT-LED118F-CW	25°				768	1017	69.5 Lm/W	

SPECIFICATIONS

Construction: Die-cast aluminum heat sink painted black. Trim, housing and junction box are 20 gauge steel. Frame and hanger bars are heavy gauge galvanized steel.

J-Box: Seven knockouts and four Romex® style wiring connectors provided for ease of installation. Rated for branch wiring.

Driver: 120VAC/60Hz input, 11W output, 450mA current. Power factor >0.9. Dimming and thermal protection.

Light Source: Utilizes one 6 × 3W Cree LED module (included with housing).

Dimming: Dim to 1% with electronic low voltage (ELV) dimmer. Recommended dimmer: Leviton VPE04

Mounting: Supplied with hanger bars, adjustable from 15"-24½" to accommodate various joist construction and grid sizes. Hanger bars include a captive mounting "screw-nail" for ease of installation. Accommodates surface up to 1" thick. 6" × 6" cutout with trim, 6½" × 6½" cutout for Invisible Trim™. See instruction sheet for details on installation using spackle ring.

Finish: Abrasion resistant powder coat paint in White (WT).

Rating: IC-Rated: Suitable for direct contact with insulation.

Standards: UL & CUL Listed.

TRIM ORDER NUMBER

Trim: **MT-LED118-WT**

Invisible Trim™: **MT-LED118TL**

FINISH

WT

REPLACEMENT MODULES

Model #	Color Temp
RM6X3-27-DL	*2700K*
RM6X3-30-DL	*3000K*
RM6X3-35-DL	*3500K*
RM6X3-45-DL	*4500K*

HOUSING ORDER NUMBER

Model #	Beam	Color Temp	Rated		Finish
MT-LED118	**S** *10°* **F** *25°*	**27** *2700K* **WW** *3000K* **35** *3500K* **CW** *4500K*	**HS** **HSNIC**	*IC* *Non-IC*	**WT** *White*

MT-LED118 | **S** | – | **3** | **HS** | – | **WT**

Example: **MT-LED118S-WWHS-WT**

WAC Lighting
www.waclighting.com
Phone (800) 526.2588 • Fax (800) 526.2585

Headquarters/Eastern Distribution Center
44 Harbor Park Drive • Port Washington, NY 11050
Phone (516) 515.5000 • Fax (516) 515.5050

Western Distribution Center
1750 Archibald Avenue • Ontario, CA 91760
Phone (800) 526.2588 • Fax (800) 526.2585

SPECIFICATION SHEET

lumenbeam™

LARGE
WHITE & STATIC COLORS

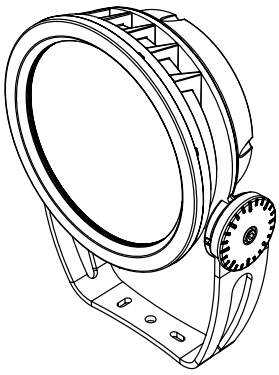
Client: _____

Project name: _____

Order #: LBL-120/277-40K-VN-SI-DIM-SY

Type: _____ Qty: _____

FEATURES AND BENEFITS



Physical :

- Low copper content high pressure die-cast aluminum housing
- Heavy aluminum formed yoke (standard yoke included)
- Stainless steel hardware
- Silicone sealing devices
- Clear tempered glass
- Dual chamber design for heat management and ease of maintenance
- Electro-statically applied polyester powder coat finish
- 5.44 kg / 12 lbs
- EPA: Front = 0.94 sq. ft. / 0.087 sq. m. Side = 0.56 sq. ft./ 0.052 sq. m.
- IP66
- Corrosion-resistant option for marine environments

Performance :

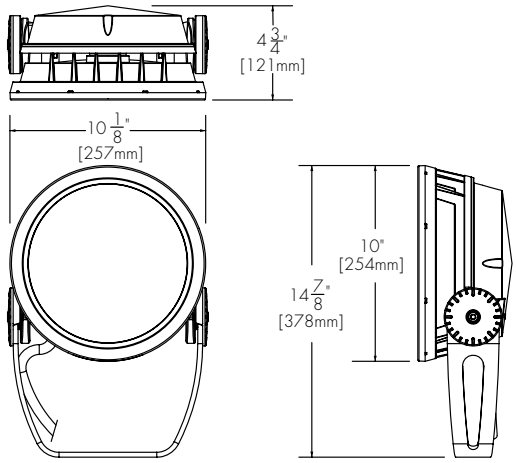
- Minimum 1 fc (10.7 lux) @ 329 feet (100.3m) distance (4000K, 6° optic)
- 2,654 delivered lumens and 108,096 candelas at nadir (4000K, 6° optic)
- 6°, 10°, 20°, 40° or 60° optics available
- CRI value: 80+
- Lumen maintenance 120,000 hrs [L70 @ 25°C]
- Lumen measurements comply with LM - 79 - 08 standard
- Operating temperatures: -25° C to 50° C [-13F to 122F]

Electrical :

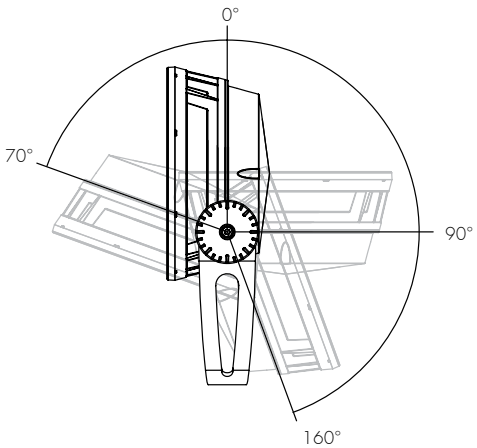
- Line voltage luminaire for 120 to 277V
- Power and data in 1 cable, 3ft/1 m cord (#16-5)
- 50 watts
- Dimming options: 0-10 volt, DMX, DALI, Lumentalk, or Lutron® EcoSystem® enabled

Wiring detail

WIRE COLOR	*/ USE*
GREEN	*GROUND*
WHITE	*NEUTRAL*
BLACK	*LIVE 120-277V*
RED	*0-10V / DATA +*
ORANGE	*0-10V / DATA -*



Standard Yoke (as shown, included)



Standard Yoke Mounting
Adjustable pivot limits

5 year warranty

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EM - R29

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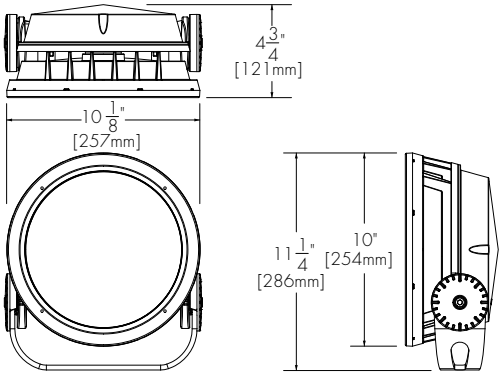
SPECIFICATION SHEET

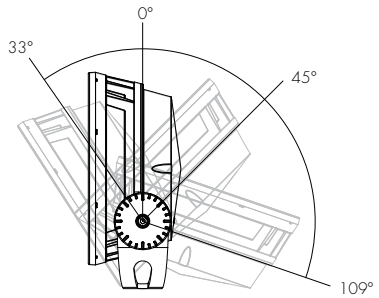
lumenbeam™

LARGE
WHITE & STATIC COLORS

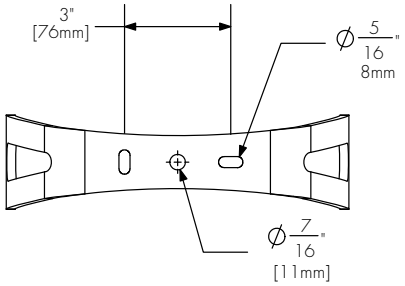
MOUNTING OPTION



SY
Short Yoke Mounting

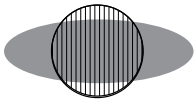


Short Yoke mounting
adjustable pivot limits



Standard and Short Yoke mounting
holes Pattern

OPTICAL OPTIONS
*Factory installed



LSLH
Linear Spread Lens
Horizontal distribution
(not adjustable on site)

LSLV
Linear Spread Lens
Vertical distribution
(not adjustable on site)

Factory installed, available for 6° to 40° optics.
See Optical Accessories for field adjustable spread lens.
*See photometric section for optical performance data with the spread lens.

*See photometric section for optical performance data using the spread lens.

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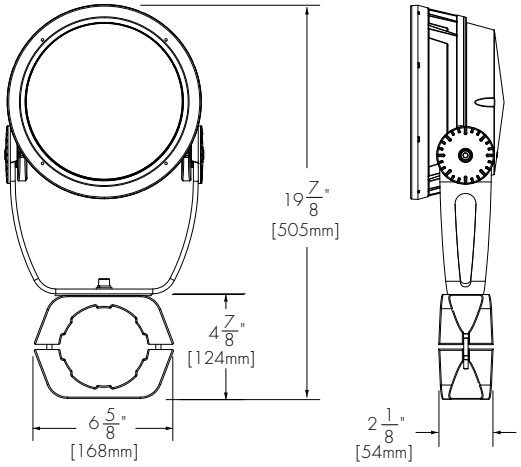
WHITE & STATIC COLORS

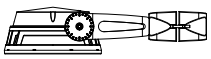
ACCESSORIES

Order separately

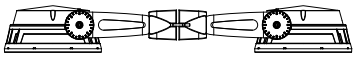
Mounting Accessories



PM
Round Pole Mounting Accessory
*Consult factory for square pole section

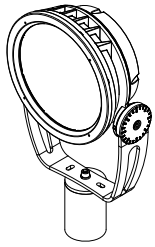


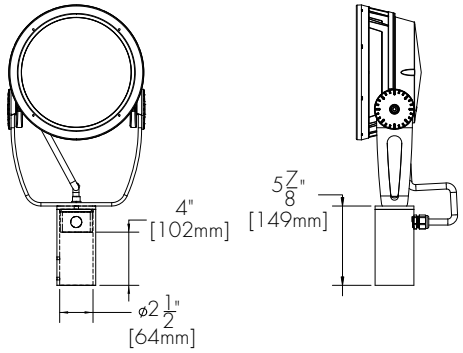
PM4-1, PM4.5-1, PM5-1
Round Pole Mounting accessory
single fixture



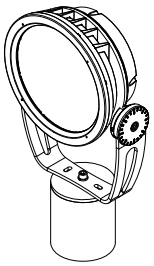
PM4-2, PM4.5-2, PM5-2
Round Pole Mounting accessory
twin fixtures

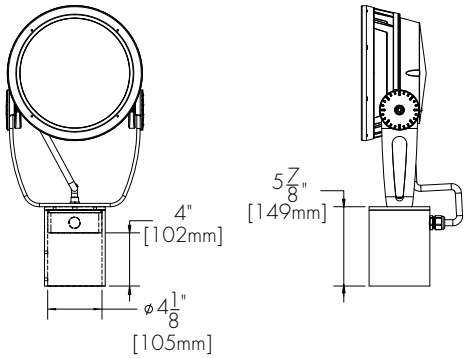
When **PM4-2, PM4.5-2 or PM5-2** are specified, one bracket assembly is supplied per 2 fixtures unless otherwise specified.





TN2
Tenon adapter
to fit on 2 3/8" O.D. tenon





TN4
Tenon adapter
to fit on 4" O.D. tenon

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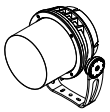
LARGE
WHITE & STATIC COLORS

ACCESSORIES

Order separately

Optical Accessories:

LBL-SN-___-BK Snoot accessory. Please specify desired exterior finish :
*Interior surface painted black.
SI - Silver SandText
BKM - Matte black
WH - White
CC - Custom, please specify RAL color



LBL-SNW-___-BK Snoot Wide accessory. Please specify desired exterior finish :
*Interior surface painted black.
SI - Silver SandText
BKM - Matte black
WH - White
CC - Custom, please specify RAL color

LBL-VS-___-BK Visor accessory. Please specify desired exterior finish :
*Interior surface painted black.
SI - Silver SandText
BKM - Matte black
WH - White
CC - Custom, please specify RAL color

LBL-WG-___ Wire Guard accessory. Please specify desired exterior finish :
SI - Silver SandText
BKM - Matte black
WH - White
CC - Custom, please specify RAL color

LBL-LSLA-___ Linear Spread Lens Adjustable accessory. Please specify desired exterior finish :
SI - Silver SandText
BKM - Matte black
WH - White
CC - Custom, please specify RAL color

Accessory combinations:

+	Snoot	Snoot Wide	Visor	Wire Guard
Snoot	NO	NO	NO	YES
Visor	NO	NO	NO	YES
Linear Spread Lens Adjustable	YES	YES	YES	NO

Accessory combinations must be ordered together on a single line.
Ex: A Snoot + Wire Guard combination order code is **LBL-SN-WG-BK-BK.**

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WHITE & STATIC COLORS

ACCESSORIES - continued from page 4
Order separately

Control Systems:

LTO Lumentouch is a wall mount DMX 512 controller keypad

LCU Lumencue is a USB / mini SD DMX 512 controller

LID LumenID is a diagnostic and addressing DMX 512 controller.
It must be specified on all DMX applications.
Refer to LID specification sheet for details.

LTN Lumentone is a simple pre-programmed DMX 512 controller
with a push button rotary dial and live feedback.

CBOX :

iCBOX-___V-___-___ Interior DMX 512 data box.
Data input and output, M20 provision holes with plugs.
Voltage input and output, M20 provision holes with plugs.
Up to six outputs to fixtures, M20 provision holes with plugs.
Please specify desired input voltage and finish.
Refer to iCBOX specification sheet for details.

CBOX-___V-___-___ DMX 512 data box.
Data input and output, M20 provision holes with plugs.
Voltage input and output, M20 provision holes with plugs.
Up to six outputs to fixtures, M20 provision holes with plugs.
Please specify desired input voltage and finish.
Refer to CBOX specification sheet for details.

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SPECIFICATION SHEET

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LARGE
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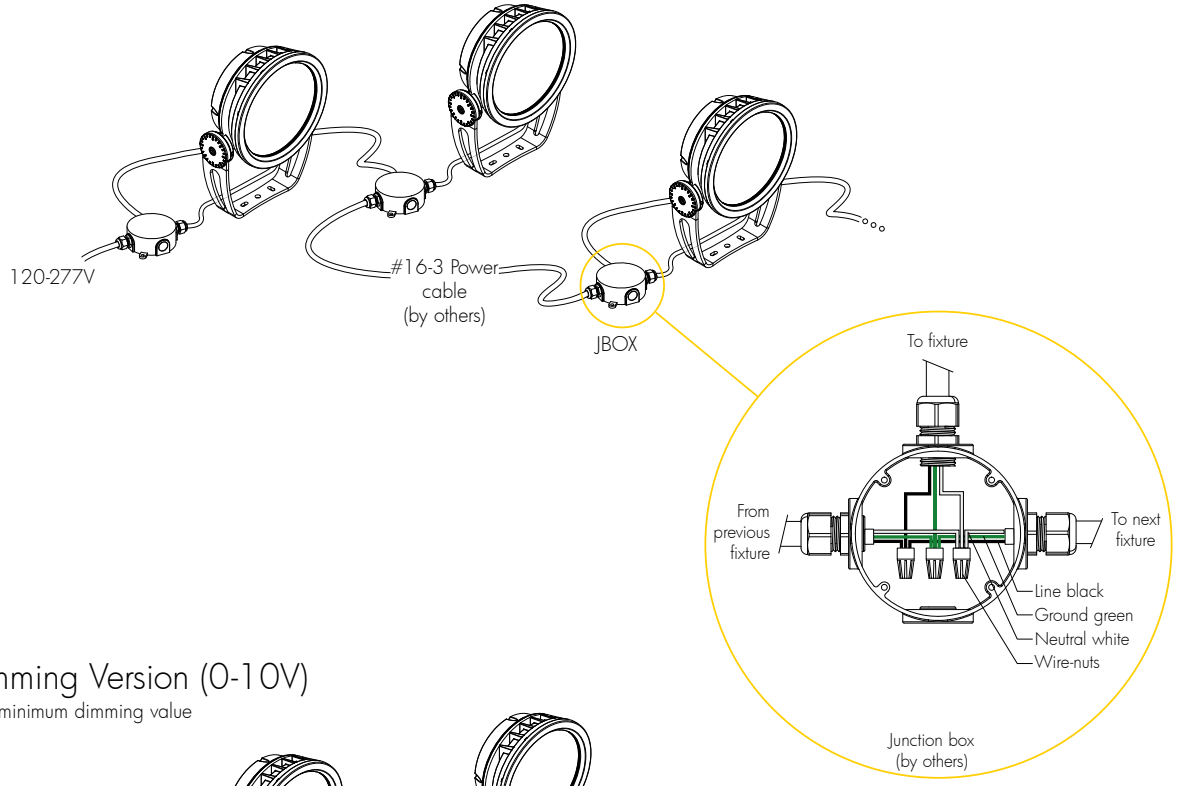
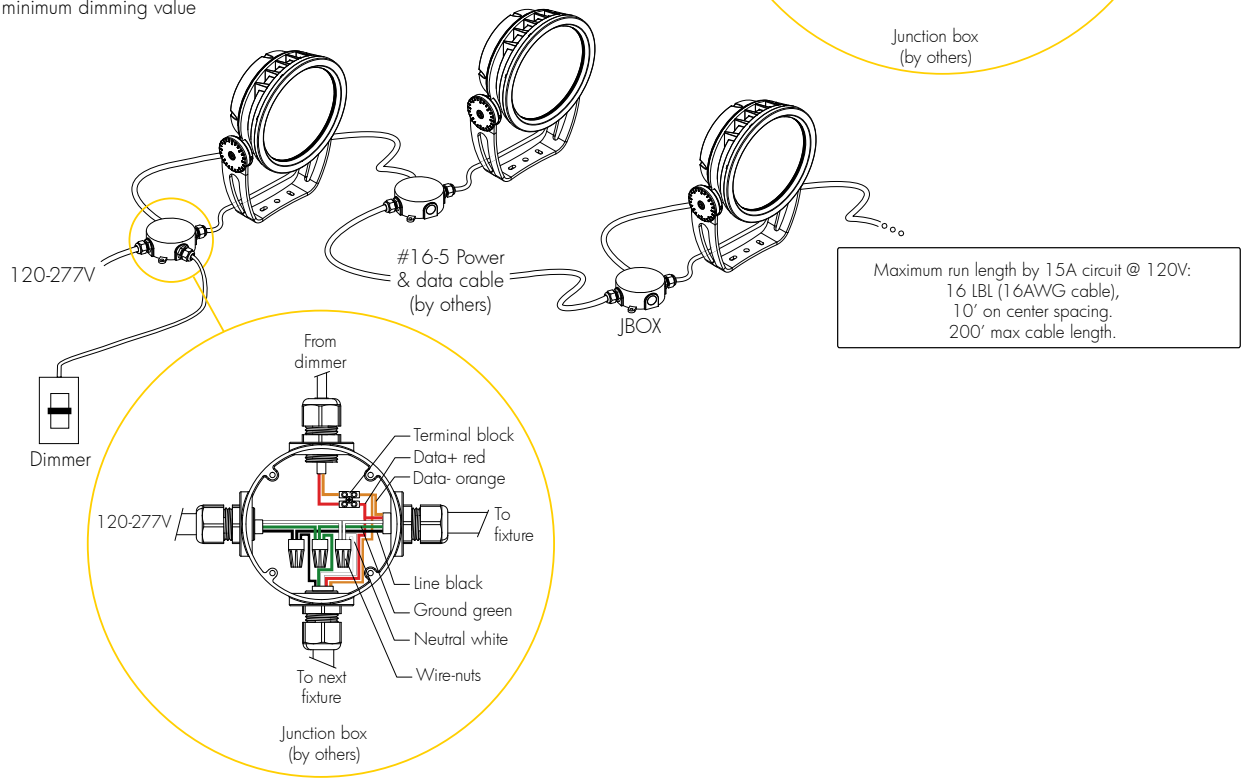
TYPICAL WIRING DIAGRAMS

Non-Dimming or Lumentalk Dimming Version



Dimming Version (0-10V)

10% minimum dimming value



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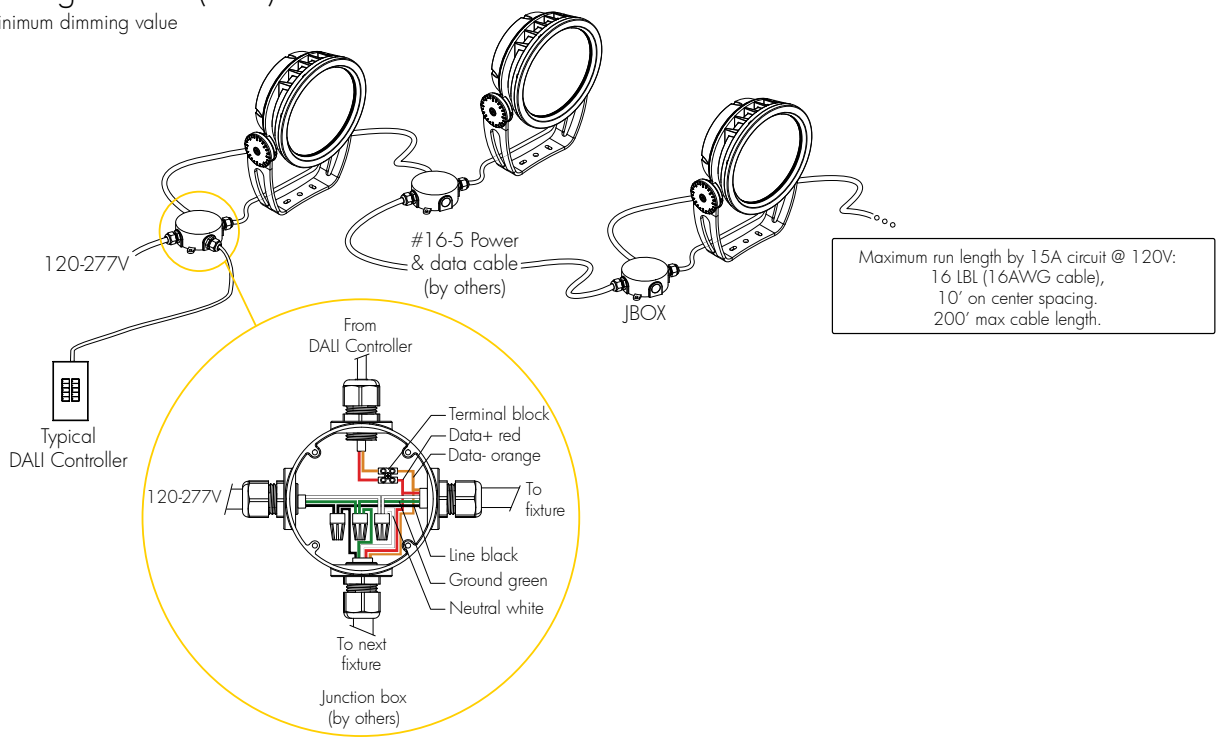
TYPICAL WIRING DIAGRAMS - continued

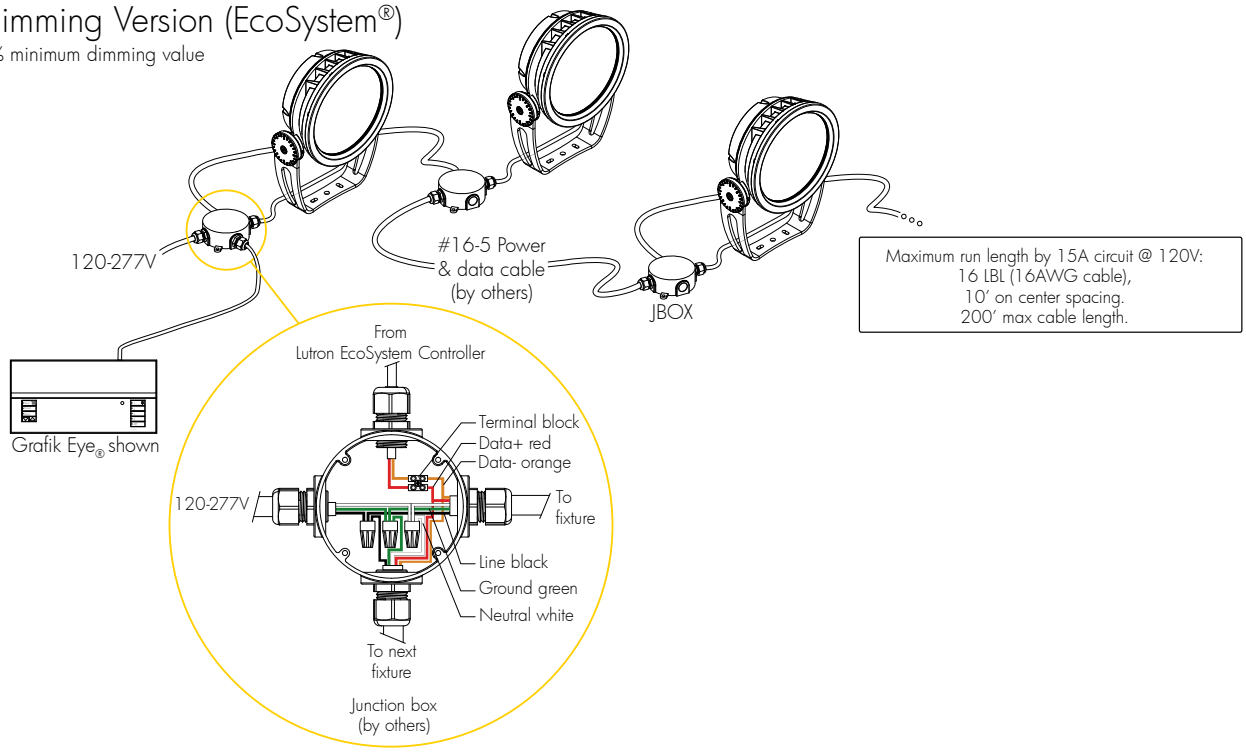
Dimming Version (DALI)

1% minimum dimming value



Dimming Version (EcoSystem®)

1% minimum dimming value



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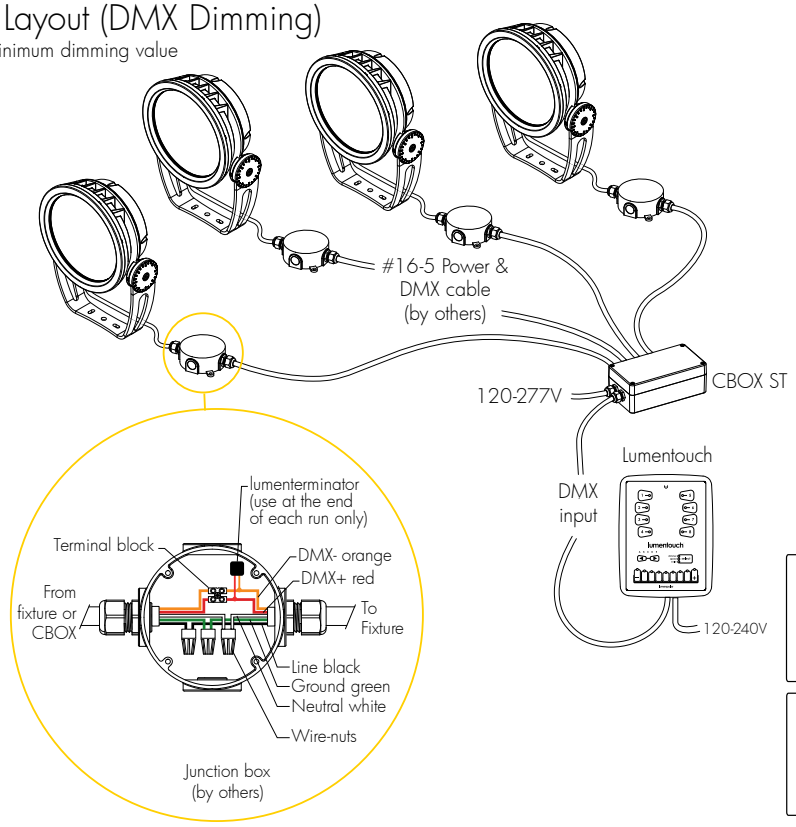
TYPICAL WIRING DIAGRAMS - continued

Star Layout (DMX Dimming)

1% minimum dimming value



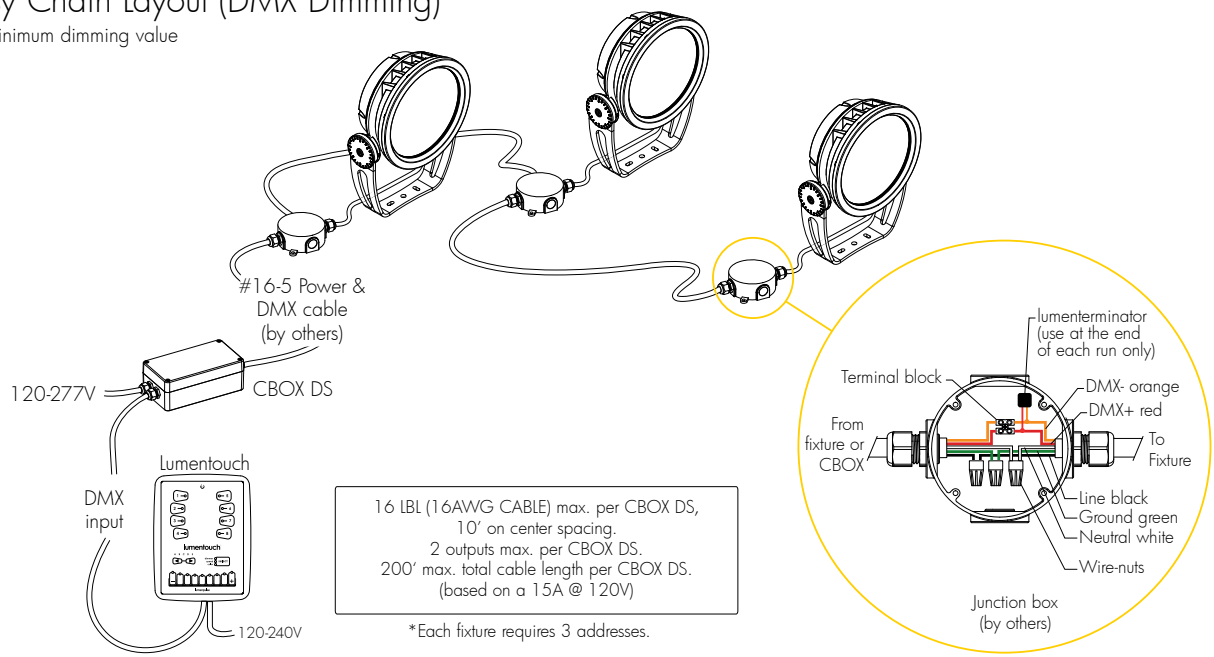
16 LBL (16AWG cable) max. per CBOX ST,
10' on center spacing.
6 outputs max. per CBOX ST.
200' max. total cable length per CBOX ST
(based on a 15A circuit @ 120V)

DMX terminator is required at the end of each run to maintain data integrity.
(2x) DMX lumenterminator included per CBOX DS
(6x) DMX lumenterminator included per CBOX ST
See installation instructions for details.

*Each fixture requires 3 addresses.

Daisy Chain Layout (DMX Dimming)

1% minimum dimming value



16 LBL (16AWG CABLE) max. per CBOX DS,
10' on center spacing.
2 outputs max. per CBOX DS.
200' max. total cable length per CBOX DS.
(based on a 15A @ 120V)

*Each fixture requires 3 addresses.

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SPECIFICATION SHEET

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LARGE
WHITE & STATIC COLORS

HOW TO ORDER

LBL		~~Select:~~	~~Select:~~	~~Select:~~	~~Select:~~	~~Select:~~	~~Select:~~
Housing	Voltage	Colors and color temperatures	Optic	Optical Option	Finish	Dimming	Option
1	2	3	4	5	6	7	8

1

Housing:

LBL - Lumenbeam™ Large

2

Voltage:

120 - 120 volts
208 - 208 volts
220/240 - 220 to 240 volts
277 - 277 volts

3

Colors and Color temperatures:

27K - 2700K
30K - 3000K
35K - 3500K
40K - 4000K
57K - 5700K
RD - Red
GR - Green
BL - Blue

4

Optic:

VN - Very Narrow 6° 

NS - Narrow Spot 10° 

NF - Narrow Flood 20° 

FL - Flood 40° 

WFL - Wide Flood 60° 

5

Optical Option:

LSLH - Linear Spread Lens Horizontal distribution
LSLV - Linear Spread Lens Vertical distribution

*Factory installed, available for 6° to 40° optics.
See Optical Accessories for field adjustable spread lens.

6

Finish:

SI - Silver SandText
BK - Black SandText
WH - White
CC - Custom (please specify RAL color)

7

Dimming:

NO - No Dimming
LT - Lumentalk (1% minimum dimming value)
DIM - 0-10V Dimming option
(10% minimum dimming value)
DMX - DMX Dimming option (3 addresses per fixture)
(1% minimum dimming value)
DALI - DALI Dimming option
(1% minimum dimming value)
ES - Lutron® EcoSystem® Enabled Dimming
(1% minimum dimming value)

8

Option:

SY - Short Yoke
CRC - Corrosion-resistant Coating

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lumencove®
WHITE & STATIC COLORS

Client: _____

Project name: _____

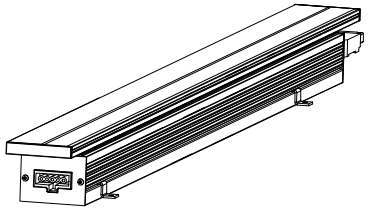
Order #: LCSRO-277-48-35K-CL-RF-WH-DIM

Type: _____ Qty: _____

FEATURES AND BENEFITS

Physical :

- Low copper content extruded aluminum housing
- Available in 1', 2', 3', 4' or 8' sections
- Electro-statically applied polyester powder coat finish
- Tool-less LED frame adjustable mechanism
- Low profile design
- White standard finish
- Indoor applications, dry location only
- 1 locking mechanism is included per fixture, installed.
  (Two locks provided for 8ft sections.Locking mechanism is made of unpainted steel).
- Single feed option available for end of run fixtures



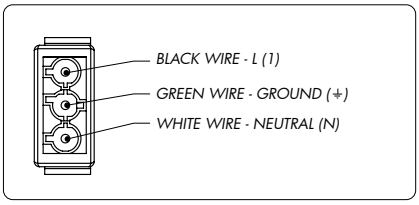
Performance :

- 2700K, 3000K, 3500K, 4000K, Red, Green, Blue static colors available
- Available in Regular Output or High Output versions
- 407 delivered lumens per foot (RO version)
- 773 delivered lumens per foot (HO version)
- Lumen maintenance L70 @ 25°C - 80,000 hrs
- Lumen measurements comply with LM - 79 - 08 standard
- Resolution per foot or per fixture (see page 9)
- Operating temperatures: -25° C to 50° C [-13F to 122F]

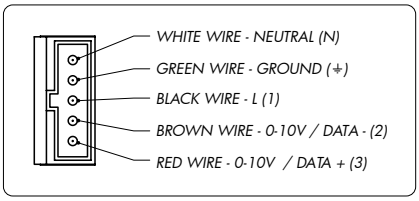
Electrical :

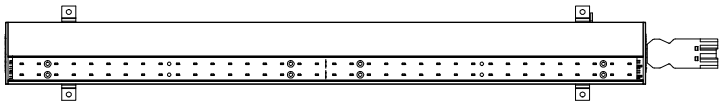
- Line voltage luminaire for 120 to 277V
- Power and data in 1 cable (#16-5)
- Up to 180 feet on 1 power feed (112 feet/HO version)
- 6W/ft - RO version, 12W/ft - HO version
- 0-10V, DMX or DALI dimming options

Wiring detail - non dimming

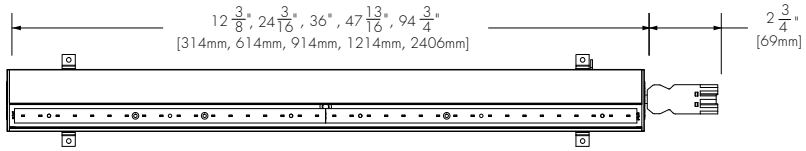


Wiring detail - dimming

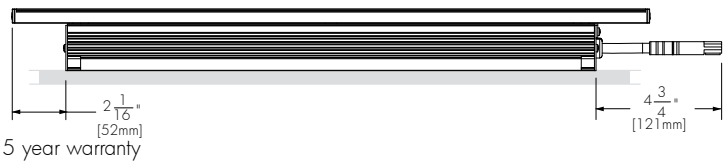




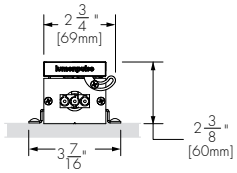
HIGH OUTPUT VERSION



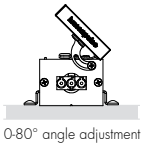
REGULAR OUTPUT VERSION



5 year warranty



Non-Dimming Fixture
(3-pin connector shown)



0-80° angle adjustment

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2012.10.17
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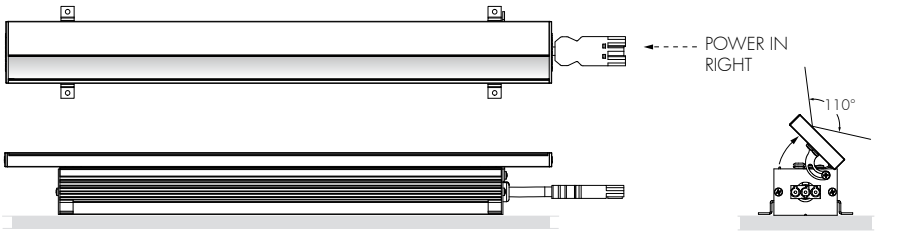
SPECIFICATION SHEET

lumencove®

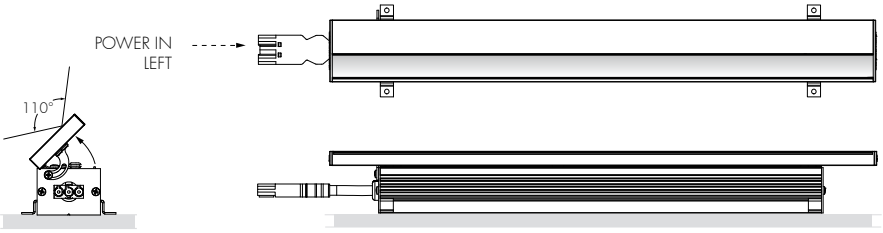
WHITE & STATIC COLORS

FEEDING SIDE



RF
Right Feeding side
standard clips shown

LED housing rotates
in a clockwise direction



LED housing rotates
in a counter-clockwise direction

LF
Left Feeding side
standard clips shown

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2012.10.17
EM - R43

lumenpulse™
Sustainable architectural LED lighting systems

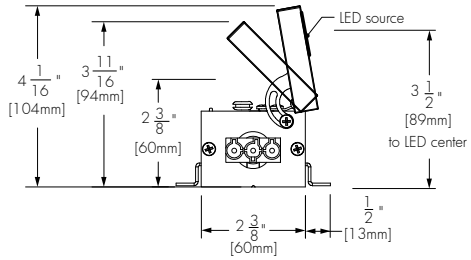
SPECIFICATION SHEET

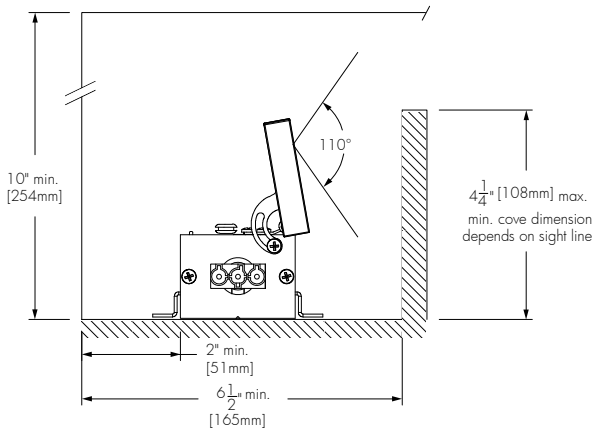
lumencove®

WHITE & STATIC COLORS

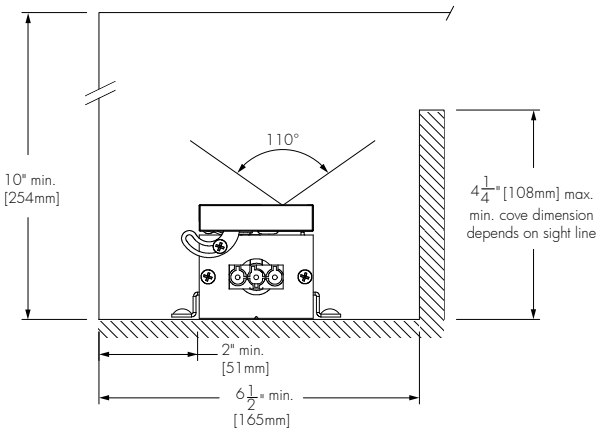
MOUNTING DETAILS

MINIMUM COVE DIMENSIONS





OUTWARD FACING



INWARD FACING

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lumencove®

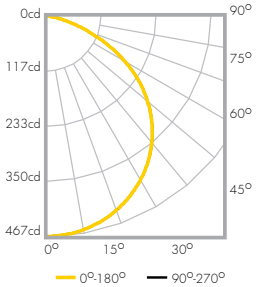
WHITE & STATIC COLORS

PHOTOMETRICS

Lumencove® RO 4'
2700K
clear lens

Lamping	25.4 W
Lumens	1269
Efficacy	50 lm/W

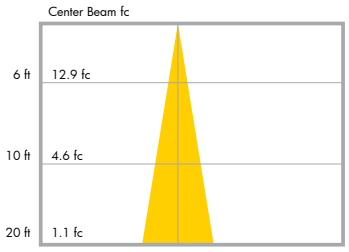
Polar Candela Distribution



Candela Table

	0	22.5	45	67.5	90
0	467	467	467	467	467
5	465	465	465	465	465
15	450	450	450	450	450
25	421	421	421	421	421
35	377	377	377	377	377
45	318	318	318	318	318
55	241	241	241	241	241
65	145	145	145	145	145
75	52	52	52	52	52
85	6	6	6	6	6
90	0	0	0	0	0

Illuminance at Distance

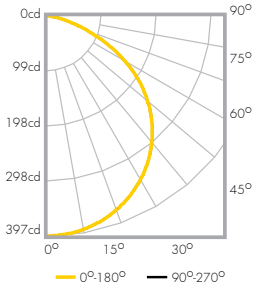


21.6 ft (6.5 m)
1 fc @ nadir maximum distance

Lumencove® RO 4'
2700K
frosted lens

Lamping	25.4 W
Lumens	1079
Efficacy	55 lm/W

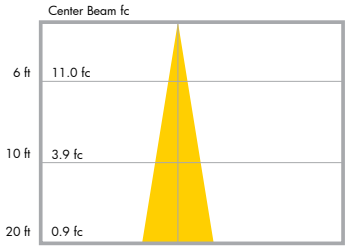
Polar Candela Distribution



Candela Table

	0	22.5	45	67.5	90
0	397	397	397	397	397
5	395	395	395	395	395
15	383	383	383	383	383
25	358	358	358	358	358
35	321	321	321	321	321
45	270	270	270	270	270
55	205	205	205	205	205
65	123	123	123	123	123
75	44	44	44	44	44
85	5	5	5	5	5
90	0	0	0	0	0

Illuminance at Distance

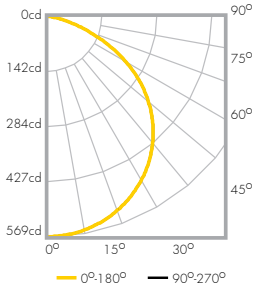


19.9 ft (6.0 m)
1 fc @ nadir maximum distance

Lumencove® RO 4'
3000K
clear lens

Lamping	25 W
Lumens	1513
Efficacy	60 lm/W

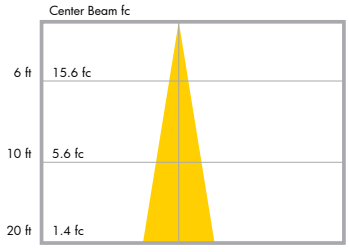
Polar Candela Distribution



Candela Table

	0	22.5	45	67.5	90
0	565	565	565	565	565
5	563	561	561	565	567
15	544	542	543	547	548
25	507	506	506	510	510
35	451	450	450	455	455
45	375	374	376	381	382
55	281	277	280	289	290
65	168	164	168	177	178
75	61	59	61	64	65
85	8	7	7	6	5
90	0	0	0	0	0

Illuminance at Distance

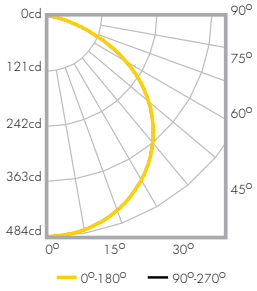


23.7 ft (7.2 m)
1 fc @ nadir maximum distance

Lumencove® RO 4'
3000K
frosted lens

Lamping	25 W
Lumens	1286
Efficacy	51 lm/W

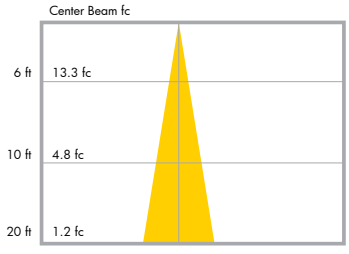
Polar Candela Distribution



Candela Table

	0	22.5	45	67.5	90
0	480	480	480	480	480
5	479	477	477	480	482
15	462	461	461	465	466
25	431	430	430	433	434
35	384	382	382	387	387
45	319	318	319	324	325
55	239	236	238	246	247
65	143	140	143	151	151
75	51	50	52	54	55
85	5	5	4	4	3
90	0	0	0	0	0

Illuminance at Distance



21.9 ft (6.6 m)
1 fc @ nadir maximum distance

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Sustainable architectural LED lighting systems

SPECIFICATION SHEET

lumencove®

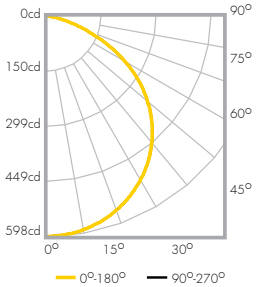
WHITE & STATIC COLORS

PHOTOMETRICS

Lumencove® RO 4'
4000K
clear lens

Lamping	25 W
Lumens	1627
Efficacy	65 lm/W

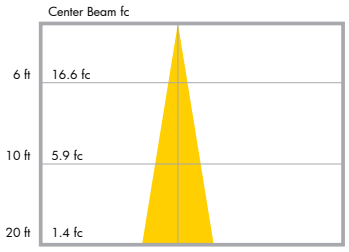
Polar Candela Distribution



Candela Table

	0	22.5	45	67.5	90
0	598	598	598	598	598
5	596	596	596	596	596
15	577	577	577	577	577
25	540	540	540	540	540
35	484	484	484	484	484
45	408	408	408	408	408
55	309	309	309	309	309
65	186	186	186	186	186
75	67	67	67	67	67
85	8	8	8	8	8
90	0	0	0	0	0

Illuminance at Distance

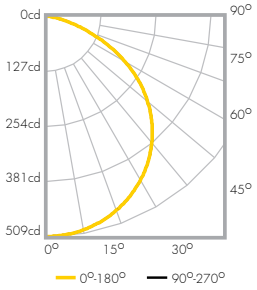


24.4 ft (7.4 m)
1 fc @ nadir maximum distance

Lumencove® RO 4'
4000K
frosted lens

Lamping	25 W
Lumens	1383
Efficacy	55 lm/W

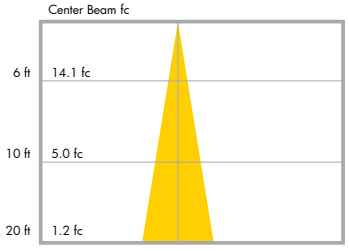
Polar Candela Distribution



Candela Table

	0	22.5	45	67.5	90
0	509	509	509	509	509
5	507	507	507	507	507
15	491	491	491	491	491
25	459	459	459	459	459
35	411	411	411	411	411
45	346	346	346	346	346
55	262	262	262	262	262
65	158	158	158	158	158
75	57	57	57	57	57
85	6	6	6	6	6
90	0	0	0	0	0

Illuminance at Distance



22.5 ft (6.8 m)
1 fc @ nadir maximum distance

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SPECIFICATION SHEET

lumencove®

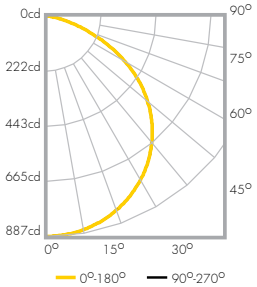
WHITE & STATIC COLORS

PHOTOMETRICS

Lumencove® HO 4'
2700K
clear lens

Lamping	45 W
Lumens	2412
Efficacy	53 lm/W

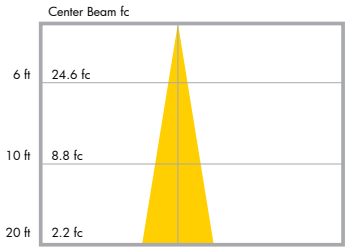
Polar Candela Distribution



Candela Table

	0	22.5	45	67.5	90
0	887	887	887	887	887
5	884	884	884	884	884
15	856	856	856	856	856
25	801	801	801	801	801
35	717	717	717	717	717
45	604	604	604	604	604
55	457	457	457	457	457
65	275	275	275	275	275
75	99	99	99	99	99
85	11	11	11	11	11
90	0	0	0	0	0

Illuminance at Distance

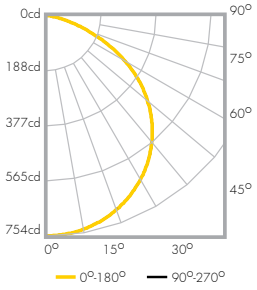


29.7 ft (9.0 m)
1 fc @ nadir maximum distance

Lumencove® HO 4'
2700K
frosted lens

Lamping	45 W
Lumens	2050
Efficacy	45 lm/W

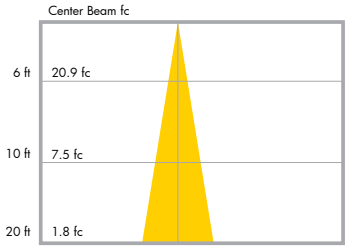
Polar Candela Distribution



Candela Table

	0	22.5	45	67.5	90
0	754	754	754	754	754
5	751	751	751	751	751
15	727	727	727	727	727
25	681	681	681	681	681
35	610	610	610	610	610
45	514	514	514	514	514
55	389	389	389	389	389
65	234	234	234	234	234
75	84	84	84	84	84
85	10	10	10	10	10
90	0	0	0	0	0

Illuminance at Distance

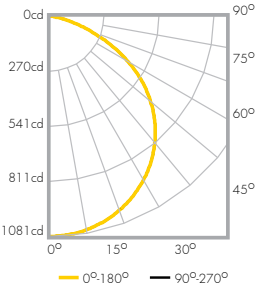


27.4 ft (8.3 m)
1 fc @ nadir maximum distance

Lumencove® HO 4'
3000K
clear lens

Lamping	45 W
Lumens	2876
Efficacy	63 lm/W

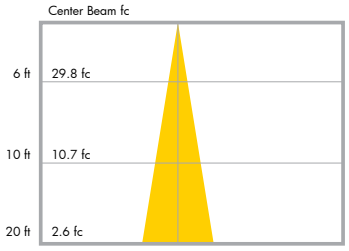
Polar Candela Distribution



Candela Table

	0	22.5	45	67.5	90
0	1075	1075	1075	1075	1075
5	1071	1067	1067	1074	1077
15	1034	1031	1032	1039	1041
25	964	961	961	969	970
35	858	855	855	865	865
45	713	711	714	725	727
55	534	527	533	550	552
65	319	313	319	337	338
75	115	113	116	122	123
85	15	14	14	12	11
90	0	0	0	0	0

Illuminance at Distance

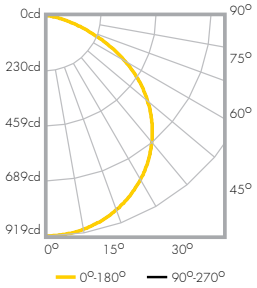


32.7 ft (9.9 m)
1 fc @ nadir maximum distance

Lumencove® HO 4'
3000K
frosted lens

Lamping	45 W
Lumens	2444
Efficacy	54 lm/W

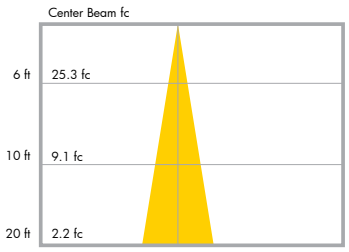
Polar Candela Distribution



Candela Table

	0	22.5	45	67.5	90
0	913	913	913	913	913
5	910	907	907	913	915
15	879	876	877	883	885
25	819	817	817	824	824
35	729	727	727	735	735
45	606	604	607	616	618
55	453	448	453	467	469
65	271	266	271	286	288
75	98	96	99	104	105
85	13	12	12	10	9
90	0	0	0	0	0

Illuminance at Distance



30.2 ft (9.2 m)
1 fc @ nadir maximum distance

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SPECIFICATION SHEET

lumencove®

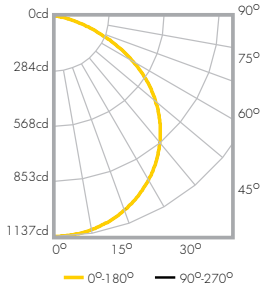
WHITE & STATIC COLORS

PHOTOMETRICS

Lumencove® HO 4′
4000K
clear lens

Lamping	45 W
Lumens	3092
Efficacy	68 lm/W

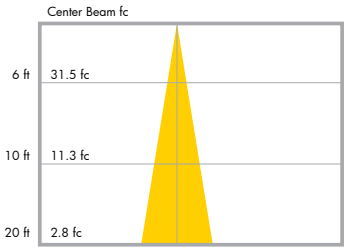
Polar Candela Distribution



Candela Table

	0	22.5	45	67.5	90
0	1137	1137	1137	1137	1137
5	1133	1133	1133	1133	1133
15	1097	1097	1097	1097	1097
25	1026	1026	1026	1026	1026
35	919	919	919	919	919
45	775	775	775	775	775
55	586	586	586	586	586
65	353	353	353	353	353
75	126	126	126	126	126
85	14	14	14	14	14
90	0	0	0	0	0

Illuminance at Distance

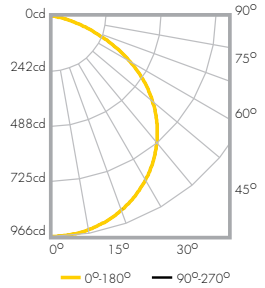


33.7 ft (10.2 m)
1 fc @ nadir maximum distance

Lumencove® HO 4′
4000K
frosted lens

Lamping	45 W
Lumens	2628
Efficacy	58 lm/W

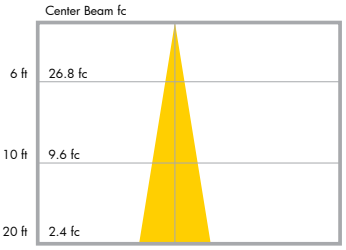
Polar Candela Distribution



Candela Table

	0	22.5	45	67.5	90
0	966	966	966	966	966
5	963	963	963	963	963
15	932	932	932	932	932
25	872	872	872	872	872
35	781	781	781	781	781
45	658	658	658	658	658
55	498	498	498	498	498
65	300	300	300	300	300
75	107	107	107	107	107
85	12	12	12	12	12
90	0	0	0	0	0

Illuminance at Distance



31.0 ft (9.4 m)
1 fc @ nadir maximum distance

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SPECIFICATION SHEET

lumencove®

WHITE & STATIC COLORS

ACCESSORIES

Order separately

Control Systems:

LTO Lumentouch is a wall mount DMX 512 controller keypad

LCU Lumencue is a USB / mini SD DMX 512 controller

LID LumenID is a diagnostic and addressing DMX 512 controller.
It must be specified on all DMX applications.
Refer to LID specification sheet for details.

LTN Lumentone is a simple pre-programmed DMX 512 controller
with a push button rotary dial and live feedback.

CBOX :

iCBOX-___V-___-___ Interior DMX 512 data box.
Data input and output, M20 provision holes with plugs.
Voltage input and output, M20 provision holes with plugs.
Up to six outputs to fixtures, M20 provision holes with plugs.
Please specify desired input voltage and finish.
Refer to iCBOX specification sheet for details.

CBOX-___V-___-___ DMX 512 data box.
Data input and output, M20 provision holes with plugs.
Voltage input and output, M20 provision holes with plugs.
Up to six outputs to fixtures, M20 provision holes with plugs.
Please specify desired input voltage and finish.
Refer to CBOX specification sheet for details.

Leader Cable :

LCSLC___ Leader Cable for Lumencove® fixture (3 conductor cable).
Please add desired cable length : 6, 8 or 10 feet

LCSLCD___ Leader Cable for dimming Lumencove® fixture (5 conductor cable).
Please add desired cable length : 6, 8 or 10 feet

Jumper Cable :

LCSJC___ Jumper Cable for Lumencove® fixture (3 conductor cable).
Please add desired cable length : 1, 2, 4 or 8 feet

LCSJCD___ Jumper Cable for dimming Lumencove® fixture (5 conductor cable).
Please add desired cable length : 1, 2, 4 or 8 feet

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Sustainable architectural LED lighting systems

SPECIFICATION SHEET

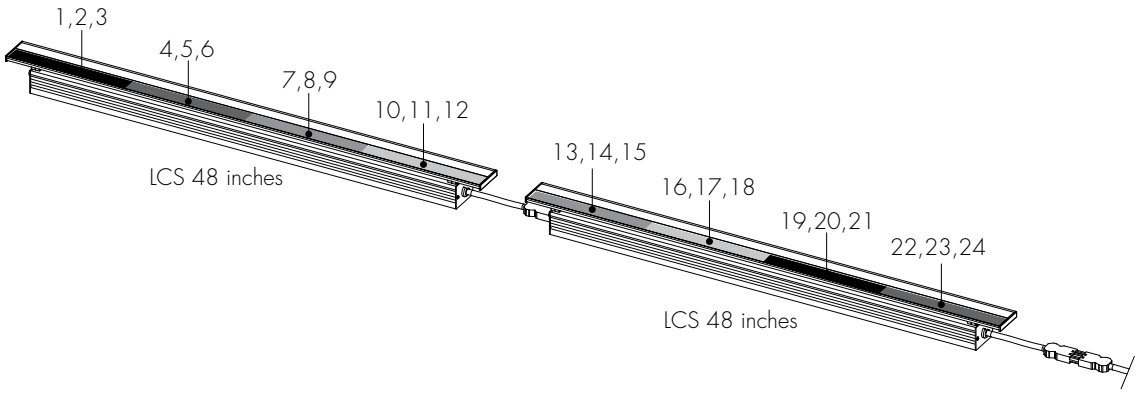
lumencove®

WHITE & STATIC COLORS

RESOLUTION DETAILS
APPLICABLE FOR DMX DIMMING OPTION ONLY

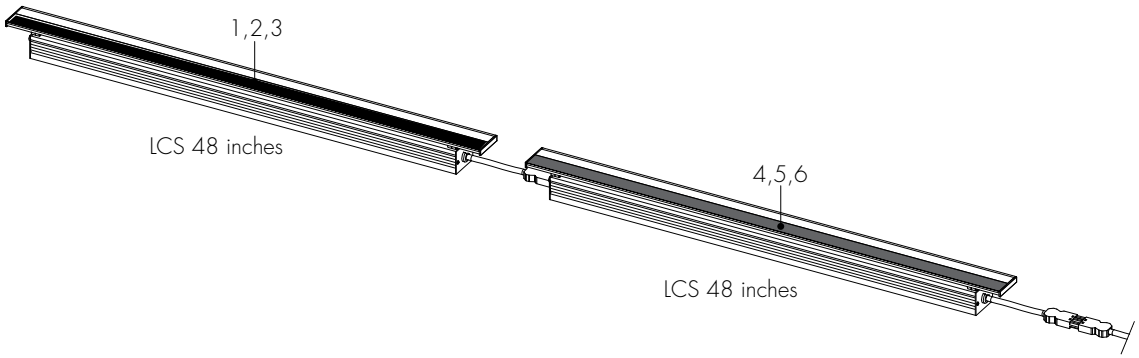
DMX 1FT - Resolution per foot: each foot is addressed independently (recommended for most installations).
1% minimum dimming value

DMX ADDRESSES:



DMX 1FX - Resolution per fixture: each fixture is addressed independently.
1% minimum dimming value

DMX ADDRESSES:



*Warning: resolution is a factory setting and cannot be changed in the field.

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info@lumenpulse.com **www.lumenpulse.com**

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Sustainable architectural LED lighting systems

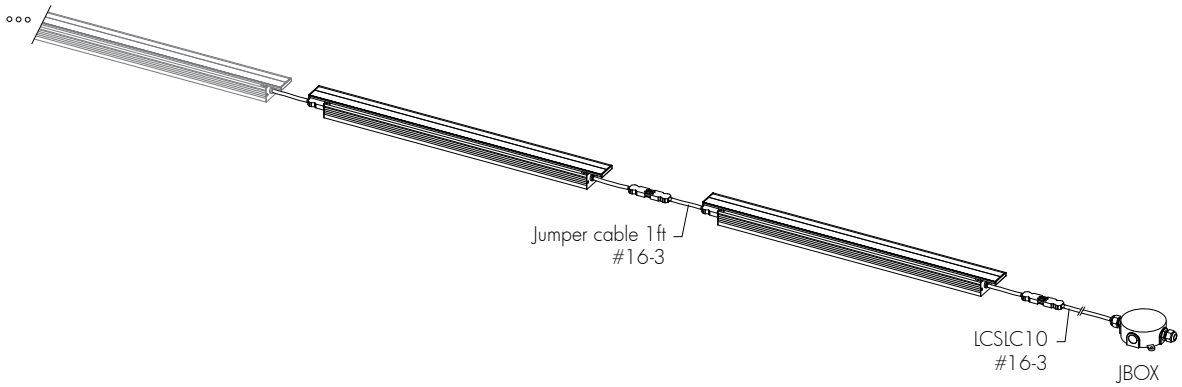
SPECIFICATION SHEET

lumencove®

WHITE & STATIC COLORS

TYPICAL WIRING DIAGRAMS

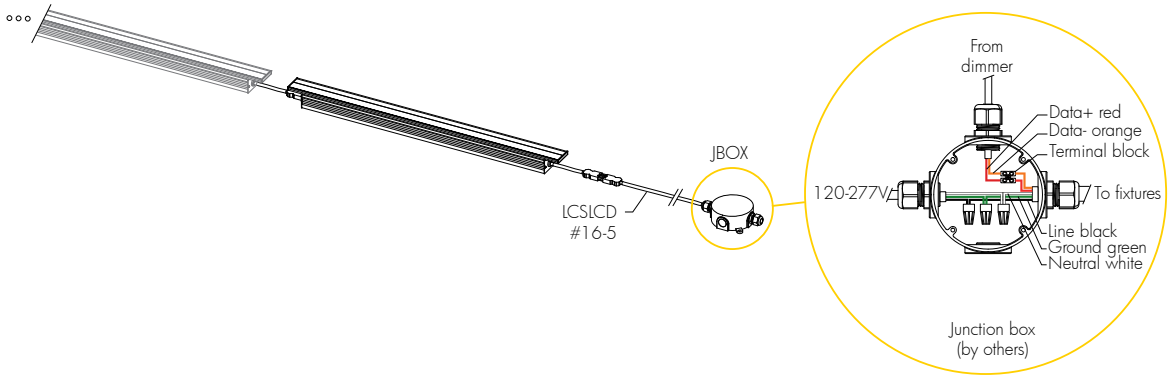
Non-Dimming Version



Maximum run length by 15A circuit - Lumencove® RO 6W/ft			
Cable length/Voltage	**120V**	**240V**	**277V**
10ft leader cable	180ft	292ft	300ft
50ft leader cable	152ft	260ft	292ft
Maximum run length by 15A circuit - Lumencove® HO 12W/ft			
Cable length/Voltage	**120V**	**240V**	**277V**
10ft leader cable	112ft	180ft	200ft
50ft leader cable	88ft	152ft	172ft

Dimming Version (0-10V)

10% minimum dimming value



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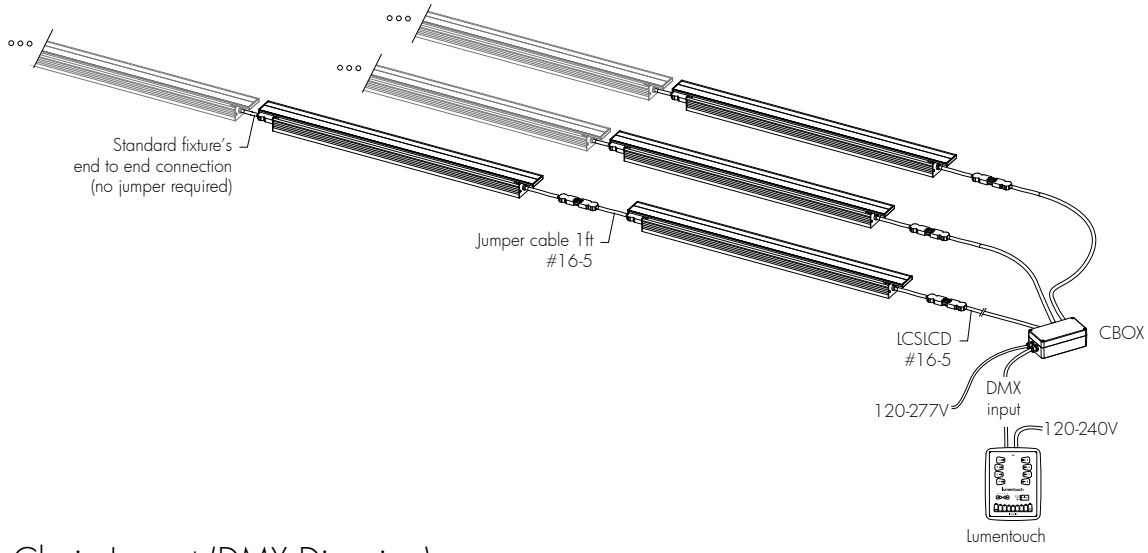
TYPICAL WIRING DIAGRAMS

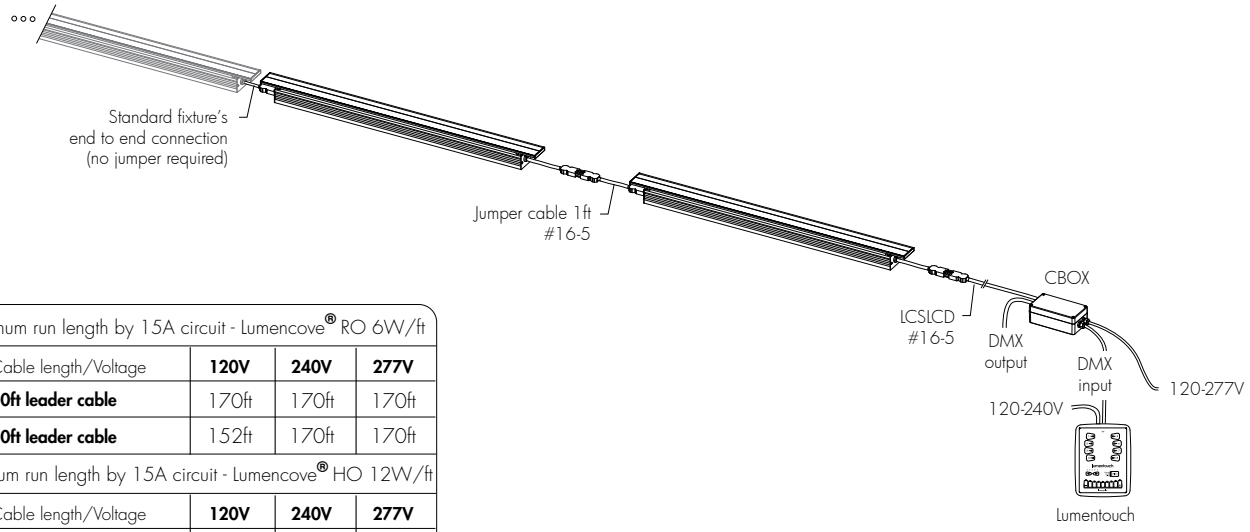
Star Layout (DMX Dimming)

*Make sure that the addition of all cable lengths and fixture lengths for each run do not exceed the recommended limit.
1% minimum dimming value



Daisy Chain Layout (DMX Dimming)

1% minimum dimming value



Maximum run length by 15A circuit - Lumencove® RO 6W/ft			
Cable length/Voltage	**120V**	**240V**	**277V**
10ft leader cable	170ft	170ft	170ft
50ft leader cable	152ft	170ft	170ft
Maximum run length by 15A circuit - Lumencove® HO 12W/ft			
Cable length/Voltage	**120V**	**240V**	**277V**
10ft leader cable	112ft	170ft	170ft
50ft leader cable	88ft	152ft	170ft

*Up to 170 individually addressable 1 foot sections per DMX run.
Consult factory for specific applications.

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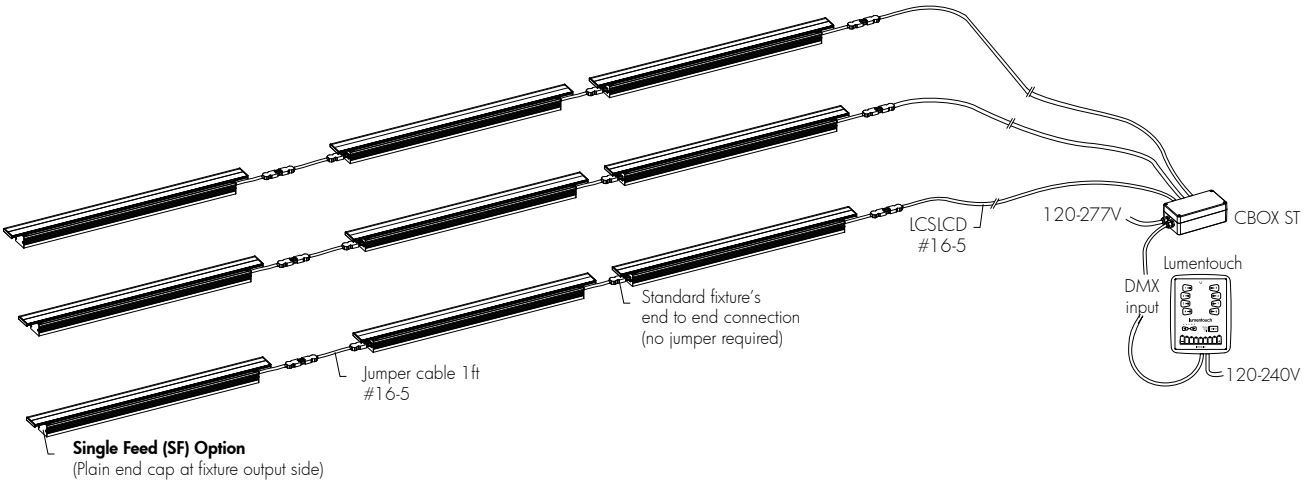
TYPICAL WIRING DIAGRAMS - Single Feed Option Shown

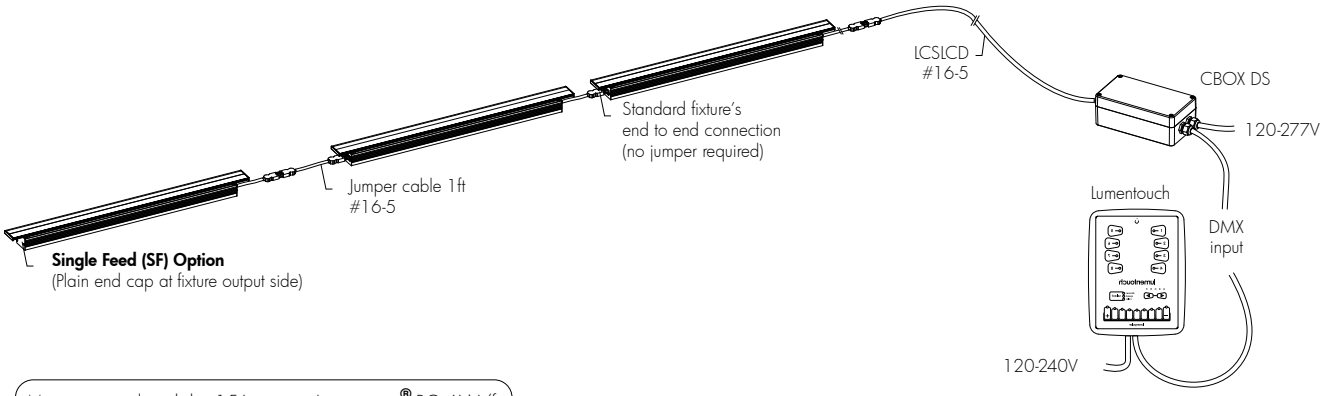
Star Layout (DMX Dimming)

*Make sure that the addition of all cable lengths and fixture lengths for each run do not exceed the recommended limit.
1% minimum dimming value



Daisy Chain Layout (DMX Dimming)

1% minimum dimming value



Maximum run length by 15A circuit - Lumencove® RO 6W/ft			
Cable length/Voltage	**120V**	**240V**	**277V**
10ft leader cable	170ft	170ft	170ft
50ft leader cable	152ft	170ft	170ft
Maximum run length by 15A circuit - Lumencove® HO 12W/ft			
Cable length/Voltage	**120V**	**240V**	**277V**
10ft leader cable	112ft	170ft	170ft
50ft leader cable	88ft	152ft	170ft

*Up to 170 individually addressable 1 foot sections per DMX run.
Consult factory for specific applications.

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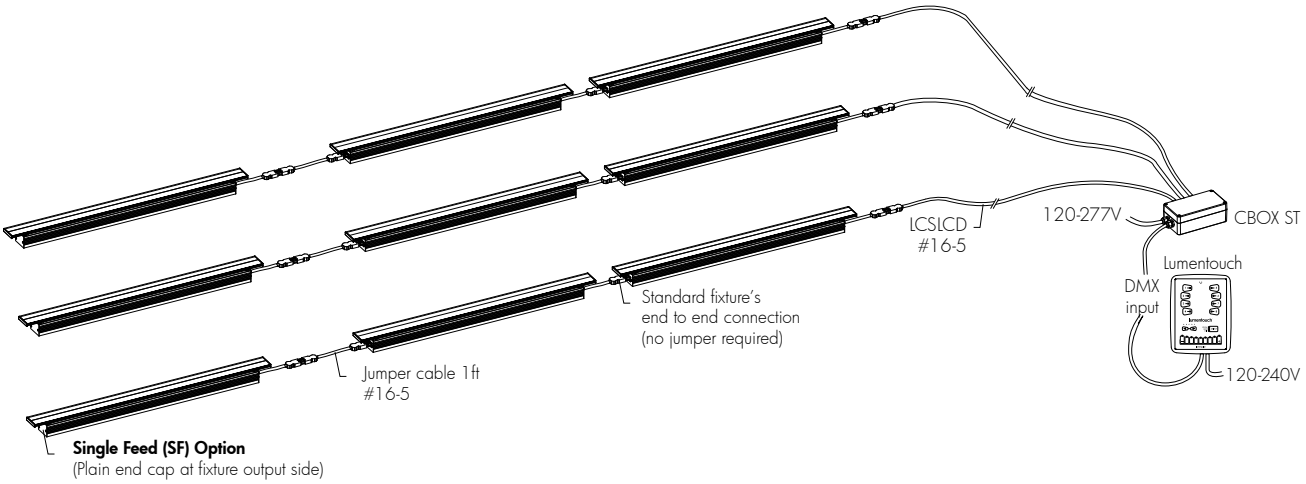
WHITE & STATIC COLORS

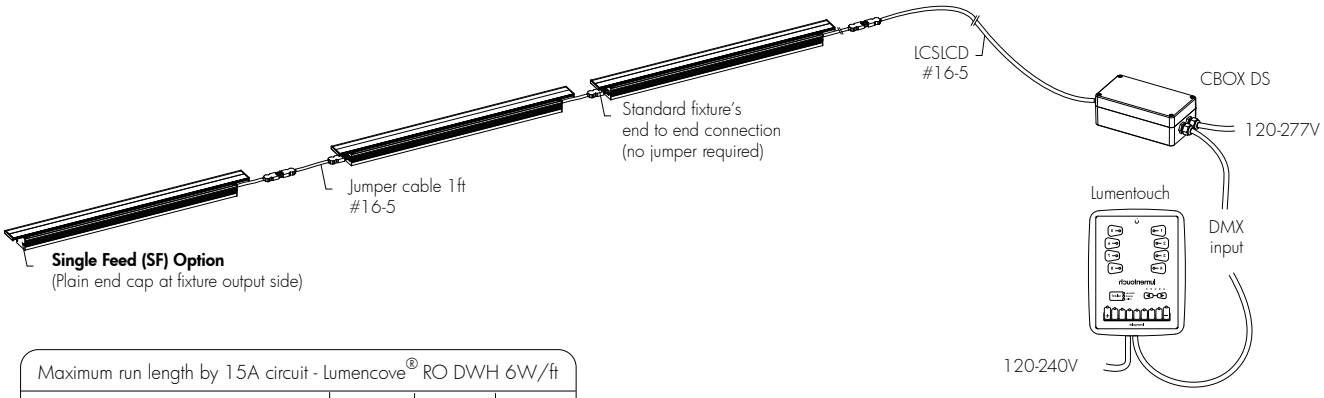
TYPICAL WIRING DIAGRAMS - Single Feed Option Shown

Star Layout

*Make sure that the addition of all cable lengths and fixture lengths for each run do not exceed the recommended limit.



Daisy Chain Layout



Maximum run length by 15A circuit - Lumencove® RO DWH 6W/ft			
Cable length/Voltage	**120V**	**240V**	**277V**
10ft leader cable	170ft	170ft	170ft
50ft leader cable	152ft	170ft	170ft
Maximum run length by 15A circuit - Lumencove® HO DWH 12W/ft			
Cable length/Voltage	**120V**	**240V**	**277V**
10ft leader cable	112ft	170ft	170ft
50ft leader cable	88ft	152ft	170ft

*Up to 170 individually addressable 1 foot sections per DMX run.
Consult factory for specific applications.

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WHITE & STATIC COLORS

HOW TO ORDER

LCS		48	35K	CL	RF	WH	DIM	
Housing	Voltage	Length	Colors and temperatures	Lens	Feeding Side	Finish	Dimming	Option
1	2	3	4	5	6	7	8	9

1

Housing:

LCS RO - Lumencove® Regular Output 6W/ft

LCS HO - Lumencove® High Output 12W/ft

2

Voltage:

120 - 120 volts

208 - 208 volts

240 - 240 volts

277 - 277 volts

3

Length:

12 - 12 3/8 inches (314mm) (0.72 kg/1.59 lbs)

24 - 24 3/16 inches (614mm) (1.45 kg/3.19 lbs)

36 - 36 inches (914mm) (2.16 kg/4.77 lbs)

48 - 47 13/16 inches (1214mm) (2.57 kg/5.68 lbs)

96 - 94 3/4 inches (2406mm) (5.76 kg/12.72 lbs)

4

Colors and Color temperatures:

27K - 2700K

30K - 3000K

35K - 3500K

40K - 4000K

RD - Red

GR - Green

BL - Blue

5

Lens:

CL - Clear lens

FR - Frosted lens

6

Feeding Side:

Please specify one of the following:

(Right Feeding side is standard unless otherwise specified)

LF - Left Feeding side

RF - Right Feeding side

7

Finish:

WH - White (standard finish)

CC - Custom (please specify RAL color)

8

Dimming:

DIM - 0-10V Dimming option (10% minimum dimming value)

DMX 1FT - DMX Dimming option, resolution per foot (1% minimum dimming value)

DMX 1FX - DMX Dimming option, resolution per fixture (1% minimum dimming value)

DALI - DALI Dimming option (1% minimum dimming value)

NO - No Dimming

9

Option:

SF - Single Feed option
(Plain end cap at fixture output side)

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Sustainable architectural LED lighting systems

GentleSpace

BY461P LED240S/740 PSD WB GC SI MB

BY461P LED240S/740 PSD WB GC SI MB

BY460P - LED Module, system flux 24,000 lm - Power supply unit with DALI interface - Wide beam - Clear glass - Mounting bracket

Customers in industrial and warehousing applications are constantly looking for ways to reduce the amount of energy required to light their facilities. GentleSpace is the first LED high-bay luminaire that can directly replace HID high-bays of up to 400 W, enabling significant energy savings. LEDs also provide instant light and the possibility to dim the light level. And GentleSpace is DALI-dimmable, so even more energy can be saved.The luminaire comes in two sizes and offers a choice of dedicated high-quality optics, which fill the space with a gentle, comfortable light. All versions include steady Gripple Y-fit hangers that can carry up to 45 kg for easy and secure installation. GentleSpace is also equipped with a high-quality, thermally toughened, extra-white glass cover for high translucence. Its flat design saves space at the top of the building, leaving room for e.g. sprinkler installations

Product data

• General information

Product family code	BY460P [BY460P]
Number of light sources	128 [128 pcs]
Lamp family code	LED240S [LED Module, system flux 24,000 lm]
Beam angle of light source	100 D [100°]
Light source color	740 [740 cool white]
Light source replaceable	true [Yes]
Driver/power unit/ transformer	PSD [Power supply unit with DALI interface]
Driver included	true [Yes]
Optic type	WB [Wide beam]
Optical cover/lens type	GC [Clear glass]
Embedded control	No [-]
Dimmable	Yes [Yes]
Protection class IEC	CLI [Safety class I]
Ingress protection code	IP65 [Dust penetration-protected, jet-proof]
Mech. impact protection code	IK08 [5 J vandal-protected]
Color	SI [Silver]
Glow-wire test	650/5 [Temperature 650 °C, duration 5 s]
Flammability mark	D [For mounting on easily flammable surfaces]
CE mark	CE [CE mark]
ENEC mark	ENEC [ENEC mark]
Ball impact resistance mark	No [-]

• Electrical

Input voltage	220-240 V [220 to 240 V]
Input frequency	50-60 Hz [50 to 60 Hz]
Control signal voltage	0-16 V [0-16 V DC DALI]

• Mechanical

Housing material	ALU [Aluminum]
Optic material	PMMA [Polymethyl methacrylate]
Optical cover/lens material	G [Glass]
Suspension accessories	MB [Mounting bracket]

• Initial perform. (IEC compliant)

Initial input power	267 W [267 W]
Initial luminous flux	24000 Lm
Initial LED luminaire efficacy	90 Lm/W
Init. Corr. Color Temperature	4000 [4000 K]
Init. Color Rendering Index	76 [76]

PHILIPS

GentleSpace

- Over time perform. (IEC compliant)

Median useful life L90B50	25000 hr
Median useful life L80B50	50000 hr
Driver failure rate at 5000 h	1 %

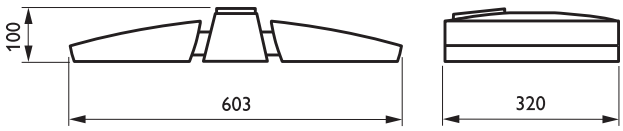
- Application conditions

Average ambient temperature	T25 [+25 °C]
Ambient temperature range	-30 to +45°C [-30 to +45 °C]
Maximum dim level	- [Not applicable]
Suitable for random switching	Yes [Yes (relates to presence/ movement detection and daylight harvesting)]

- Product Data

Order code	910930204012
Full product code	910930204012
Full product name	BY461P LED240S/740 PSD WB GC SI MB
Order product name	BY461P LED240S/740 PSD WB GC SI MB
Pieces per pack	0
Packs per outerbox	1
Bar code on outerbox - EAN3	8718291075134
Logistic code(s) - 12NC	910930204012
Net weight per piece	18.600 kg

Dimensional drawing



BY461P LED240S/740 PSD WB GC SI MB

Recessed wall luminaires with adjustable light distribution

Housing: Die-cast aluminum with integral wiring compartment. Provided with two ⅞" openings suitable for ½" conduit, rated for through wiring, maximum of four (4) No. 12 AWG conductors (plus ground) suitable for 90° C. All aluminum used in the construction is marine grade and copper free.

Enclosure: A clear, tempered glass diffuser is secured by a die-cast aluminum faceplate. Faceplate is secured by captive, stainless steel fasteners threaded into stainless steel inserts. Fully gasketed for weather tight operation using a molded silicone gasket.

Adjustable optical assembly: A reflector of pure anodized aluminum is adjustable 0° to 30° vertical in 5° increments and 180° horizontal. The reflector can be locked in place with an internal fastener. Internal color filters, spread lens and a glare shield may be added as accessories.

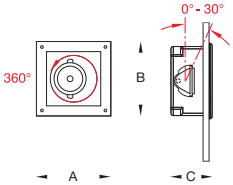
Electrical: Porcelain bi-pin lamp holder with nickel plated copper contacts for GU6.5 base T4 metal halide lamps. 120 V or 277 V internal electronic ballast - specify.

Finish: Available in four standard BEGA colors: Black (BLK); White (WHT); Bronze (BRZ); Silver (SLV). To specify, add appropriate suffix to catalog number. Custom colors supplied on special order.

UL listed, suitable for wet locations and for installation within 3 feet of ground.
Protection class: IP 65.

Temperature caution: The column 'T' in this chart indicates the temperature in degrees Celsius which is reached on the center of the glass surface during operation, measured at an ambient temperature of approximately 25°C.

Type:
BEGA Product: 2198 MH
Project:
Voltage:
Color:
Options:
Modified:



Recessed floodlights · **adjustable**

		Lamp	Lumen	T	A	B	C						
2198 MH	ADA	1 20 W T4 GU6.5 MH	1615	68.7°	7½	7½	5½	**648**	**115**	**116**	**117**	**200**	**213**

Louver · Color effect filters · Diffuser lenses · Wide beam · Flat beam

BEGA-US 1000 BEGA Way, Carpinteria, CA 93013 (805) 684-0533 FAX (805) 566-9474 www.bega-us.com

Drive-over in-grade linear floodlights with LEDs - Asymmetrical

Type:
BEGA Product: 7917LED
Project:
Voltage:
Color:
Options:
Modified:

Enclosure: Outer housing: Constructed of high tensile strength, copper free die-cast aluminum alloy.

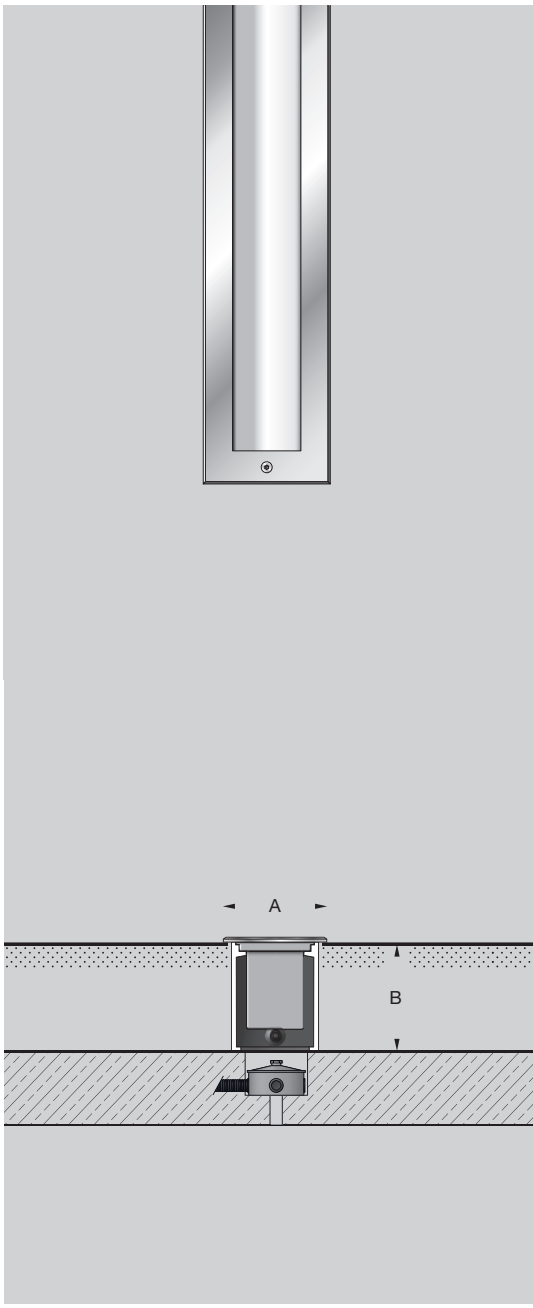
Inner housing: Constructed of extruded stainless steel. Trim/Faceplate is heavy gauge, machined stainless steel secured to the inner housing by stainless steel threaded welded studs. Maintenance requires removal of inner housing/trim/faceplate assembly from outer housing by means of two flush, socket head stainless steel screws. ¼" thick tempered matte safety glass machined flush to faceplate. One piece molded U-channel, high temperature silicone gasket. Reflector is aluminum with high gloss coating.

Electrical: 22 W LED luminaire, 27 total system watts, -30° C start temperature. Integral 120 V through 277 V electronic LED driver, 0-10 V dimming. Standard LED color temperature is 4000K with a >80 CRI. Available in 3000K (>80 CRI); add suffix K3 to order. Inner housing pre-wired with nine (9) feet of 18/3 water stopper cable, cable clamp, and waterproof cable gland entry into housing. A separate weatherproof single gang wiring box for power supply must be proved (by contractor).
Note: Due to the dynamic nature of LED technology, LED luminaire data on this sheet is subject to change at the discretion of BEGA-US. For the most current technical data, please refer to www.bega-us.com.

Finish: #4 brushed stainless steel. Custom colors are not available.

CSA certified to U.S. and Canadian standards, suitable for wet locations. Protection class IP67.

Note: A foundation and proper drainage must be supplied by the contractor. These luminaires are designed to bear pressure loads up to 2,200 lbs. from vehicles with pneumatic tires. The luminaires must not be used for traffic lanes where they are subject to horizontal pressure from vehicles braking, accelerating and changing direction.



Floodlights · **Asymmetrical**

	Lamp	A	B
7917 LED	19.8 W LED	20⅞ x 3½	5

SPECIFICATION SHEET

lumenbeam™

GRANDE
WHITE & STATIC COLORS

Client: _____

Project name: _____

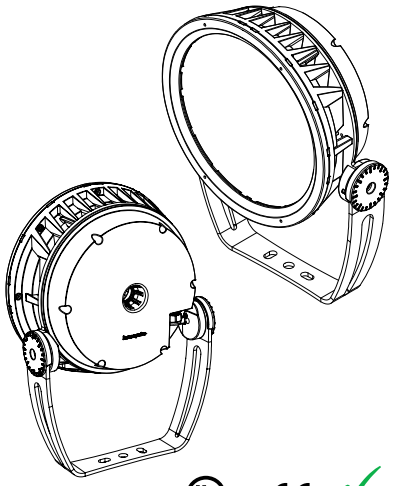
Order #: LBG-277-40K-WFL-LSLH-BK-NO-TBD

Type: _____ Qty: _____

FEATURES AND BENEFITS

Physical :

- Low copper content high pressure die-cast aluminum housing
- Heavy aluminum formed yoke (standard yoke included)
- Stainless steel hardware
- Silicone sealing devices
- Clear tempered glass
- Dual chamber design for heat management and ease of maintenance
- Electro-statically applied polyester powder coat finish
- 10.90 kg / 24 lbs
- EPA: Front = 1.60 sq. ft. / 0.15 sq. m. Side = 0.97 sq. ft./ 0.090 sq. m.
- IP66
- Corrosion-resistant option for marine environments
- Meets 3G ANSI C136.31 Vibration standard for bridge applications



Performance :

- Minimum 1fc (10.7 lux) @ 571 feet (174m) distance (4000K, 6° optic)
- 5,178 delivered lumens and 326,433 candelas at nadir (4000K, 6° optic)
- 6°, 10°, 20°, 40° or 60°, Elliptical distribution on 10° to 20° optics
- Lumen maintenance 120,000 hrs [L70 @ 25°C]
- Resolution per board or per fixture (see page 6)
- Lumen measurements comply with LM - 79 - 08 standard
- Operating temperatures: -25° C to 50° C [-13F to 122F]

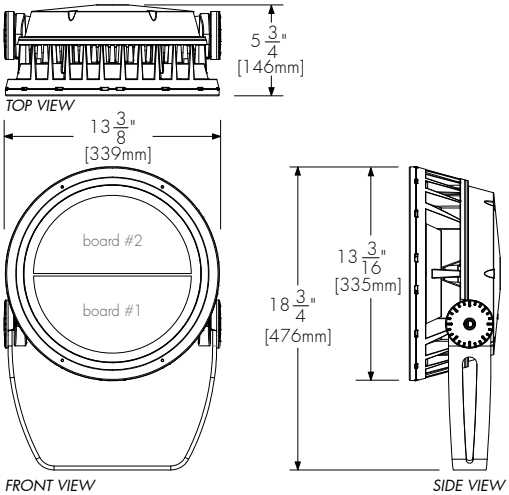
Electrical :

- Line voltage luminaire for 120 to 277V
- Power and data in 1 cable, 3ft/1 m cord (#16-5)
- 48 LEDs (24 LEDs per board)
- 100W
- Dimming options: 0-10 volt, DMX, DALI, Lumentalk, or Lutron® EcoSystem® enabled

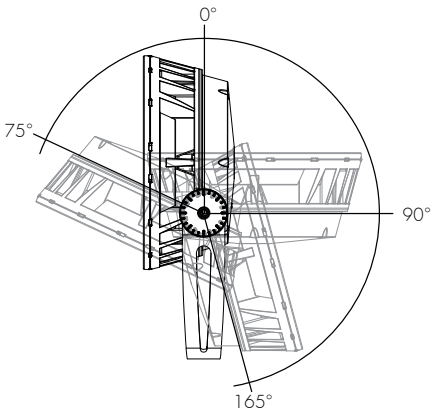
lumentalk™ EcoSystem® Enabled

Wiring detail

CE wire color	*US wire color*	*USE*
Yellow/Green	*Green*	*Ground*
Blue	*White*	*Neutral*
Brown	*Black*	*Live 120-277V*
Black	*Red*	*0-10V / data +*
Grey	*Orange*	*0-10V / data -*



Standard Yoke (as shown, included)



Standard Yoke Mounting
Adjustable pivot limits

5 year warranty

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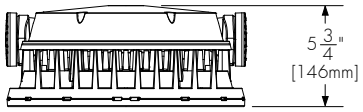
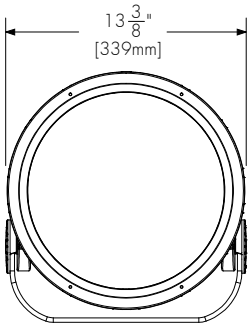
SPECIFICATION SHEET

lumenbeam™

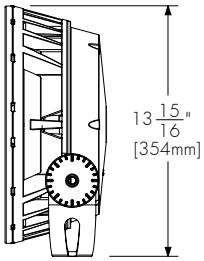
GRANDE
WHITE & STATIC COLORS

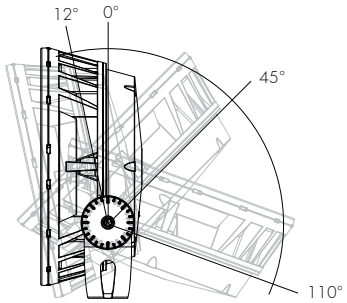
MOUNTING OPTION



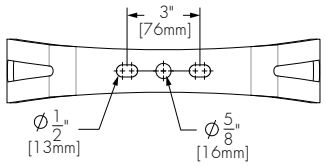


SY
Short Yoke mounting



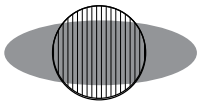


Short Yoke mounting
adjustable pivot limits



Standard and Short Yoke mounting
holes pattern

OPTICAL OPTIONS
***Factory installed**



LSLH
Linear Spread Lens
Horizontal distribution
(not adjustable on site)

LSLV
Linear Spread Lens
Vertical distribution
(not adjustable on site)

Factory installed, available for 6° to 20° optics.
See Optical Accessories for field adjustable spread lens.
*See photometric section for optical performance data with the spread lens.

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EM - R4

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Sustainable architectural LED lighting systems

SPECIFICATION SHEET

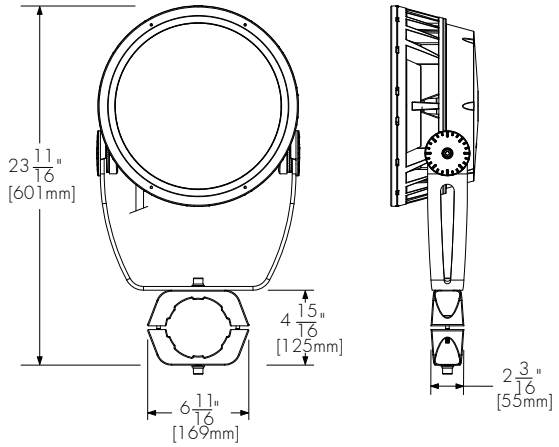
lumenbeam™

GRANDE
WHITE & STATIC COLORS

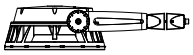
ACCESSORIES

Order separately

Mounting Accessories



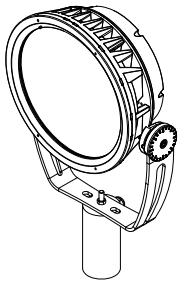
PM
Round Pole Mounting Accessory
*Consult factory for square pole section



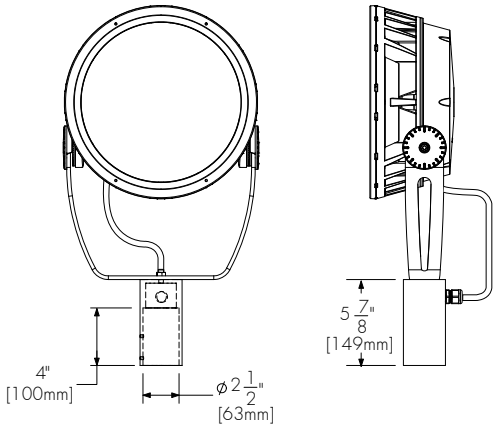
PM4-1, PM4.5-1, PM5-1
Round Pole Mounting accessory
single fixture

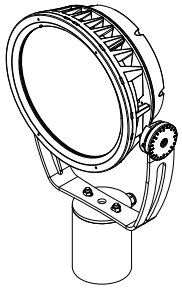
PM4-2, PM4.5-2, PM5-2
Round Pole Mounting accessory
twin fixtures

When **PM4-2, PM4.5-2 or PM5-2** are specified, one bracket assembly is supplied per 2 fixtures unless otherwise specified.

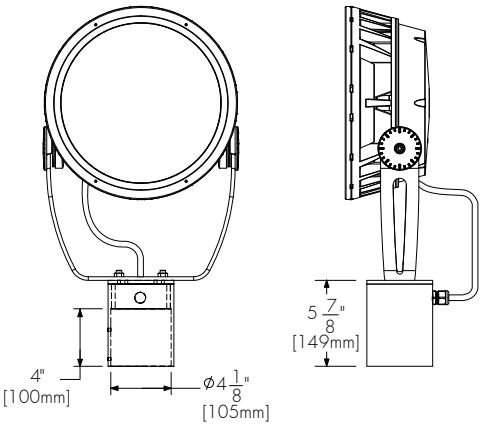


TN2
Tenon adapter
to fit on 2 3/8″ O.D. tenon





TN4
Tenon adapter
to fit on 4″ O.D. tenon



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GRANDE
WHITE & STATIC COLORS

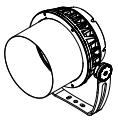
ACCESSORIES

Order separately

Optical Accessories:

LBG-SN-___-BK
*Interior surface painted black.

Snoot accessory. Please specify desired exterior finish :
SI - Silver SandText
BKM - Matte black
WH - White
CC - Custom, please specify RAL color



LBG-SNW-___-BK
*Interior surface painted black.

Snoot Wide accessory. Please specify desired exterior finish :
SI - Silver SandText
BKM - Matte black
WH - White
CC - Custom, please specify RAL color

LBG-VS-___-BK
*Interior surface painted black.

Visor accessory. Please specify desired exterior finish :
SI - Silver SandText
BKM - Matte black
WH - White
CC - Custom, please specify RAL color

LBG-WG-___

Wire Guard accessory. Please specify desired exterior finish :
SI - Silver SandText
BKM - Matte black
WH - White
CC - Custom, please specify RAL color

LBG-LSLA-___

Linear Spread Lens Adjustable accessory. Please specify desired exterior finish :
SI - Silver SandText
BKM - Matte black
WH - White
CC - Custom, please specify RAL color

Accessory combinations:

+	Snoot	Snoot Wide	Visor	Wire Guard
Snoot	NO	NO	NO	YES
Visor	NO	NO	NO	YES
Linear Spread Lens Adjustable	YES	NO	YES	NO

Accessory combinations must be ordered together on a single line.
Ex: A Snoot + Wire Guard combination order code is **LBG-SN-WG-BK-BK.**

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SPECIFICATION SHEET

ACCESSORIES

Order separately

Control Systems:

LTO Lumentouch is a wall mount DMX 512 controller keypad

LCU Lumencue is a USB / mini SD DMX 512 controller

LID LumenID is a diagnostic and addressing DMX 512 controller.
It must be specified on all DMX applications.
Refer to LID specification sheet for details.

LTN Lumentone is a simple pre-programmed DMX 512 controller
with a push button rotary dial and live feedback.

CBOX :

iCBOX-___V-___-___ Interior DMX 512 data box.
Data input and output, M20 provision holes with plugs.
Voltage input and output, M20 provision holes with plugs.
Up to six outputs to fixtures, M20 provision holes with plugs.
Please specify desired input voltage and finish.
Refer to iCBOX specification sheet for details.

CBOX-___V-___-___ DMX 512 data box.
Data input and output, M20 provision holes with plugs.
Voltage input and output, M20 provision holes with plugs.
Up to six outputs to fixtures, M20 provision holes with plugs.
Please specify desired input voltage and finish.
Refer to CBOX specification sheet for details.

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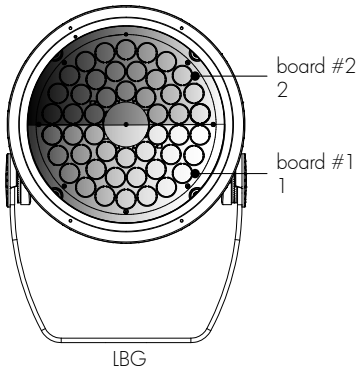
SPECIFICATION SHEET

RESOLUTION DETAILS
APPLICABLE FOR DMX DIMMING OPTION ONLY

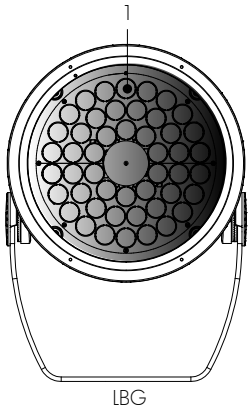
DMX 1BD - Resolution per board: each board is addressed independently (recommended for most installations).

DMX ADDRESSES:



DMX 1FX - Resolution per fixture: each fixture is addressed independently

DMX ADDRESSES:



*Warning: resolution is a factory setting and cannot be changed in the field.

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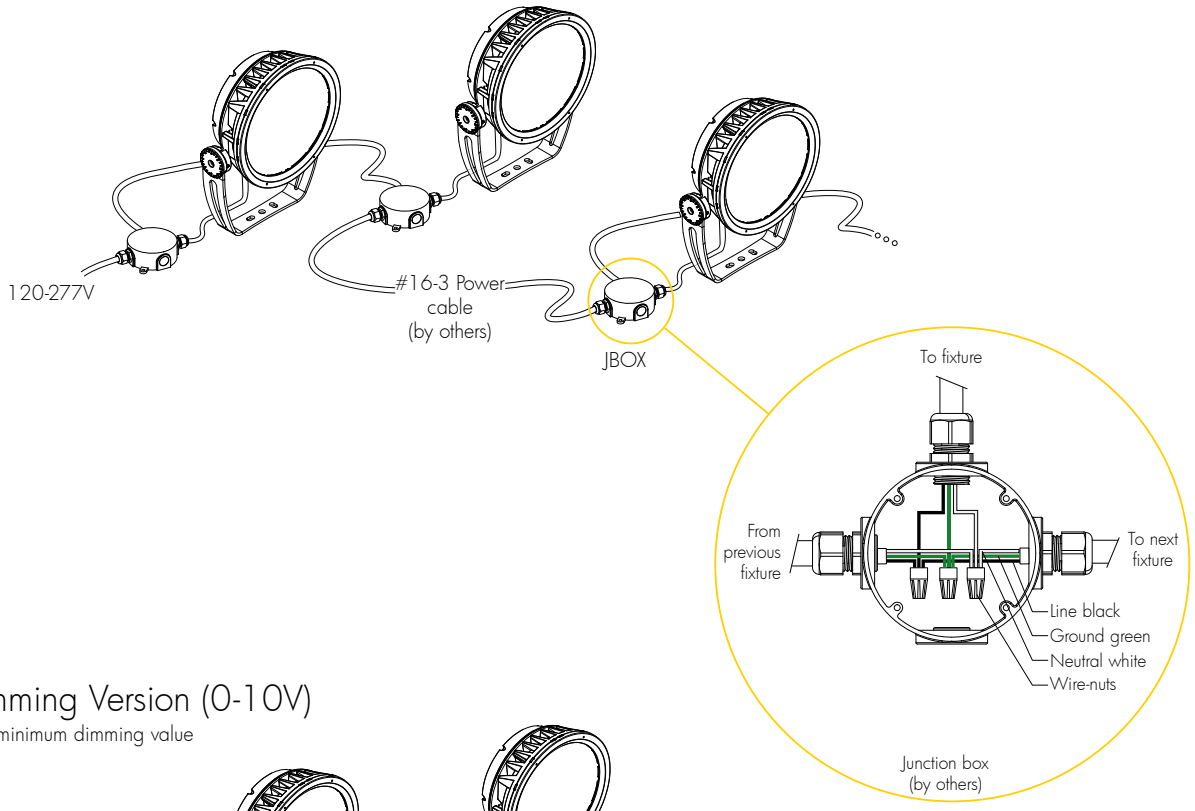
SPECIFICATION SHEET

lumenbeam™

GRANDE
WHITE & STATIC COLORS

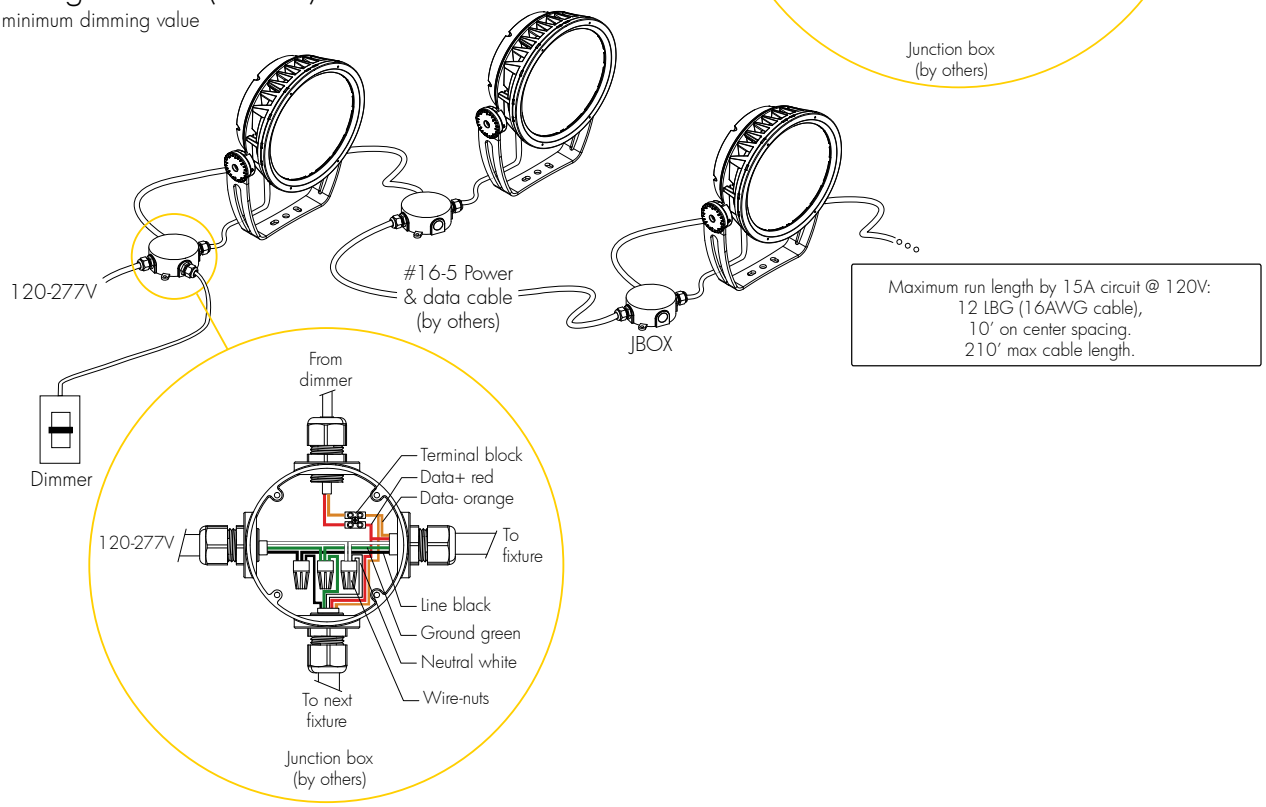
TYPICAL WIRING DIAGRAMS

Non-Dimming or Lumentalk Dimming Version



Dimming Version (0-10V)

10% minimum dimming value



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SPECIFICATION SHEET

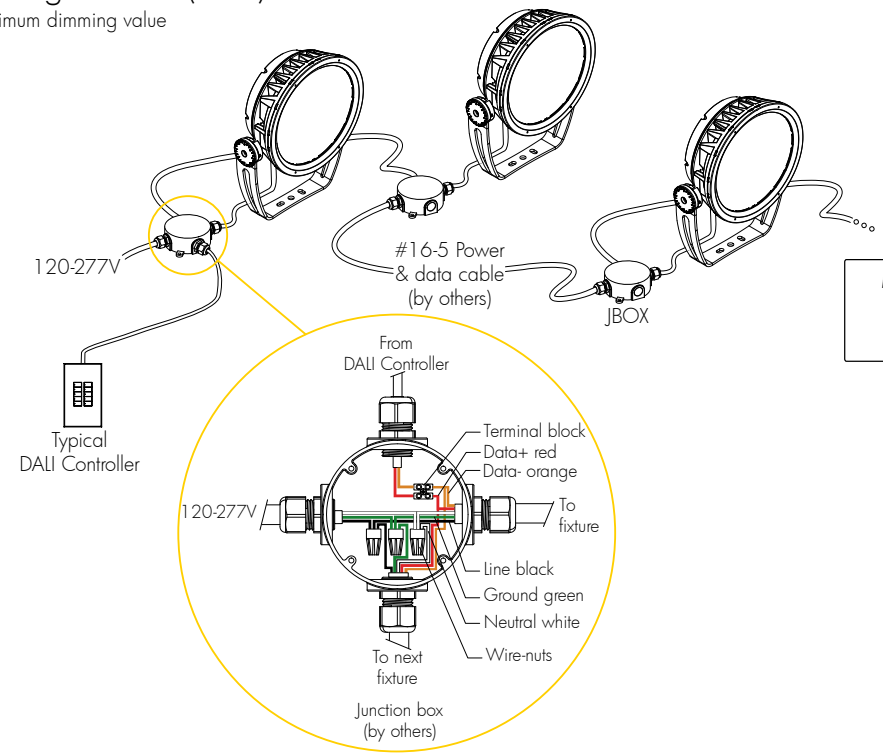
lumenbeam™

GRANDE
WHITE & STATIC COLORS

TYPICAL WIRING DIAGRAMS - continued

Dimming Version (DALI)

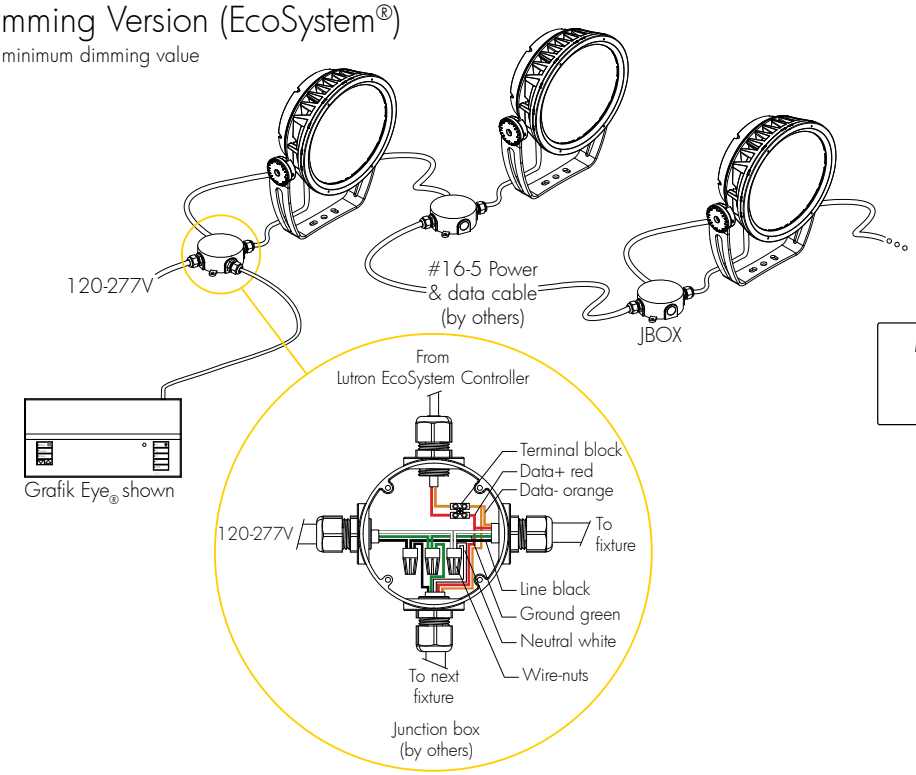
1% minimum dimming value



Maximum run length by 15A circuit @ 120V:
12 LBG (16AWG cable),
10' on center spacing.
210' max cable length.

Dimming Version (EcoSystem®)

1% minimum dimming value



Maximum run length by 15A circuit @ 120V:
12 LBG (16AWG cable),
10' on center spacing.
210' max cable length.

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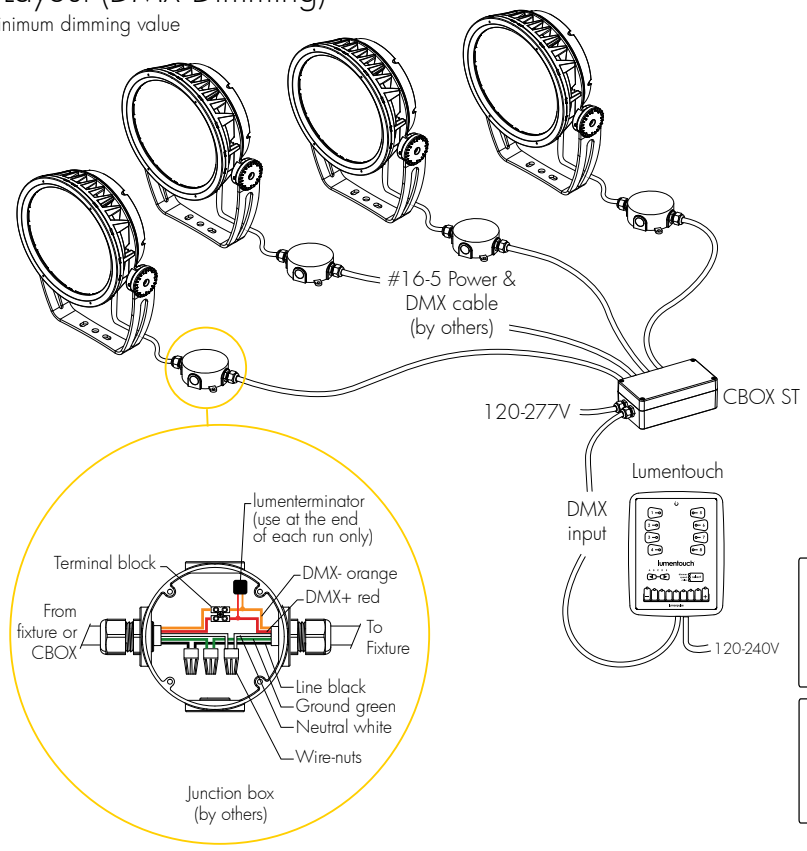
GRANDE
WHITE & STATIC COLORS

TYPICAL WIRING DIAGRAMS - continued

Star Layout (DMX Dimming)

1% minimum dimming value



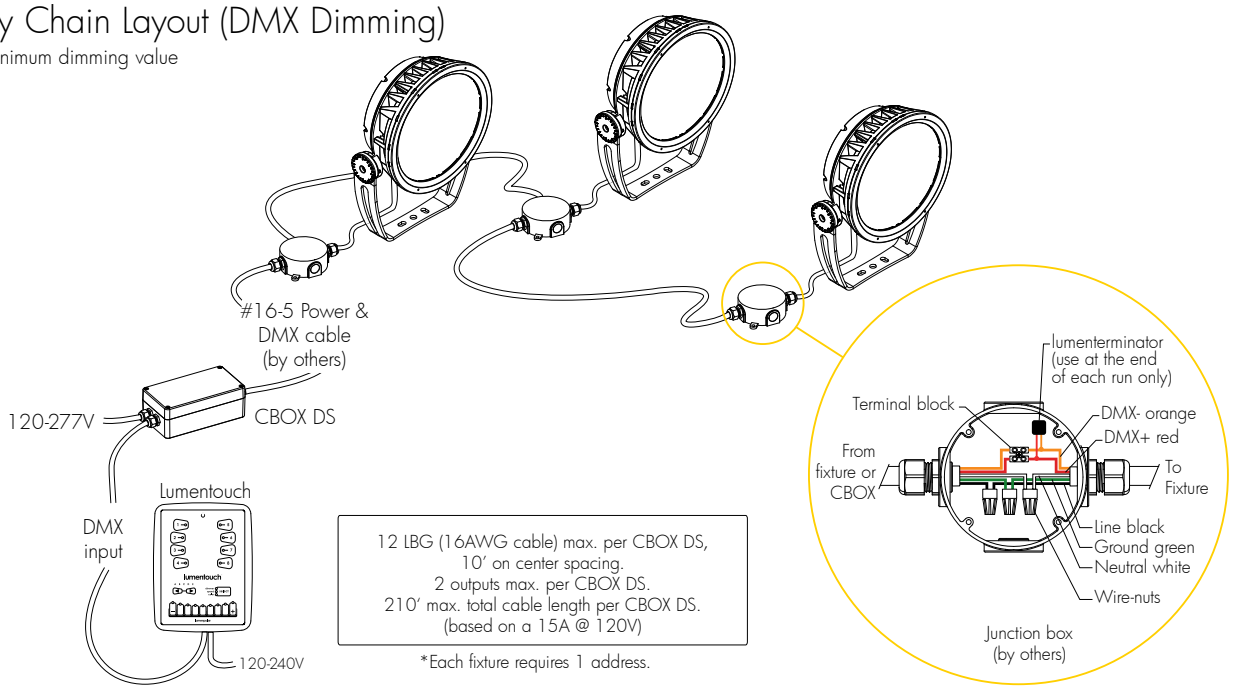
12 LBG (16AWG cable) max. per CBOX ST,
10' on center spacing.
6 outputs max. per CBOX ST.
210' max. total cable length per CBOX ST
(based on a 15A circuit @ 120V)

DMX terminator is required at the end of each run to maintain data integrity.
(2x) DMX lumenterminator included per CBOX DS
(6x) DMX lumenterminator included per CBOX ST
See installation instructions for details.

*Each fixture requires 1 address.

Daisy Chain Layout (DMX Dimming)

1% minimum dimming value



12 LBG (16AWG cable) max. per CBOX DS,
10' on center spacing.
2 outputs max. per CBOX DS.
210' max. total cable length per CBOX DS.
(based on a 15A @ 120V)

*Each fixture requires 1 address.

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SPECIFICATION SHEET

lumenbeam™

GRANDE
WHITE & STATIC COLORS

HOW TO ORDER

LBG				Select:		Select:	Select:
Housing	Voltage	Colors and color temperatures	Board 1 / Board 2 Optic	Optical Option	Finish	Dimming	Option
1	2	3	4	5	6	7	8

1

Housing:

LBG - Lumenbeam™ Grande

2

Voltage:

120 - 120 volts
208 - 208 volts
220/240 - 220 to 240 volts
277 - 277 volts

3

Colors and Color temperatures:

27K - 2700K
30K - 3000K
35K - 3500K
40K - 4000K
57K - 5700K
RD - Red
GR - Green
BL - Blue

4

Optic (Please specify for each board):

VN - Very Narrow 6°

NS - Narrow Spot 10°

NF - Narrow Flood 20°

FL - Flood 40°
(cannot be combined with other optics)

WFL - Wide Flood 60°
(cannot be combined with other optics)

5

Optical Option:

LSLH - Linear Spread Lens Horizontal distribution
LSLV - Linear Spread Lens Vertical distribution

*Factory installed, available for 6° to 20° optics.
See Optical Accessories for field adjustable spread lens.

6

Finish:

SI - Silver SandText
BK - Black SandText
WH - White
CC - Custom (please specify RAL color)

7

Dimming:

NO - No Dimming
LT - Lumentalk (1% minimum dimming value)
DIM - 0-10V Dimming option
(10% minimum dimming value)
DMX 1BD - DMX Dimming option, resolution per board (2 addresses per fixture)
(1% minimum dimming value)
DMX 1FX - DMX Dimming option, resolution per fixture (1 address per fixture)
(1% minimum dimming value)
DALI - DALI Dimming option
(1% minimum dimming value)
ES - Lutron® EcoSystem® Enabled Dimming
(1% minimum dimming value)

8

Option:

SY - Short Yoke
SY-3GV - Reinforced Short Yoke to meet 3G ANSI C136.31 Vibration Rating standard
CRC - Corrosion-resistant Coating

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SPECIFICATION SHEET

lumenfacade™

REMOTE POWER SUPPLY
WHITE & STATIC COLORS

Client: _____

Project name: _____

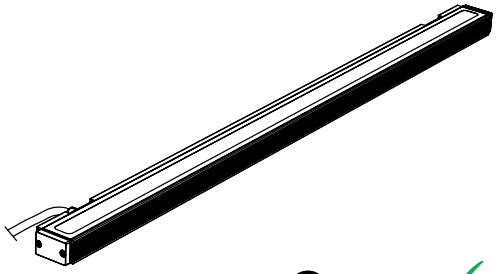
Order #: LOGR_ASHRAE-24V-48-40K-60x60-WAMR6-BK-DMX 1FX-CRC

Type: _____ Qty: _____

FEATURES AND BENEFITS

Physical :

- Low copper content extruded aluminum housing
- Electro-statically applied polyester powder coat finish
- Machined aluminum end caps and silicone gaskets
- Stainless steel hardware
- Clear tempered glass
- 10° x 10°,10° x 60°, 30° x 60° or 60° x 60° optics
- IP66
- Corrosion-resistant option for marine environments



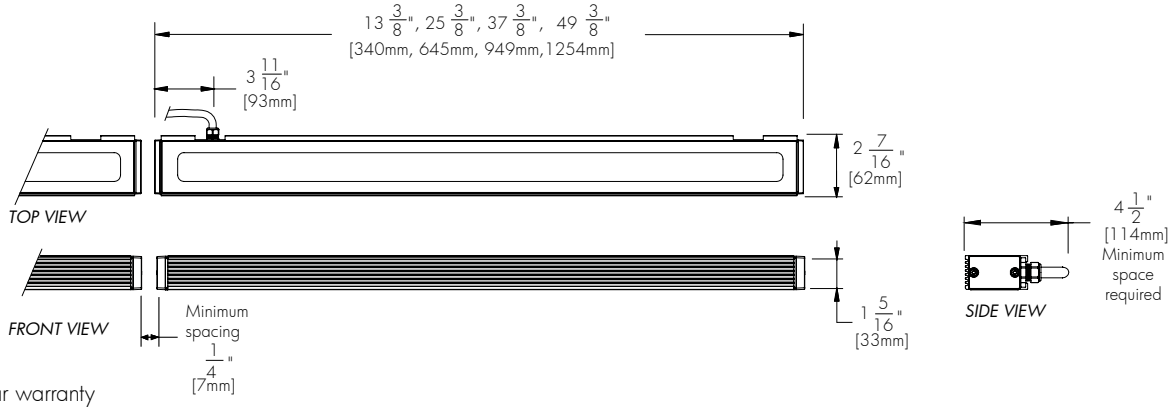
*Strain relief connectors and cables by others.

Performance :

- Minimum 1fc (10.7 lux) @ 129 feet (39.3m) distance (4000K, 4' unit, 10° x 60° optic, HO version)
- 2,929 delivered lumens and 16,765 candelas at nadir (4000K, 4' unit, 10° x 60° optic, HO version)
- CRI values: 85+ (2700K), 80+ (3000K), 78+ (4000K)
- Lumen maintenance 120,000 hrs [L70 @ 25°C]
- Lumen measurements comply with LM - 79 - 08 standard
- Resolution per foot or per fixture (see page 6)
- Operating temperatures: -25° C to 50° C [-13F to 122F]

Electrical :

- 24V DC luminaire, remote power & data supply for 100 to 277V required but not included. See interior and exterior Control & Power box specification sheets for details.
- Power and data in 1 cable (#16-4)
- 5W/ft version meets ASHRAE standards for linear lighting on building facades
- 8.5W/ft (15.25W/ft HO version)
- 0-10 volt, DMX or DALI dimming options
- Maximum run length and fixtures quantity vary according to installation layout, please consult factory



5 year warranty

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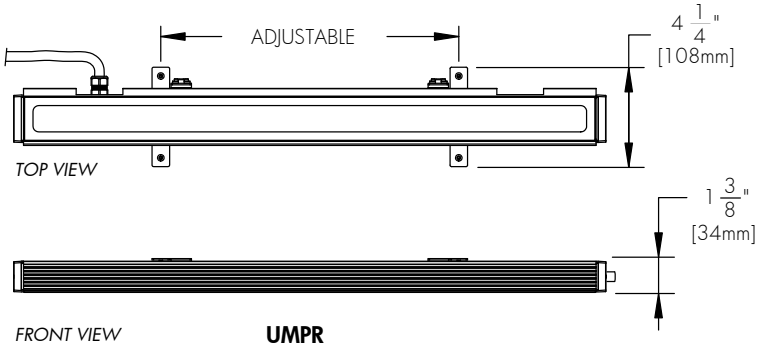
SPECIFICATION SHEET

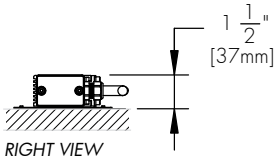
lumenfacade™

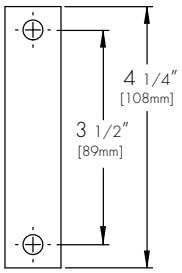
REMOTE POWER SUPPLY
WHITE & STATIC COLORS

MOUNTING OPTIONS

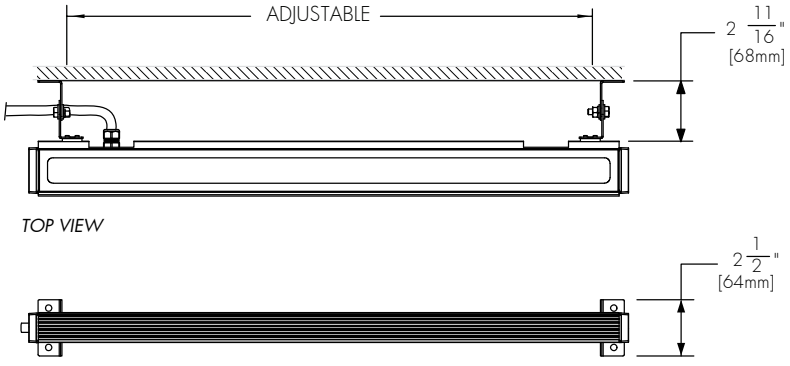


UMPR
Fixed Mounting
Remote Version

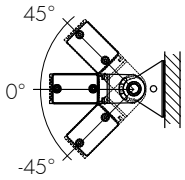




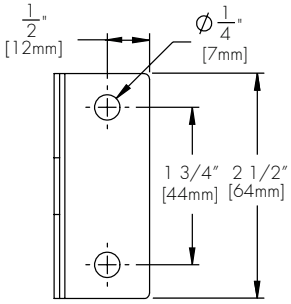
UMPR
Mounting Hole Pattern



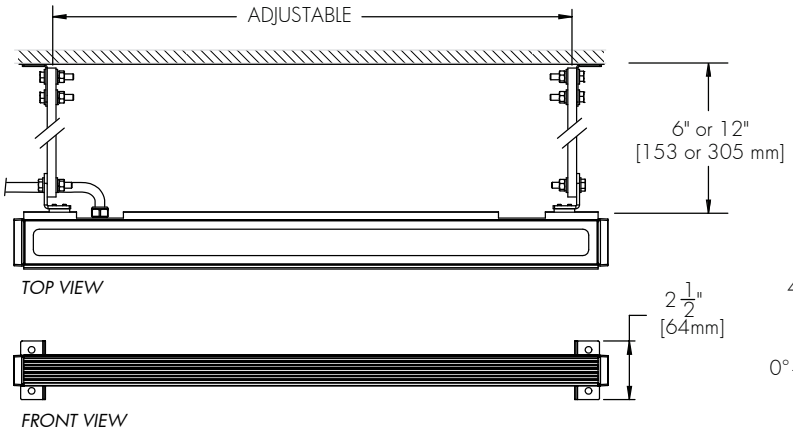
WAMR3
Adjustable Arm Mounting
Remote version



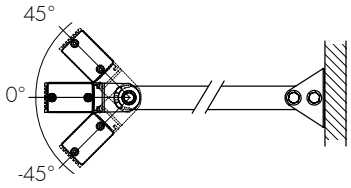
RIGHT VIEW



WAMR
Mounting Hole Pattern



WAMR6 & WAMR12
Adjustable Arm Mounting
Remote version



RIGHT VIEW

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SPECIFICATION SHEET

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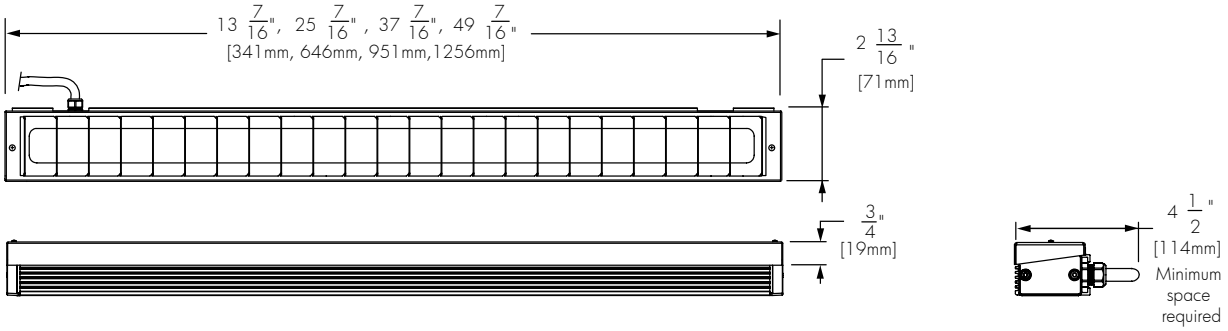
REMOTE POWER SUPPLY
WHITE & STATIC COLORS

LOUVER ACCESSORY INSTALLATION DETAIL



LOGRRD
Radial Louver for Lumenfacade Remote
(2 mounting screws included)
(see page 5 for ordering code)

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SPECIFICATION SHEET

ACCESSORIES

Order separately

Exterior remote power supply boxes:

PSBOX60 -___-___ Remote class 2 power supply 60W (100-277V to 24V DC) and enclosure for outdoor applications.
Please specify desired input voltage and finish.
Refer to PSBOX60 specification sheet for dimensions.

PSBOX60-010 - ___-___ Remote class 2 power supply 60W (100-277V to 24V DC) and outdoor rated enclosure, 0-10V dimming enabled.
Please specify desired input voltage and finish.
Refer to PSBOX60-010 specification sheet for dimensions.

PSBOX100 -___-___ Remote class 2 power supply 100W (100-277V to 24V DC) and enclosure for outdoor applications.
Please specify desired input voltage and finish.
Refer to PSBOX100 specification sheet for dimensions.

PSBOX100 -010___-___ Remote class 2 power supply 100W (100-277V to 24V DC) outdoor rated enclosure, 0-10V dimming enabled.
Please specify desired input voltage and finish.
Refer to PSBOX100-010 specification sheet for dimensions.

Interior remote power supply boxes :

iPSBOX60-___-___ Interior remote class 2 power supply 60W (100-277V to 24V DC) and enclosure for indoor applications.
Please specify desired input voltage and finish.
Refer to iPSBOX60 specification sheet for dimensions.

iPSBOX60-010___-___ Interior remote class 2 power supply 60W (100-277V to 24V DC) and indoor rated enclosure, 0-10V dimming enabled.
Please specify desired input voltage and finish.
Refer to iPSBOX60-010 specification sheet for dimensions.

iPSBOX100-___-___ Interior remote class 2 power supply 100W (100-277V to 24V DC) and enclosure for indoor applications.
Please specify desired input voltage and finish.
Refer to iPSBOX100 specification sheet for dimensions.

iPSBOX100-010___-___ Interior remote class 2 power supply 100W (100-277V to 24V DC) and indoor rated enclosure, 0-10V dimming enabled.
Please specify desired input voltage and finish.
Refer to iPSBOX100-010 specification sheet for dimensions.

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EM - R40

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Sustainable architectural LED lighting systems

ACCESSORIES - continued from page 4
Order separately

Control Systems:

LTO2 Lumentouch 2.0 is a wall mount DMX 512 controller keypad

LCU Lumencue is a USB / mini SD DMX 512 controller

LID LumenID is a serializing and addressing DMX 512 controller.
It must be specified on all white DMX applications.
Refer to LID specification sheet for details.

LTN Lumentone is a simple pre-programmed DMX 512 controller
with a push button rotary dial and live feedback.

Interior Control & Power boxes :

iCBOX60-___-24V-___ Remote interior control & power box assembly 60W (100-277V to 24V DC)
Please specify input voltage and finish.

iCBOX100-___-24V-___ Remote interior control & power box assembly 100W (100-277V to 24V DC)
Please specify input voltage and finish.

Exterior Control & Power boxes :

CBOX60-___-24V-___ Remote exterior control & power box assembly 60W (100-277V to 24V DC)
Please specify input voltage and finish.

CBOX100-___-24V-___ Remote exterior control & power box assembly 100W (100-277V to 24V DC)
Please specify input voltage and finish.

Radial Louver :

LOGRRD___-___ Radial louver for Lumenfacade Remote.

1. Please specify desired nominal length: 1', 2', 3' or 4'.
2. Please specify finish as BK - Black SandText
(Custom color available on request, please specify as CC together with RAL color : _____)

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info@lumenpulse.com **www.lumenpulse.com**

2014.04.02
EM - R40

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SPECIFICATION SHEET

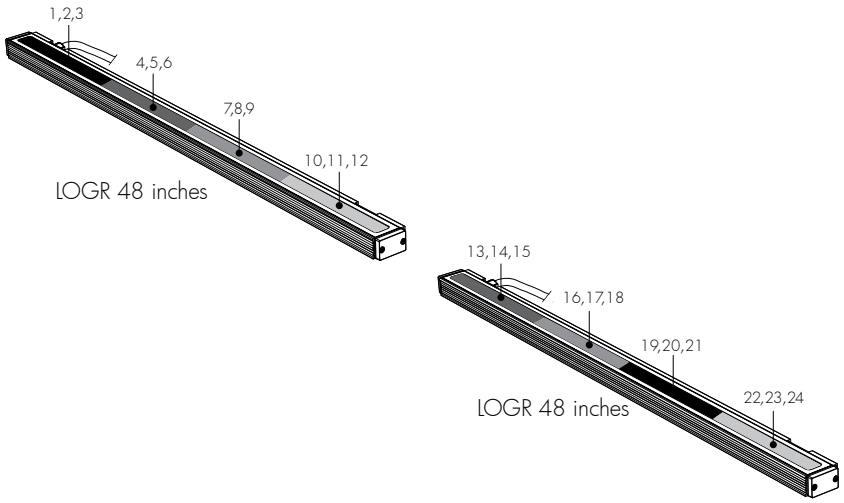
lumenfacade™

REMOTE POWER SUPPLY
WHITE & STATIC COLORS

RESOLUTION DETAILS
APPLICABLE FOR DMX DIMMING OPTION ONLY

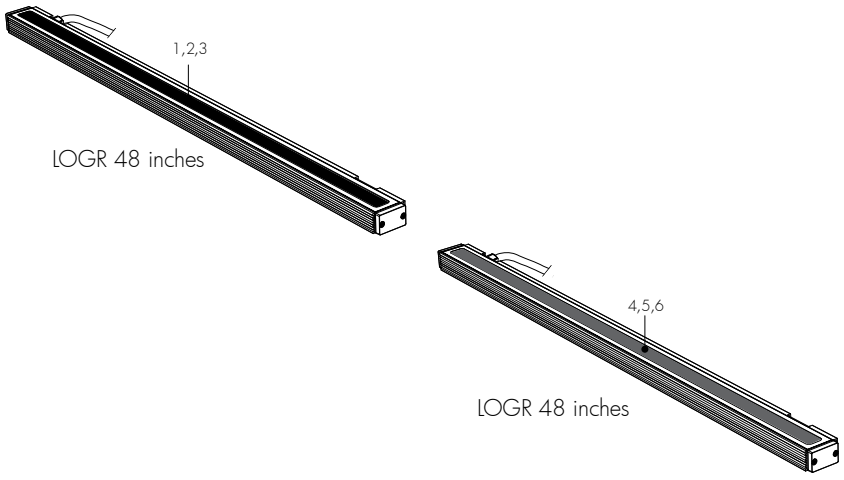
DMX 1FT - Resolution per foot: each foot is addressed independently (recommended for most installations).

DMX ADDRESSES:



DMX1FX - Resolution per fixture: each fixture is addressed independently

DMX ADDRESSES:



*Warning: resolution is a factory setting and cannot be changed in the field.

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SPECIFICATION SHEET

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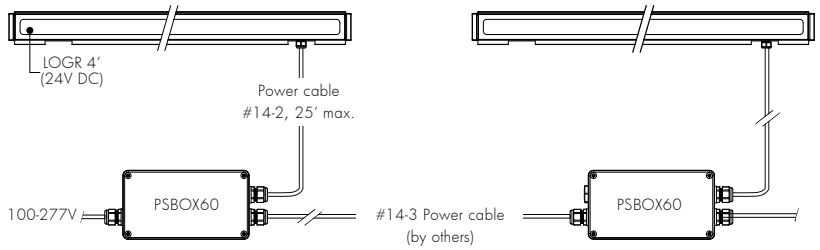
REMOTE POWER SUPPLY
WHITE & STATIC COLORS

TYPICAL WIRING DIAGRAMS

4ft Fixture Non-Dimming Version

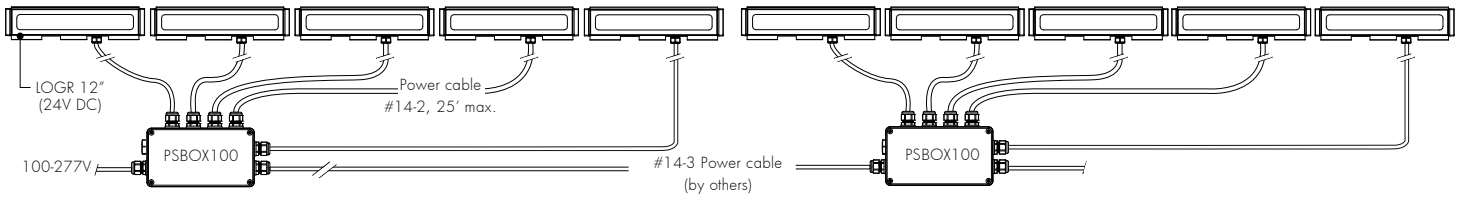
Maximum run length for non-dimming applications:
64 linear feet of fixture - 320' feet maximum cable length.
(Consult factory for custom applications).

American Color Code	*CE Color Code*	*USE*
Red	*Black*	*0-10V / Data +*
Green	*Grey*	*0-10V / Data -*
Black	*Brown*	*Live 100-277V*
White	*Blue*	*Neutral*



1ft Fixture Non-Dimming Version

Maximum run length for non-dimming applications:
64 linear feet of fixture - 320' feet maximum cable length.
(Consult factory for custom applications).



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REMOTE POWER SUPPLY
WHITE & STATIC COLORS

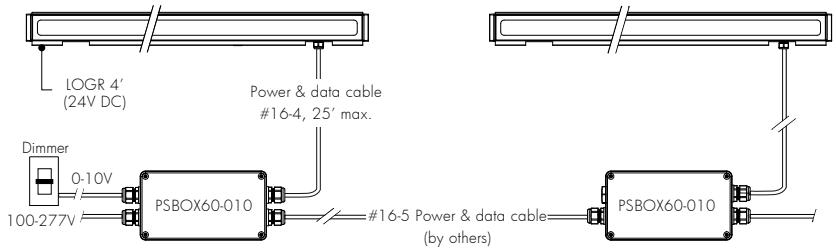
TYPICAL WIRING DIAGRAM - continued from page 7

4ft Fixture Dimming Version (0-10V)

10% minimum dimming value

Maximum run length for dimming applications:
48 linear feet of fixture - 400' feet maximum cable length.
(Consult factory for custom applications).

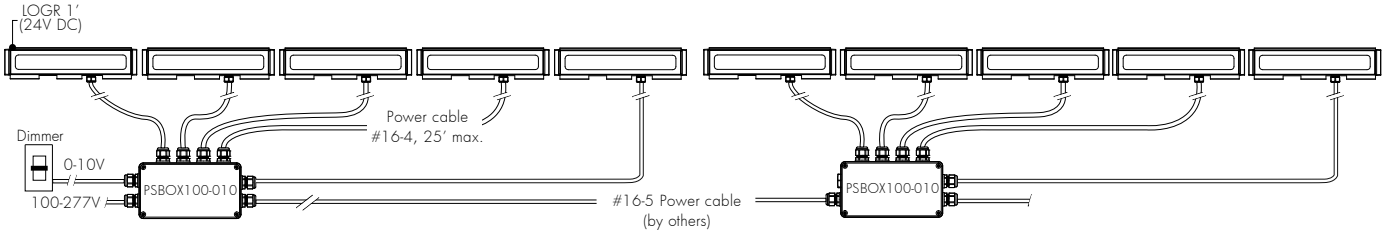
American Color Code	*CE Color Code*	*USE*
Red	*Black*	*0-10V / Data +*
Green	*Grey*	*0-10V / Data -*
Black	*Brown*	*Live 100-277V*
White	*Blue*	*Neutral*



1ft Fixture Dimming Version (0-10V)

10% minimum dimming value

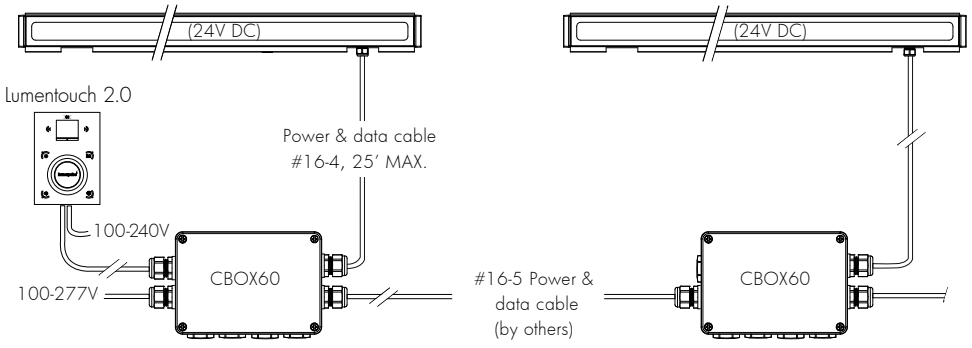
Maximum run length for dimming applications:
48 linear feet of fixture - 400' feet maximum cable length.
(Consult factory for custom applications).



DMX Dimming Version

1% minimum dimming value

Maximum run length:
64 linear feet of fixture - 320' feet maximum cable length.
(Consult factory for custom applications).



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SPECIFICATION SHEET

lumenfacade™

REMOTE POWER SUPPLY
WHITE & STATIC COLORS

HOW TO ORDER

LOGR	24V							
Housing	Voltage	Length	Colors and color temperatures	Optic	Mounting Option	Finish	Control	Option
1	2	3	4	5	6	7	8	9

1

Housing:

LOGR___ ASHRAE - Lumenfacade™ Remote Power Supply, 5W/ft ASHRAE compliant
*Specify desired cable length, up to 25ft with no additional charges.
LOGR___ RO - Lumenfacade™ Remote Power Supply, Regular Output 8.5W/ft
*Specify desired cable length, up to 25ft with no additional charges.
LOGR___ HO - Lumenfacade™ Remote Power Supply, High Output 15.25W/ft
*Specify desired cable length, up to 25ft with no additional charges.

*1ft fixture - 100' cable length max
2ft fixture - 70' cable length max
3ft fixture - 30' cable length max
4ft fixture - 20' cable length max

2

Voltage:

24V DC fixture. Refer to accessory pages for control & power box options.

3

Length:

12 - 13 3/8 inches (340mm) (0.95 kg/2.10 lbs)
24 - 25 3/8 inches (645mm) (1.78 kg/3.90 lbs)
36 - 37 3/8 inches (949mm) (2.55 kg/5.60 lbs)
48 - 49 3/8 inches (1254mm) (3.40 kg/7.40 lbs)

4

Colors and Color temperatures:

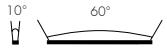
27K - 2700K
30K - 3000K
35K - 3500K
40K - 4000K
RD - Red
GR - Green
BL - Blue

5

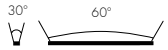
Optics:

10x10 - 10° x 10°
*For best results use with HO fixtures at a 6-inch (15cm) setback from surface. Contact factory for application support.

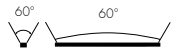
10x60 - 10° x 60°



30x60 - 30° x 60°



60x60 - 60° x 60°



6

Mounting Option:

UMPR - Fixed Mounting remote version

WAMR3 - Adjustable arm mounting 3"remote version

WAMR6 - Adjustable arm mounting 6" remote version

WAMR12 - Adjustable arm mounting 12" remote version

7

Finish:

SI - Silver SandText
BK - Black SandText
WH - White
CC - Custom (please specify RAL color)

8

Control:

DIM - 0-10V Dimming option (10% minimum dimming value)
DMX 1FT - DMX Dimming option, resolution per foot (1% minimum dimming value)
DMX 1FX - DMX Dimming option, resolution per fixture (1% minimum dimming value)
DALI - DALI Dimming option (1% minimum dimming value)
NO - No Dimming

9

Finish:

CRC - Corrosion-resistant Coating

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EM - R40

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040914 David S. Ingalls Rink 100% CD Package

Date: _____ Type: 523-000080-46

Firm Name: _____

Project: _____

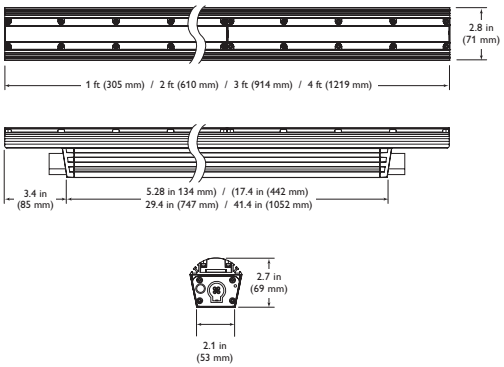
eW Graze MX Powercore

4000 K, 9° x 9° beam angle

Premium linear exterior LED wall grazing fixture with solid white light

eW Graze MX Powercore features the most light output in our line of solid white light grazing fixtures for high-intensity multi-story façade and surface illumination. Featuring Powercore technology, fixtures process power directly from line voltage, eliminating the need for external power supplies. Fixtures are available in standard color temperatures of 2700 K, 4000 K, and 5500 K, with additional custom color temperatures available, ranging from 3000 K to 6500 K. Four fixture lengths and five beam angles support a large range of façade or surface illumination applications.

For detailed product information, please refer to the eW Graze Powercore Family Product Guide at www.philipscolorkinetics.com/ls/essentialwhite/ewgrazemxpowercore/



Specifications

Due to continuous improvements and innovations, specifications may change without notice.

Item	Specification	1 ft (305 mm)	2 ft (610 mm)	3 ft (914 mm)	4 ft (1219 mm)
Output	Lumens*	875	1750	2625	3500
	Efficacy (lm / W)	60.3			
	CRI	81			
	Lumen Maintenance†	60,000 hours L_{70} @ 25° C	60,000 hours L_{70} @ 50° C	60,000 hours L_{50} @ 25° C	60,000 hours L_{50} @ 50° C
Electrical	Input Voltage	100 – 277 VAC, auto-ranging, 50 / 60 Hz			
	Power Consumption	15 W	30 W	45 W	60 W
Control	Dimming	Compatible with selected commercially available reverse-phase ELV-type dimmers‡			
Physical	Dimensions *(Height x Width x Depth)*	2.7 x 12 x 2.8 in (69 x 305 x 71 mm)	2.7 x 24 x 2.8 in (69 x 610 x 71 mm)	2.7 x 36 x 2.8 in (69 x 914 x 71 mm)	2.7 x 48 x 2.8 in (69 x 1219 x 71 mm)
	Weight	2.1 lb (1.0 kg)	4.6 lb (2.1 kg)	7.1 lb (3.2 kg)	9.3 lb (4.2 kg)
	Housing	Extruded anodized aluminum			
	Lens	Clear polycarbonate			
	Fixture Connectors	Integral male / female waterproof connectors			
	Mounting	Multi-positional, constant torque locking hinges			
	Temperature	-40° – 122° F (-40° – 50° C) Operating -4° – 122° F (-20° – 50° C) Startup -40° – 176° F (-40° – 80° C) Storage			
	Humidity	0 – 95%, non-condensing			
	Fixture Run Lengths	To calculate fixture run lengths and total power consumption for your specific installation, download the Configuration Calculator from www.philipscolorkinetics.com/support/install_tool/			
Certification and Safety	Certification	UL / cUL, FCC Class A, CE, PSE, C-Tick			
	Environment	Dry / Damp / Wet Location, IP66			

* 1 ft (305 mm) lumen output measurements comply with IES LM-79-08 testing procedures. 2 ft (610 mm), 3 ft (914 mm), and 4 ft (1219 mm) measurements are estimated based on the 1 ft (305 mm) measurements.

† L_{70} = 70% lumen maintenance (when light output drops below 70% of initial output). L_{50} = 50% lumen maintenance (when light output drops below 50% of initial output). Ambient luminaire temperatures specified. Lumen maintenance calculations are based on lifetime prediction graphs supplied by LED source manufacturers. Calculations for white-light LED fixtures are based on measurements that comply with IES LM-80-08 testing procedures. Refer to www.philipscolorkinetics.com/support/appnotes/lm-80-08.pdf for more information.

‡ Refer to www.philipscolorkinetics.com/support/appnotes/ for more information.

PHILIPS

Fixtures

Item	Beam Angle	2700 K		4000 K		5500 K	
		Item Number	Philips 12NC	Item Number	Philips 12NC	Item Number	Philips 12NC
eW Graze MX Powercore 1 ft (305 mm)	9° x 9°	523-000080-00	910503703152	523-000080-01	910503703688	523-000080-02	910503703689
	10° x 60°	523-000080-03	910503703690	523-000080-04	910503703691	523-000080-05	910503703692
	15° x 30°	523-000080-06	910503703693	523-000080-07	910503703694	523-000080-08	910503703695
	30° x 60°	523-000080-09	910503703696	523-000080-10	910503703697	523-000080-11	910503703698
	60° x 30°	523-000080-12	910503703699	523-000080-13	910503703701	523-000080-14	910503703702
eW Graze MX Powercore 2 ft (610 mm)	9° x 9°	523-000080-15	910503703703	523-000080-16	910503703704	523-000080-17	910503703705
	10° x 60°	523-000080-18	910503703706	523-000080-19	910503703707	523-000080-20	910503703708
	15° x 30°	523-000080-21	910503703709	523-000080-22	910503703710	523-000080-23	910503703711
	30° x 60°	523-000080-24	910503703712	523-000080-25	910503703713	523-000080-26	910503703714
	60° x 30°	523-000080-27	910503703715	523-000080-28	910503703716	523-000080-29	910503703717
eW Graze MX Powercore 3 ft (914 mm)	9° x 9°	523-000080-30	910503703718	523-000080-31	910503703719	523-000080-32	910503703720
	10° x 60°	523-000080-33	910503703721	523-000080-34	910503703722	523-000080-35	910503703723
	15° x 30°	523-000080-36	910503703724	523-000080-37	910503703725	523-000080-38	910503703726
	30° x 60°	523-000080-39	910503703727	523-000080-40	910503703728	523-000080-41	910503703729
	60° x 30°	523-000080-42	910503703730	523-000080-43	910503703731	523-000080-44	910503703732
eW Graze MX Powercore 4 ft (1219 mm)	9° x 9°	523-000080-45	910503703733	523-000080-46	910503703734	523-000080-47	910503703735
	10° x 60°	523-000080-48	910503703736	523-000080-49	910503703737	523-000080-50	910503703738
	15° x 30°	523-000080-51	910503703739	523-000080-52	910503703740	523-000080-53	910503703741
	30° x 60°	523-000080-54	910503703742	523-000080-55	910503703743	523-000080-56	910503703744
	60° x 30°	523-000080-57	910503703745	523-000080-58	910503703746	523-000080-59	910503703747

Use Item Number when ordering in North America.

Accessories

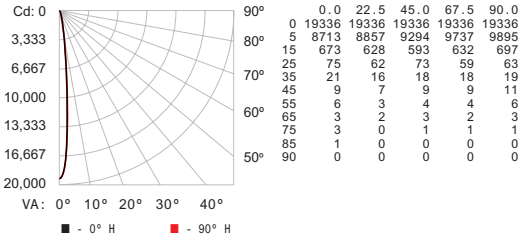
Item	Type		Item Number	Philips 12NC
Leader Cable with Terminator	UL / cUL	10 ft (3.0 m)	108-000056-03	910503704071
		50 ft (15.2 m)	108-000056-00	910503703138
	CE / PSE	10 ft (3.0 m)	108-000056-04	910503704072
		50 ft (15.2 m)	108-000056-01	910503704069
Jumper Cable	UL / cUL	End-to-End	108-000057-00	910503703139
		1 ft (305 mm)	108-000057-03	910503704076
		5 ft (1.5 m)	108-000057-06	910503704079
		10 ft (3.0 m)	108-000057-09	910503704082
	CE / PSE	End-to-End	108-000057-01	910503704074
		1 ft (305 mm)	108-000057-04	910503704077
		5 ft (1.5 m)	108-000057-07	910503704080
		10 ft (3.0 m)	108-000057-10	910503704083
Glare Shield		1 ft (305 mm)	120-000081-00	910503700745
		2 ft (610 mm)	120-000081-01	910503700746
		3 ft (914 mm)	120-000081-02	910503700747
		4 ft (1219 mm)	120-000081-03	910503700748
Additional Terminators		Quantity 10	120-000157-00	910503703142
Additional Hinge		Quantity 1	120-000098-00	910503700772

Use Item Number when ordering in North America.

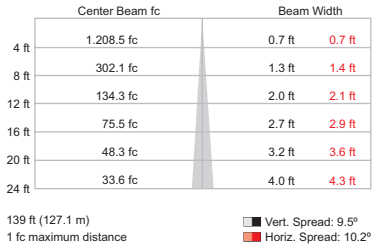
Photometrics

eW Graze MX Powercore
4000 K, 1 ft, 9° x 9° beam angle

Polar Candela Distribution



Illuminance at Distance



Lumens	Efficacy
875	60.3 lm / W

For lux multiply fc by 10.7

OPTIBIN® CK TECHNOLOGY | POWERCORE® CK TECHNOLOGY | DIMAND® CK TECHNOLOGY

Philips Color Kinetics
3 Burlington Woods Drive
Burlington, Massachusetts 01803 USA
Tel 888.385.5742
Tel 617.423.9999
Fax 617.423.9998
www.philipscolorkinetics.com

Date: _____ Type: 523-000081-46

Firm Name: _____

Project: _____

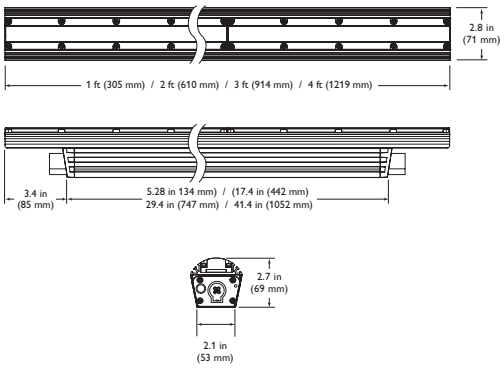
eW Graze QLX Powercore

4000 K, 9° x 9° beam angle

Performance linear exterior LED wall grazing fixture with solid white light

With a light output of up to 595 lumens and power consumption of only 10 W per foot, eW Graze QLX Powercore is perfect for applications calling for a balance of cost and performance. Featuring Powercore technology, fixtures process power directly from line voltage, eliminating the need for external power supplies. Fixtures are available in standard color temperatures of 2700 K, 4000 K, and 5500 K, as well as custom color temperatures ranging from 3000 K to 6500 K. Multiple fixture lengths and beam angles support a large range of façade or surface illumination applications.

For detailed product information, please refer to the eW Graze Powercore Family Product Guide at www.philipscolorkinetics.com/ls/essentialwhite/ewgrazeqlxpowercore/



Specifications

Due to continuous improvements and innovations, specifications may change without notice.

Item	Specification	1 ft (305 mm)	2 ft (610 mm)	3 ft (914 mm)	4 ft (1219 mm)
Output	Lumens*	595	1190	1785	2380
	Efficacy (lm / W)	63.1			
	CRI	81			
	Lumen Maintenance†	60,000 hours L_{70} @ 25° C	60,000 hours L_{70} @ 50° C	60,000 hours L_{50} @ 25° C	60,000 hours L_{50} @ 50° C
Electrical	Input Voltage	100 – 277 VAC, auto-ranging, 50 / 60 Hz			
	Power Consumption	10 W	20 W	30 W	40 W
Control	Dimming	Compatible with selected commercially available reverse-phase ELV-type dimmers‡			
Physical	Dimensions *(Height x Width x Depth)*	2.7 x 12 x 2.8 in (69 x 305 x 71 mm)	2.7 x 24 x 2.8 in (69 x 610 x 71 mm)	2.7 x 36 x 2.8 in (69 x 914 x 71 mm)	2.7 x 48 x 2.8 in (69 x 1219 x 71 mm)
	Weight	2.1 lb (1.0 kg)	4.6 lb (2.1 kg)	7.1 lb (3.2 kg)	9.3 lb (4.2 kg)
	Housing	Extruded anodized aluminum			
	Lens	Clear polycarbonate			
	Fixture Connectors	Integral male / female waterproof connectors			
	Mounting	Multi-positional, constant torque locking hinges			
	Temperature	-40° – 122° F (-40° – 50° C) Operating -4° – 122° F (-20° – 50° C) Startup -40° – 176° F (-40° – 80° C) Storage			
	Humidity	0 – 95%, non-condensing			
	Fixture Run Lengths	To calculate fixture run lengths and total power consumption for your specific installation, download the Configuration Calculator from www.philipscolorkinetics.com/support/install_tool/			
Certification and Safety	Certification	UL / cUL, FCC Class A, CE, PSE, C-Tick			
	Environment	Dry / Damp / Wet Location, IP66			

* 1 ft (305 mm) lumen output measurements comply with IES LM-79-08 testing procedures. 2 ft (610 mm), 3 ft (914 mm), and 4 ft (1219 mm) measurements are estimated based on the 1 ft (305 mm) measurements.

† L_{70} = 70% lumen maintenance (when light output drops below 70% of initial output). L_{50} = 50% lumen maintenance (when light output drops below 50% of initial output). Ambient luminaire temperatures specified. Lumen maintenance calculations are based on lifetime prediction graphs supplied by LED source manufacturers. Calculations for white-light LED fixtures are based on measurements that comply with IES LM-80-08 testing procedures. Refer to www.philipscolorkinetics.com/support/appnotes/lm-80-08.pdf for more information.

‡ Refer to www.philipscolorkinetics.com/support/appnotes/ for more information.

PHILIPS

Fixtures

Item	Beam Angle	2700 K		4000 K		5500 K	
		Item Number	Philips 12NC	Item Number	Philips 12NC	Item Number	Philips 12NC
eW Graze QLX Powercore 1 ft (305 mm)	9° x 9°	523-000081-00	910503703153	523-000081-01	910503703748	523-000081-02	910503703749
	10° x 60°	523-000081-03	910503703750	523-000081-04	910503703751	523-000081-05	910503703752
	15° x 30°	523-000081-06	910503703753	523-000081-07	910503703754	523-000081-08	910503703755
	30° x 60°	523-000081-09	910503703756	523-000081-10	910503703757	523-000081-11	910503703758
	60° x 30°	523-000081-12	910503703759	523-000081-13	910503703760	523-000081-14	910503703761
eW Graze QLX Powercore 2 ft (610 mm)	9° x 9°	523-000081-15	910503703762	523-000081-16	910503703763	523-000081-17	910503703764
	10° x 60°	523-000081-18	910503703765	523-000081-19	910503703766	523-000081-20	910503703767
	15° x 30°	523-000081-21	910503703768	523-000081-22	910503703769	523-000081-23	910503703770
	30° x 60°	523-000081-24	910503703771	523-000081-25	910503703772	523-000081-26	910503703773
	60° x 30°	523-000081-27	910503703774	523-000081-28	910503703775	523-000081-29	910503703776
eW Graze QLX Powercore 3 ft (914 mm)	9° x 9°	523-000081-30	910503703777	523-000081-31	910503703778	523-000081-32	910503703779
	10° x 60°	523-000081-33	910503703780	523-000081-34	910503703781	523-000081-35	910503703782
	15° x 30°	523-000081-36	910503703783	523-000081-37	910503703784	523-000081-38	910503703785
	30° x 60°	523-000081-39	910503703786	523-000081-40	910503703787	523-000081-41	910503703788
	60° x 30°	523-000081-42	910503703789	523-000081-43	910503703790	523-000081-44	910503703791
eW Graze QLX Powercore 4 ft (1219 mm)	9° x 9°	523-000081-45	910503703792	523-000081-46	910503703793	523-000081-47	910503703794
	10° x 60°	523-000081-48	910503703795	523-000081-49	910503703796	523-000081-50	910503703797
	15° x 30°	523-000081-51	910503703798	523-000081-52	910503703799	523-000081-53	910503703801
	30° x 60°	523-000081-54	910503703802	523-000081-55	910503703803	523-000081-56	910503703804
	60° x 30°	523-000081-57	910503703805	523-000081-58	910503703806	523-000081-59	910503703807

Use Item Number when ordering in North America.

Accessories

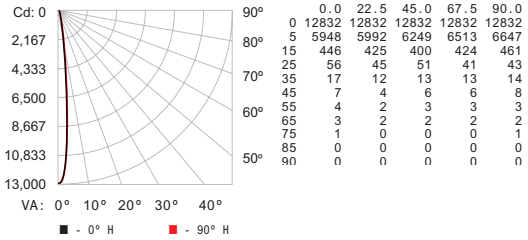
Item	Type		Item Number	Philips 12NC
Leader Cable with Terminator	UL / cUL	10 ft (3.0 m)	108-000056-03	910503704071
		50 ft (15.2 m)	108-000056-00	910503703138
	CE / PSE	10 ft (3.0 m)	108-000056-04	910503704072
		50 ft (15.2 m)	108-000056-01	910503704069
Jumper Cable	UL / cUL	End-to-End	108-000057-00	910503703139
		1 ft (305 mm)	108-000057-03	910503704076
		5 ft (1.5 m)	108-000057-06	910503704079
		10 ft (3.0 m)	108-000057-09	910503704082
	CE / PSE	End-to-End	108-000057-01	910503704074
		1 ft (305 mm)	108-000057-04	910503704077
		5 ft (1.5 m)	108-000057-07	910503704080
		10 ft (3.0 m)	108-000057-10	910503704083
Glare Shield		1 ft (305 mm)	120-000081-00	910503700745
		2 ft (610 mm)	120-000081-01	910503700746
		3 ft (914 mm)	120-000081-02	910503700747
		4 ft (1219 mm)	120-000081-03	910503700748
Additional Terminators		Quantity 10	120-000157-00	910503703142
Additional Hinge		Quantity 1	120-000098-00	910503700772

Use Item Number when ordering in North America.

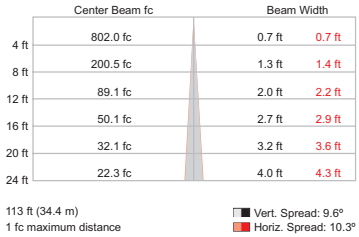
Photometrics

eW Graze QLX Powercore
4000 K, 1 ft, 9° x 9° beam angle

Polar Candela Distribution



Illuminance at Distance



Lumens	Efficacy
595	63.1 lm / W

For lux multiply fc by 10.7

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Burlington, Massachusetts 01803 USA
Tel 888.385.5742
Tel 617.423.9999
Fax 617.423.9998
www.philipscolorkinetics.com

040914 David S. Ingalls Rink 100% CD Package

AX05

Date: _____ Type: 523-000086-46

Firm Name: _____

Project: _____

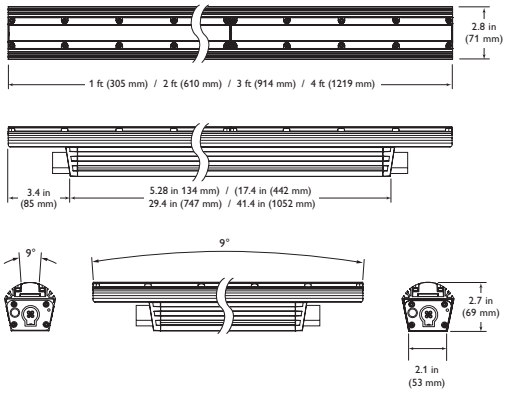
iW Graze QLX Powercore 5W

9° x 9° beam angle

Low-power linear exterior LED wall grazing fixture with intelligent white light

Factory-set to consume a maximum of 5 W per foot, iW Graze QLX Powercore 5W supports ASHRAE standards, LEED green building certification, and other power-limited projects. Offers the same beam spread options as iW Graze QLX Powercore.Fixtures process power directly from line voltage, eliminating the need for external power supplies. Channels of cool, neutral, and warm white LEDs produce color temperatures ranging from 2700 K – 6500 K. Four fixture lengths and five beam angles support a large range of façade or surface illumination applications.

For detailed product information, please refer to the iW Graze Powercore Family Product Guide at www.philipscolorkinetics.com/ls/intelligentwhite/iwgrazeqlxpowercore5w/



Specifications

Due to continuous improvements and innovations, specifications may change without notice.

Item	Specification	1 ft (305 mm)	2 ft (610 mm)	3 ft (914 mm)	4 ft (1219 mm)
Output	Lumens*	189	378	567	756
	Efficacy (lm / W)	20.9			
	CRI	82			
	Lumen Maintenance‡	60,000 hours L70 @ 25° C	60,000 hours L70 @ 50° C	60,000 hours L50 @ 25° C	60,000 hours L50 @ 50° C
Electrical	Input Voltage	100 – 277 VAC, auto-ranging 50 / 60 Hz			
	Power Consumption	5 W	10 W	15 W	20 W
Control	Interface	Data Enabler Pro (DMX or Ethernet)			
	Control System	Philips Color Kinetics full range of controllers, including Light System Manager and iPlayer 3, or third-party controllers			
Physical	Dimensions *(Height x Width x Depth)*	2.7 x 12 x 2.8 in (69 x 305 x 71 mm)	2.7 x 24 x 2.8 in (69 x 610 x 71 mm)	2.7 x 36 x 2.8 in (69 x 914 x 71 mm)	2.7 x 48 x 2.8 in (69 x 1219 x 71 mm)
	Weight	2.1 lb (1.0 kg)	4.6 lb (2.1 kg)	7.1 lb (3.2 kg)	9.3 lb (4.2 kg)
	Housing	Extruded anodized aluminum			
	Lens	Clear polycarbonate			
	Fixture Connectors	Integral male / female waterproof connectors			
	Mounting	Multi-positional, constant torque locking hinges			
	Temperature	-40° – 122° F (-40° – 50° C) Operating -4° – 122° F (-20° – 50° C) Startup -40° – 176° F (-40° – 80° C) Storage			
	Humidity	0 – 95%, non-condensing			
	Fixture Run Lengths	To calculate fixture run lengths and total power consumption for your specific installation, download the Configuration Calculator from www.philipscolorkinetics.com/support/install_tool/			
Certification and Safety	Certification	UL / cUL, FCC Class A, CE, PSE, C-Tick			
	Environment	Dry / Damp / Wet Location, IP66			

* 1 ft (305 mm) lumen output measurements comply with IES LM-79-08 testing procedures. 2 ft (610 mm), 3 ft (914 mm), and 4 ft (1219 mm) measurements are estimated based on the 1 ft (305 mm) measurements.

‡ L70 = 70% lumen maintenance (when light output drops below 70% of initial output). L50 = 50% lumen maintenance (when light output drops below 50% of initial output). Ambient luminaire temperatures specified. Lumen maintenance calculations are based on lifetime prediction graphs supplied by LED source manufacturers. Calculations for white-light LED fixtures are based on measurements that comply with IES LM-80-08 testing procedures. Refer to www.philipscolorkinetics.com/support/appnotes/lm-80-08.pdf for more information.

PHILIPS

Fixtures

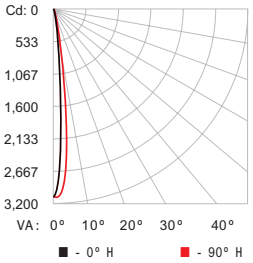
Item	Beam Angle	Item Number	Philips 12NC
iW Graze QLX Powercore 5W 1 ft (305 mm)	9° x 9°	523-000085-00	910503704062
	10° x 60°	523-000085-01	910503703819
	15° x 30°	523-000085-02	910503703820
	30° x 60°	523-000085-03	910503703821
	60° x 30°	523-000085-04	910503703822
iW Graze QLX Powercore 5W 2 ft (610 mm)	9° x 9°	523-000085-05	910503703823
	10° x 60°	523-000085-06	910503703824
	15° x 30°	523-000085-07	910503703825
	30° x 60°	523-000085-08	910503703826
	60° x 30°	523-000085-09	910503703827
iW Graze QLX Powercore 5W 3 ft (914 mm)	9° x 9°	523-000085-10	910503703828
	10° x 60°	523-000085-11	910503703829
	15° x 30°	523-000085-12	910503703830
	30° x 60°	523-000085-13	910503703831
	60° x 30°	523-000085-14	910503703832
iW Graze QLX Powercore 5W 4 ft (1219 mm)	9° x 9°	523-000085-15	910503703833
	10° x 60°	523-000085-16	910503703834
	15° x 30°	523-000085-17	910503703835
	30° x 60°	523-000085-18	910503703836
	60° x 30°	523-000085-19	910503703837

Use Item Number when ordering in North America.

Photometrics

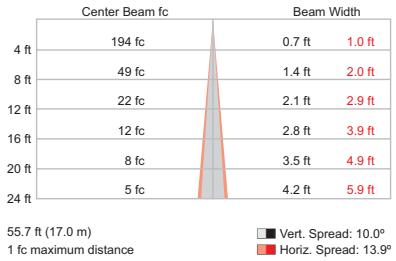
iW Graze QLX Powercore 5W
1 ft, 9° x 9° beam angle

Polar Candela Distribution



	0	25	45	70	90
0	985	985	985	985	985
5	741	761	808	869	890
15	152	181	250	395	455
25	21	28	47	97	127
35	5	6	9	18	21
45	2	3	3	5	5
55	2	2	2	2	3
65	1	1	1	1	2
75	1	1	1	1	1
85	0	0	0	0	0
90	0	0	0	0	0

Illuminance at Distance



Lumens	Efficacy
189	20.9

For lux multiply fc by 10.7

Accessories

Item	Type		Item Number	Philips 12NC
Leader Cable with Terminator	UL / cUL	10 ft (3.0 m)	108-000055-03	910503704066
		50 ft (15.2 m)	108-000055-00	910503703137
	CE / PSE	10 ft (3.0 m)	108-000055-04	910503704067
		50 ft (15.2 m)	108-000055-01	910503704064
Jumper Cable	UL / cUL	End-to-End	108-000057-00	910503703139
		1 ft (305 mm)	108-000057-03	910503704076
		5 ft (1.5 m)	108-000057-06	910503704079
		10 ft (3.0 m)	108-000057-09	910503704082
	CE / PSE	End-to-End	108-000057-01	910503704074
		1 ft (305 mm)	108-000057-04	910503704077
		5 ft (1.5 m)	108-000057-07	910503704080
		10 ft (3.0 m)	108-000057-10	910503704083
Glare Shield		1 ft (305 mm)	120-000081-00	910503700745
		2 ft (610 mm)	120-000081-01	910503700746
		3 ft (914 mm)	120-000081-02	910503700747
		4 ft (1219 mm)	120-000081-03	910503700748
Additional Terminators		Quantity 10	120-000157-00	910503703142
Additional Hinge		Quantity 1	120-000098-00	910503700772

Use Item Number when ordering in North America.

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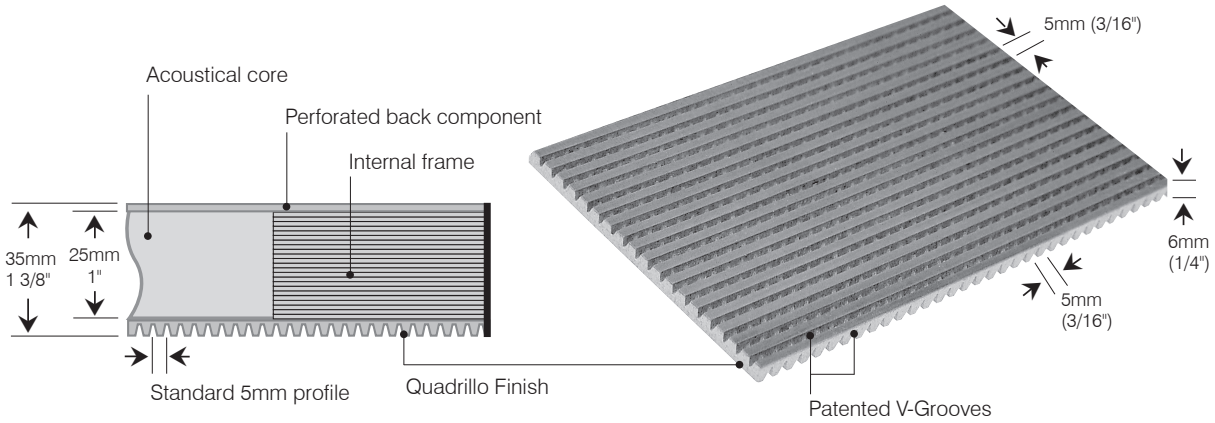
Tel 617.423.9999
Fax 617.423.9998
www.philipscolorkinetics.com

Quadrillo® Wood Panel

decoustics®



DESIGN AND SPECIFICATIONS

Description

Quadrillo is a natural wood veneer finish. Acoustical absorption is achieved by a unique patented perforation technology in combination with Decoustics high performance acoustical cores.

Panel edge conditions are available plain (unfinished), edge banded or fully framed with matching veneer finish. Panels can be mounted into existing millwork frames, or splined to create a monolithic appearance. Face frames of almost any width and profile can be created with a variety of corner details.

Standard profiles: grooves 5mm o.c. and 10mm o.c. however other design profiles are available. (see Decoustics Wood brochure). When used as a monolithic panel system, kerfed edges with splines are used to level the panel faces. The reveal between the panels is 3 mm which simulates the v-groove on a panel having ribs at 5 mm centers. Installed carefully, surfaces can appear monolithic, however panel joints are not invisible due to the change in geometry of the panel edges.

Quadrillo is available in nine different natural wood veneers. Matching and custom veneers can also be accommodated.

When veneers are supplied by others, the minimum thickness is 0.6mm.

Limitations

FIRE CLASSIFICATIONS: The veneer thickness is less than 1/28" which is generally not used in rating the structure.
The lacquer finish applied is a fire retardant version.

The Quadrillo composite panel is currently "Class B" (per ASTME-84). If Class A composite material is required, consider using Decoustics Solo products.

Wood products are highly susceptible to changes in humidity and temperature. Close attention must be paid to acclimatization during installation, as per accepted millwork industry practice.

Recommended Uses

Ceilings and walls.

Available with Decoustics Ceilencio ceiling suspension system (downward access) and other direct mount and suspended ceiling systems. Note: the use of curved panels on Ceilencio may be limited. Consult Decoustics for use criteria.

The grooved Quadrillo facer is not available by itself as a finish for non-acoustical applications. The facer is designed to be used in a laminated or "sandwich" construction. Consult Decoustics for any non-acoustical application.

Features and Advantages

Available in both standard and custom sizes.

Impressive sound control properties.

Panels can be manufactured with grooves running horizontally or vertically. The grain and groove must be in the same direction. Consult Decoustics for maximum sizes.

Quadrillo panels are available with a clear, natural lacquer or toned or tinted to match other finishes. "See Finishing" under Design Considerations. Quadrillo is also available in a painted version to match any color.

Although the percentage of open area of Quadrillo is only approx. 4%, the patented v-grooves create a four sided "funnel" effect that allows sound to arrive at a variety of angles thereby focusing the transfer of energy over a broader surface area of absorption material.

Additional Product Data

ORDERING: As with most millwork process, Quadrillo is a longer lead time item and should generally be dealt with early in a project. Allow eight to ten weeks manufacturing time after all dimensions, veneer, samples and drawing approvals are provided. Custom matched or sequenced veneers may take longer and should be reviewed with DECOUSTICS in advance of ordering.

SAMPLES: It is important that samples be approved based on the finished product and not just a sample of veneer only. Held close in hand, a dark veneer with a lighter groove could be quite evident but when viewed at a moderate distance, the color will appear as one.

PANEL WEIGHT: Depending upon thickness and whether or not framed, generally a QPP-25 panel having an overall thickness of 1-3/8" (35mm) weighs an average of 3.5 lbs. per sq. ft. (17.1 kg/m^2). A QPP-50 panel thickness of 2-3/8" (60mm) weighs an average of 5.5 lbs. per sq. ft. (26.85 kg/m^2). Solid wood border frames can add significantly to these weights.

Decoustics Quadrillo® Wood Panel

Design Considerations

RECOMMENDED MAX PANEL SIZE: 4'-0" x 5'-0" (1220mm x 1525mm). Note: Large panels can be manufactured however a typical QPP-25 panel weighs approximately 3.50 lbs. per sq. ft. (17.1 kg/m^2) and therefore a large 4'-0" x 10'-0" panel would weigh over 100 lbs. (45 kg) which may be impractical. Also, large panels are more susceptible to climactic changes. This can be overcome by using smaller panels. Decoustics typically recommends a more manageable size of 12 to 20 sq. ft. (1.1 to 1.9 m^2) per panel.

VENEER SPECIFICATION: Quadrillo veneer lay up is produced as slip matched, quarter sliced as a standard. Other veneer cuts and lay up options are available by request at additional cost. Veneer sequencing is not a standard practice but can be specified as required.

CURVED PANELS: See Maximum Panel Size above. Minimum radius for outside curve is approximately 16" (400mm) and inside curve is 24" (600 mm); tight radius panels may be non-acoustical.

FINISHING: Quadrillo is available prefinished in natural lacquer or unfinished for post application by others. DECOUSTICS can provide custom lacquer toning, tinting and sheen to match other wood finishes. An acceptable representation should be supplied and a prototypical sample produced for design acceptance and sign off.

Cautionary Note: Quadrillo panels are frequently used in conjunction with solid, millwork veneer panels. It is highly recommended that a single finishing source produce both Quadrillo and Flat panels where toning and sheen are matched. In these instances, DECOUSTICS can provide unfinished panels.

ENVIRONMENT: Quadrillo panels must be stored, installed, and maintained only in a stable ambient environment (relative humidity of minimum 35% - maximum 55%, temperature to be maintained between 20 - 27°C (68-80°F)) Quadrillo panels must be allowed to stabilize on site for 72 hours prior to installation.

After Installation - Maintenance Requirements

Quadrillo Acoustic Wood panels are manufactured using real wood veneers and engineered wood components and therefore should be cared for as all other Architectural wood products are. When cleaning, vacuum panel surfaces using a non-marring, natural bristle head. Avoid hard or very short bristle cleaning heads.

Minor surface scuffing or scratches can be removed by lightly rubbing the affected area with a dry, clean pad of #0000 fine steel wool. Do not over apply. Avoid using water or a damp cloth on large surfaces as this may affect the stability of the membrane surface. Aerosol furniture polishes can be used on small areas, however, do not spray directly on the surface of the acoustic membrane. Apply small amounts on a soft cloth and rub gently.

Wood is a hydroscopic material, and under normal use conditions all wood products contain some moisture. Wood readily exchanges this molecular moisture with water vapor in the surrounding atmosphere according to existing relative humidity. In high humidity, wood picks up moisture and swells and in low humidity, gives up moisture and shrinks. These uncontrolled extremes may affect the structural integrity of the panels and cause visual problems. To avoid this, relative humidity should always be maintained between 35% and 55% in the area where panels are installed.

Note: The information provided in this Data Sheet is accurate to the best of our knowledge at the time of printing. However, we reserve the right to make changes when necessary without further notification. Suggested applications may need to be modified to conform with local building codes and conditions. We cannot accept responsibility for products that are not used, or installed to our specifications. Please refer to our website for most current data.

Note: Only handle panels wearing clean, lightweight, white gloves during installation. Follow manufacturer's printed instructions for installation as well as field cutting of panels.

FINISH	PANEL THICKNESS	FREQUENCY (Hz) 125	250	500	1000	2000	4000	NRC	SAA
Quadrillo	Type F5 Mounting								
QPP-19	Panel 1-1/8" (28mm) Core 3/4" (19mm)	0.04	0.23	0.52	0.90	0.94	0.66	0.65	0.64
QPP-25	Panel 1-3/8" (35mm) Core 1" (25mm)	0.09	0.25	0.75	1.05	0.99	0.77	0.75	0.75
QPP-50	Panel 2-3/8" (60mm) Core 2" (50mm)	0.28	0.67	1.13	1.03	1.01	0.94	0.95	0.96
Quadrillo	Type E400 Mounting								
QPP-19	Panel 1-1/8" (28mm) Core 3/4" (19mm)	0.78	0.77	0.61	0.86	1.04	0.70	0.80	0.82
QPP-25	Panel 1-3/8" (34mm) Core 1" (25mm)	0.79	0.90	0.81	0.95	1.05	1.05	0.90	0.91
QPP-50	Panel 2-3/8" (60mm) Core 2" (50mm)	0.80	0.87	1.00	1.07	1.08	1.00	1.00	0.98

Additional test results available.

decoustics
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