2011

Drexel University Recreation Center
Philadelphia, PA

Final Thesis Report

Britnei Godusky | Lighting/Electrical

Faculty Consultants:

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the drexel university recreation center philadelphia, pa

britnei godusky | lighting + electrical

image courtesy of drexel university

building statistics

size | 84,400sf
levels | three stories above grade
cost | $40.2 million
construction dates | summer.2008-winter.2009
delivery method design-bid-build

project team

drexel university | owner
sasaki associates, inc. | architecture/interiors
ewingcole | electrical/lighting
ewingcole | structural
ewingcole | mechanical
turner construction | contractor

lighting electrical

1500kva 480Y/277 3θ dual supply from existing campus substation.
indoor diesel 350kw 480/277 3θ 4W emergency generator.
dry-type step-down transformers on each floor for appliance and lighting panels.
primarily fluorescent lighting at 4100K, metal halide for accent in hall of fame.
public and circulation spaces switched via relay-based building wide controls.
energy efficient exterior induction lighting with integral photocell control.

architecture

strong lines and sharp angles are emphasized on glazing/aluminum panel façade, combining for a modern play on transparency and concealment.
athletic center addition includes sports bar, gymnasium with elevated track, fitness centers, rock-climbing wall, racquetball courts and group fitness rooms.
exposed concrete ceilings and columns create exposed, spacious impression.

mechanical

mechanical system operates at full occupancy 24/7 and is composed of:
seven rooftop air handling units, four VAV and three CV,
ranging from 1880cfm for lobby to 32,550cfm in fitness/weight room.
three parallel boilers providing hot water for gas heating system.
air cooled condensers in AHUs feeding blower coil air conditioning.
system controls monitored by supervisory network on Drexel campus.

structural

structural system based entirely on reinforced concrete including:
concrete caissons founded on rock auger refusal.
one-way slab on grade ground floor with perimeter foundation walls.
exposed concrete columns throughout building interior.
additional stories and roof of structural concrete flat plate slabs.
gymnasium roof supported by truss system, the only completely steel structure.

http://www.engr.psu.edu/ae/thesis/portfolios/2011/bjg5004

executive summary

This report provides a comprehensive overview of all work and analysis completed during the AE 897G Senior Thesis and includes four lighting and four electrical depth topics, as well as three additional breadth topics resulting in a re-design of several systems present in the Drexel Recreation Center. This study does not conclude that there are actual problems with the existing designs, but was simply intended to investigate and approach alternative solutions.

The lighting depth follows the design process through schematic design, design development, and construction documentation of four spaces: the exterior courtyard, lobby, fitness center, and restaurant. All three of the interior spaces selected span the Market Street façade, allowing the lighting design to greatly influence the aesthetics of the facility and to directly influence the experience of the passing pedestrians and drivers. The facility is fueled by the energy of the occupants as they move within the space just as the body is fueled by core energy during a workout. The minimalist design of the architecture with its structurally exposed concrete, straight lines, clean materials, and strong angles allow the energy and active users to become the feature of the space, which they are with the interactive LED element in the fitness center that allows the exerciser to generate kinetic energy which is harvested and converted into a color changing design that allows the energy to be visible from the exterior.

The electric depth modified the branch circuit distribution for each space listed above in response to the lighting redesign, and feeders and panels were analyzed for coordination and voltage drop. A protective device coordination study was performed along with short circuit analysis for a path originating at the utility entrance through the main switchboard to distribution panel DP-1-1, and down to panel AP-1-1. A system to convert kinetic energy from the cardio machines into DC power for an interactive LED lighting load was designed and implemented in the fitness center. A cost comparison will be completed of an alternative solution to the existing PVC conduit distribution system located within the concrete slab of MC cable run through solid bottom cable trays on the ceiling below utilizing poke-throughs to distribute power to branch circuit loads.

An MAE focus of daylighting integration into the gymnasium using skylights in turn initiated the two out-of-option breadths of study: acoustical and structural. To incorporate daylight the dropped panel ceiling in the gymnasium was removed, and resulting load distribution adjustments required an analysis of the existing spacing and loading of steel truss system, as well as reverberation time calculations and consideration of echo and noise within the gymnasium. The structural and acoustic studies within prove that not only are daylights beneficial for the electric power consumption, they are also completely feasible without negatively impacting other scopes of the project.

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background

Centrally located in the heart of Drexel's Campus in Philadelphia PA, the 84,000sf University Recreation Center is a $41 million state of the art addition to Drexel's existing athletic facility. Doors opened in January 2010, providing students and faculty with ID swipe card access to athletic areas including a rock climbing wall, group exercise center, and gymnasium with elevated track. The western half of the southern Market Street façade is dedicated to a restaurant and sports bar, contributing an exciting new venue to University City.

The building façade is the highlight and focal point of the Drexel Recreation Center design, reinforcing the main design goal for designer Sasaki Associates: to give the university a strong, modern presence along Market Street, the main thoroughfare directly into Center City. A result of extensive energy studies, the strong lines and sharp angles of the glazing/aluminum panel façade utilize daylighting in the most energy efficient way to create a bold presence with a modern play on transparency and concealment. Exposed concrete interiors interact with the extensive glazing on the southern façade to create an exposed, bright, spacious impression in interior spaces.

building statistics

general building information

location | NW Corner of 33rd and Market Streets Philadelphia, PA

building occupant | Drexel University faculty and students

occupancy type | Gymnasium/Lounge Café

size | The entire athletic center is 250,000sf but the addition covered by this investigation is 84,000sf

total levels | Three levels above grade

dates of construction | June 2008-December 2009

actual cost | $41 million

project delivery method | Design-bid-build with a gross maximum price

primary project team

Drexel University	*owner*
Sasaki Associates	*architecture* *interiors* *landscaping*
EwingCole	*mechanical/electrical/plumbing* *structural* *fire protection*
Pennoni Associates	*civil* *site design* *geotechnical/environmental engineering*
Turner Construction	*contractor*

restaurant fit-out

LDL Studio Inc.	*architect*
FXBonnes Associates Inc.	*mechanical/electrical/plumbing* *fire protection*

architecture

Intended to give a new face to Drexel's presence on Market Street in downtown Philadelphia, the Drexel University Athletic Center is a state of the art facility with ID swipe card access to athletic areas including a rock climbing wall, group exercise center, and gymnasium with elevated track. The western half of their southern Market Street façade is dedicated to a restaurant and sports bar, contributing an exciting new venue to University City. Exposed concrete interiors and floor to ceiling glazing on the southern façade create an exposed, bright, spacious impression.

national code models:

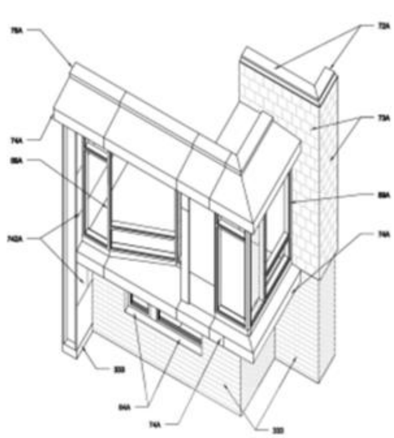
2006 International Building Code with Philadelphia Amendments
2006 International Fire Code
2006 International Fuel Gas Code
2006 International Mechanical Code
2006 International Energy Conservation Code
2006 International Existing Building Code
Pennsylvania Uniform Construction Code
National Electrical Code, 2002 Edition
2006 International Mechanical Code
NFPA Standards 13, 14, 20, 72

zoning requirements:

occupancy | A-3 gymnasium, A-2 Lounge Café
usage| mixed use non-separated occupancy
building occupant | Drexel University faculty and students
construction type | type IIA
allowable height | 3 stories, 85'
allowable area | 151,125'

building enclosure:

envelope | The athletic center uses a thermal envelope system including an exterior air/vapor barrier system (726), cavity insulation (72), and membrane flashing (76).



Façade materials:

architectural concrete exterior wall (333)
slate shingle wall system (73A)
metal plate wall panel system (74A)
solid phenolic exterior wall system (742A)
aluminum window system including metal flashings (84A)

roofing | roofing materials include Zinc-coated steel, aluminum sheet, extruded aluminum, semi-rigid glass fiberboards, asphaltic roofing cement, and bituminous mastic isolation coating on a concrete flat plate slab.

construction

The Daskalakis expansion wraps around the existing Athletic Center, adding 84,000sf to the existing building and more than doubling the amount of recreation space in Drexel's athletic center. Turner Construction won the design-bid-build project with a Guaranteed Maximum Price. The GMP budget for construction was $31 million with the total final project cost coming in at $42 million. The project broke ground in June 2008, and as an initiative to be environmentally conscious, for every tree that was removed in the facility's construction a new tree was planted elsewhere on Drexel's campus.

electrical

The DAC's overall electrical system is a radial system with one point of 13.2 kV service entrance in the main electrical room in the basement of the Fitness Center. This service entrance is fed from existing PECO service switchgear in the Nesbit Building. The entrance is powered by a 1500kVA transformer that steps down the voltage from 13.2kV to a 480Y/277V, 3P, 4W voltage system located in a newly constructed substation to feed the new addition as well as the existing substation in the DAC. A 2500A main distribution system provides power 480Y/277V power to all loads. Dry-type, step-down transformers feed 208Y/120V, 3P, 4W power to receptacles and appliance loads, while lighting panels use 277V power. For backup power to emergency branches powering emergency/egress lighting, sewage ejector pumps, existing sump pumps, and boiler controls, the DAC utilizes an indoor diesel emergency generator rated at 350kW, 480Y/277P, 3P, 4W.

lighting

The lighting throughout the Daskalakis Athletic Center successfully creates a bright, energetic space that interacts and responds directly to the architecture and aesthetic intent of the façade and the building within. Direct and reflected glare is avoided and an attractive rendering of people and objects in the space is achieved by the use of mostly indirect lighting to illuminate the task plane. The lighting design was ASHRAE 90.1 compliant using the total building method, and all of the spaces met or exceeded IESNA's recommended illuminance values. Just as the glazing on the southern and eastern building façades demands attention in each space in the facility, the continuity of both a cool color temperature of 4100K and the linear response to the façade creates cohesion when transitioning from space to space.

mechanical

Drexel's Athletic Center is conditioned by seven direct expansion rooftop air-handling units ranging from 1,880cfm for the lobby to 32,550cfm in the fitness/weight rooms. Three parallel BHP hot water heaters are located below the gymnasium partner with the 3,000 gallon fuel oil tank located in an underground vault to power the duel heating system. Four AHUs are variable air volume and three are constant volume, utilizing an associated supply, return, and exhaust duct distribution. Shell space was provided in the mechanical room for a future water cooled chiller.

structural

The structural system for the facility is based entirely on reinforced concrete. The one-way slab on grade foundation rests on concrete caissons, with cast-in-place perimeter foundation walls formed above concrete grade beams. Exposed concrete columns are prevalent throughout the building interior, with additional stories and roof composed of structural concrete flat plate slabs. The gymnasium roof is supported by a steel truss system designed to support air handling equipment and cooling towers. The lateral system consists of concrete shear walls in the four gymnasium corners as well as in the space south of the existing DAC.

fire protection

The Athletic Center is utilizes a full sprinkler system supplied by the city's water supply and designed in accordance with NFPA 13. The floor control stations are located in stair towers 3 and 4 and served from a combination sprinkler riser including floor control valve assemblies, test valves, and drains. A manual fire alarm system is installed with an interfaced control system tied into a campus supervising system. Activation initiates an emergency voice/alarm communication system with using speaker strobes that are white in color. Smoke detection is provided in electrical/telecom rooms, above doors controlled by the system, in elevator lobbies, elevator machine rooms, and in HVAC ducts.

transportation

Two hydraulic elevators serve the first through third floors of the DAC. The main stairway is accessed just through the swipe card entrance, and is the primary means of vertical transport between the lobby, gymnasium, and second and third level fitness areas. Additional staircases are located at the north- and south-eastern corners of the fitness areas, and are primarily used for egress.

telecommunications

Voice and data are provided to the conference rooms, offices, and retail space via 4" PVC sleeves in cable trays mounted within the structural concrete slabs. Emergency phones are located in the elevator lobbies, equipment issue room, gymnasium, retail café, and recreation spaces to provide quick response in case of injury during physical activity. A fire alarm annunciator with live voice capability is located at the security desk at the east lobby entrance.

AV

The audiovisual system in the athletic center incorporates an audio/paging system through pendant speakers throughout the lobby and fitness area, as well as ceiling mounted speakers in the gymnasium. LCD screens are located in the climbing lounge, at the east and west lobby entrances, with a total of twenty screens mounted on each floor of the fitness area. AV equipment rooms are provided on the second and third floors with the second floor space feeding the LCD screens and speakers on the first floor.

security

Electronic security control modules are located in the main security room east of the electrical room on the ground level beneath the gymnasium. Each main entrance is controlled by electronic locks with an emergency override located at the security desk. Electronic locks also guard the gymnasium entrance and each stairway. A pole mounted security camera monitors the exterior on the eastern and alternate north entrance to the new facility, with interior cameras located in the athletics gallery. Swipe card access is required to enter the recreation center, and is located beyond the security desk.

lighting depth

introduction

The Drexel Recreation Center uses its transparent façade to prominently establish Drexel's visual presence in an energy efficient way. Constructed by linear panels of floor-to-ceiling glazing along a majority of the streetscape, the façade is lit almost completely by the interior lighting. The four spaces to be analyzed and redesigned include:

exterior space | courtyard
large workspace | fitness center
circulation space | lobby
special purpose space | restaurant

All three of the interior spaces selected span the Market Street façade, allowing the lighting design to greatly influence the aesthetics of the facility and to directly influence the experience of the passing pedestrians and drivers. Sasaki Associates took care to expose the core energy of the building. The facility is fueled by the energy of the occupants as they move within the space just as the body is fueled by core energy during a workout. The minimalist design of the architecture with its structurally exposed concrete, straight lines, clean materials, and strong angles allow the energy and active users to become the feature of the space. In addition to accentuating the architecture and core concept, the lighting must be designed to meet established design criteria that are outlined for each space, which includes guidelines from both the IESNA handbook and ASHRAE energy Standard 90.1. Included in the lighting analysis are a summary of the space, design concepts criteria and considerations, equipment and controls schedules, and all technical documentation of the design and its performance.

exterior space | courtyard

overall design goals

To reinforce the perception of energy from within the facility, the core of the building appears glowing from the courtyard, and minimalist fixtures were chosen to highlight the architectural features of the area.

The athletic center's courtyard and plaza will feel welcoming while balancing the feeling of a public space during the day and a more private, enjoyable shortcut across campus after dark. Keeping the central area dimmer and guiding the pedestrians through the space with light can transform this space from its current state as a scarecely lit, unnoticeable space to an inviting, engaging spot in which to walk.

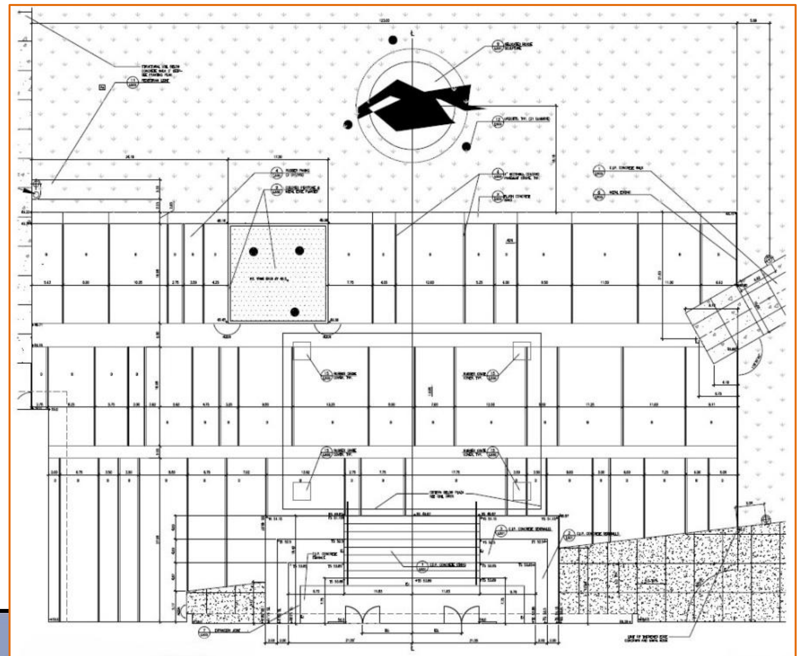


figure 2 - Enlarged courtyard plan

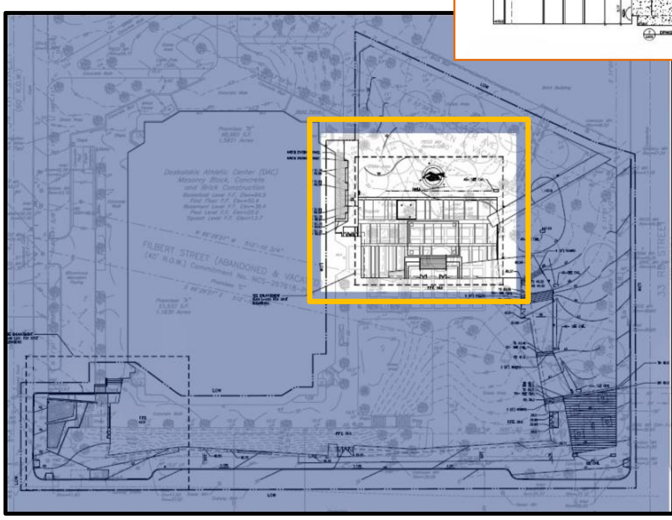


figure 1 - Orientation of courtyard to building site

description

The exterior courtyard space is located on the northern side of the Athletic Center addition, and is bordered on the west by the existing athletic center. Measuring 123’ x 117’, the courtyard covers close to 15,000sf. Providing access to both the gymnasium and the Hall of Fame entrance to the facility, the space is an important circulation space and is the first impression portrayed to visitors approaching the DAC from the north side. Due to the dynamic functions of the space during the day, no fixtures can obstruct the colored rubber pavement tiles, providing a challenging aspect to the design in order to ensure that facial recognition is heightened to promote a feeling of safety.

Materials and Finishes		
Surface	**Description**	**Reflectance**
asphalt shingles	-	0.24
brick façade	existing brick façade of DAC	0.38
grass	-	0.24
railing and mullions	metal	0.27
rubber pavement	Panorama eggshell 3/8” rubber tiles	0.57
rubber pavement	Panorama light blue 3/8” rubber tiles	0.47
rubber pavement	Panorama blue 3/8” rubber tiles	0.32
rubber pavement	Panorama orange 3/8” rubber tiles	0.23
sidewalk/stairs	concrete	0.25
glazing	insulating laminated Viracon glazing	t = .46

table 1 - exterior materials and finishes

tasks/activities

For a majority of the day, this space is simply a space in which students cut through on their way to class, and a visibly engaging courtyard for the secondary northern entrance to the workout facility. The springy rubber tiles allow yoga, martial arts, and other physical tasks typically needing an indoor practice space performed on wrestling mats to take advantage of this open outdoor space for group activity.

design criteria and considerations

desired illuminance levels and design considerations- **IESNA 2000 *Parks, Plazas, and Pedestrian Malls***

quantity of light

general lighting: **0.5fc**
paths/steps leading away from building: **1fc**
active entrances: **5fc**
vertical: **0.3fc**

ASHRAE/IESNA 90.1: Building grounds- *Plaza areas* ***0.2W/sf***

quality of light

Very Important Criteria

Color Appearance (and Color Contrast)- In low light levels especially, color rendering plays an important role in the appearance of both individuals and objects throughout the space. To complement the glow from within the gymnasium and also to play on the yellows and blues of the courtyard itself, a cooler temperature will interact in a more pleasing manner with the space.

Direct and Reflected Glare- Glare can be avoided by positioning fixtures outside the direct line of sight of a pedestrian. The expansive glazing on the façade of the gymnasium as well as the glass vestibule the hall of fame have the potential to cause reflected glare if up lighting luminaires are reflecting into the façade.

Light Pollution/Trespass- Specifying shielding or cutoff fixtures can minimize light pollution and trespass. Located in downtown Philadelphia, this is less of an issue and more of a general consideration. Pathway lighting should follow the path, and general luminaires should only send illuminance to the space intended for lighting.

Modeling of Faces or Objects- Due to the levels of foot traffic on campus at night, the modeling of both faces and objects is important within this space to promote a general feeling of safety.

Peripheral Detection- The courtyard is open on two sides to the campus, but both the southeast and northwest entrances to the space are well lit by the entrances to the DAC. However, the location of Drexel on the outskirts of west Philly still make this an important design consideration.

Shadows- The courtyard is a small enough space that shadows should add to the guidance of pedestrians throughout the space. Shadow in the trees and on the plaza will actually add a dramatic and aesthetically pleasing effect for those to view when passing the Rec Center.

Important Criteria

Appearance of Space and Luminaires- The openness of the area makes both the space itself and the luminaires within it on display to the public. To avoid light trespass, luminaires should be placed so as not to be visible from someone not directly inside the boundaries of the space.

Light Distribution on Surfaces- Guided pathways both between entrances and through the space are important and pedestrians are encouraged to walk along them. To counteract the uniform glow from within, the lighting on either side of the façade and on any objects within the space should be dynamic and interesting.

Points of Interest- The gymnasium with its glow from within is automatically highlighted as a main focal point of the space. Interesting patterns could be brought out of the rubber tile at night by grazing the ground's surface. In addition to guiding pedestrians around the building, a clear path into the Hall of Fame entrance should be set by the lighting.

fixtures and equipment

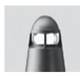
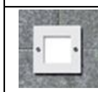
Luminaire Schedule			
Type		**Description**	**Manufacturer**
	M1	13.7' indirect pole-top ceramic metal halide luminaire with square top reflector and asymmetrical distribution	Bega
	M2	Aluminum alloy bollard fixture with 180° distribution with crystal glass optical lens	Bega
	N1	Recessed LED step luminaire with aluminum housing and white safety glass	Bega
	N2	4' linear fluorescent wet location listed surface mounted steplight with aluminum housing and white safety glass	Bega
	N3	4000K Linear LED cove mounted strip fixture with 110° beam spread	Winona
	N4	Ceramic metal halide exterior wall washing luminaire with two-sided light output and 10' mounting height	Bega
	Z1	4" gasketed metal halide floodlight with 20° beam spread, aluminum housing and clear safety glass	Bega

table 2: exterior luminaire schedule

Note: for full luminaire schedule including lamp and power source information and specification, see Appendix A.

Light Loss Factors				
Lamp Type	**LLD**	**LDD**	**BF**	**Total**
M1	0.82	0.8	1.0	0.66
M2	0.85	0.82	1.1	0.77
N1	0.85	0.82	1.0	0.70
N2	0.92	0.82	1.08	0.81
N3	0.7	0.82	-	.574
N4	0.74	0.82	1.0	.61
Z1	0.7	0.82	-	.57

table 3: exterior light loss factors

**The above light loss factors were calculated using the new method in the 2010 IESNA handbook. The Room Surface Dirt Depreciation (RSDD) was neglected and the Luminaire Dirt Depreciation (LDD) was calculated using the updated calculation outlined in the book. A lamp maintenance schedule of twenty-four months was assumed.*

controls

All of the exterior lighting utilizes controllable breakers by photocell.

renderings

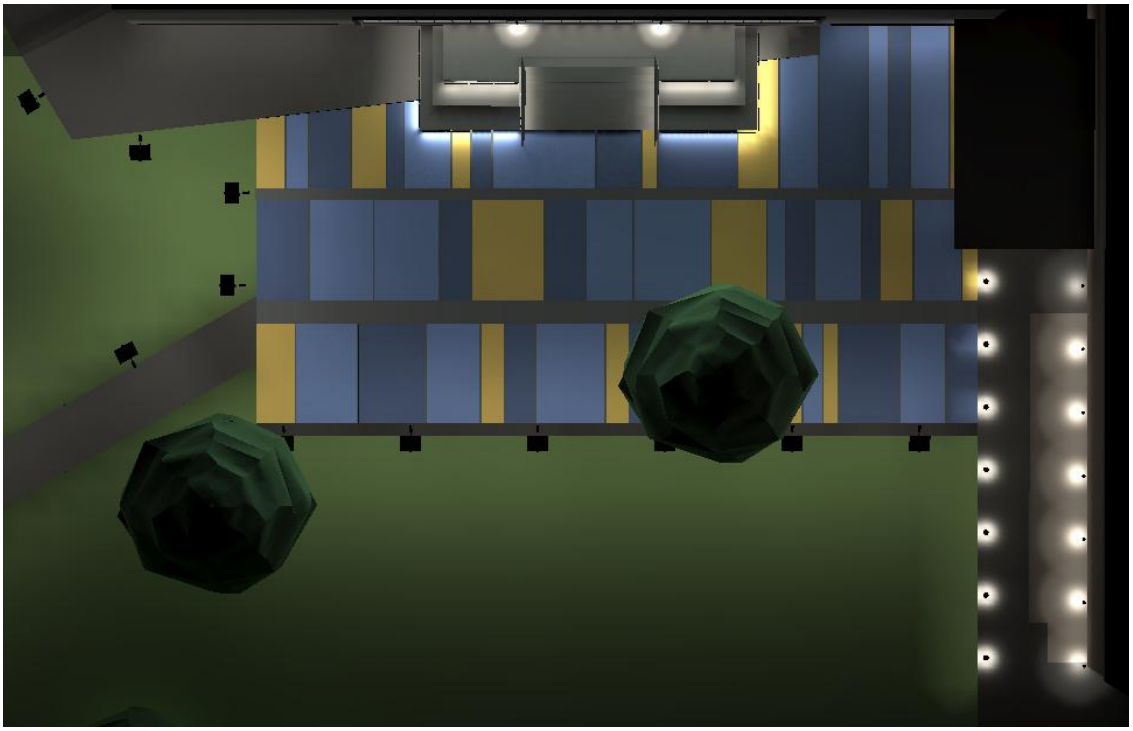


figure 3: aerial rendering of exterior space

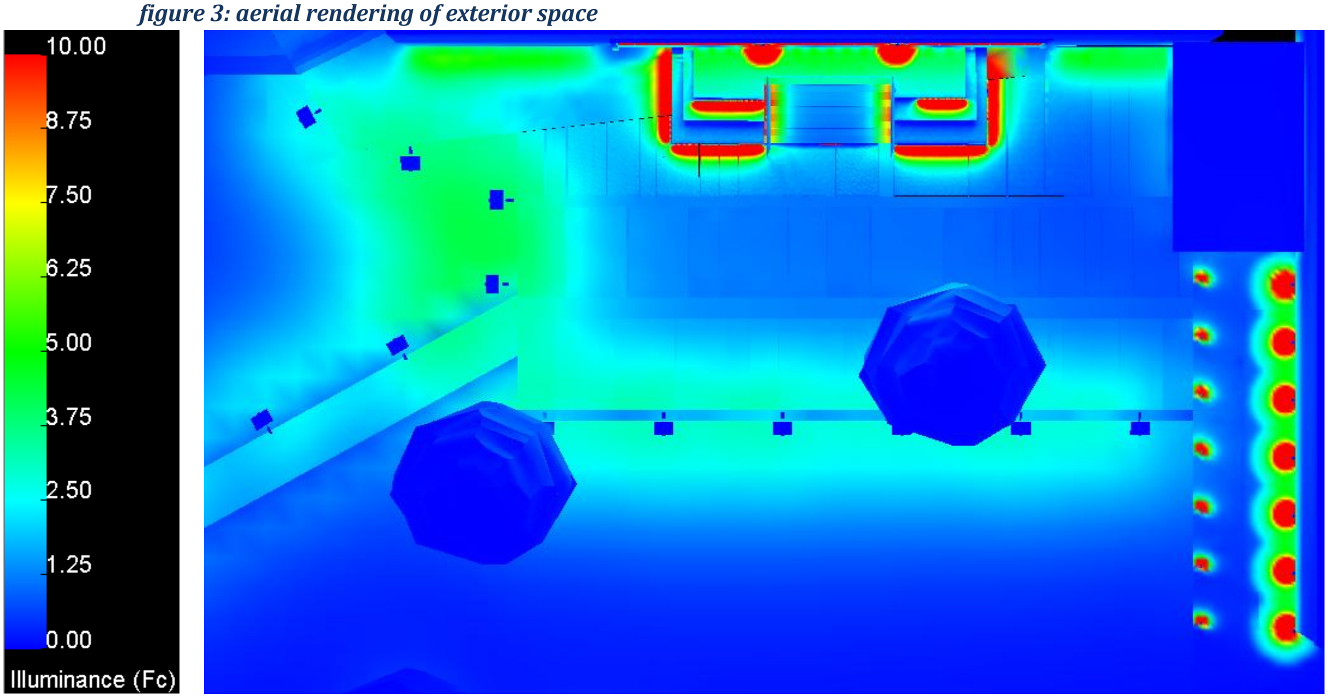


figure 4: aerial psuedocolor rendering of exterior space

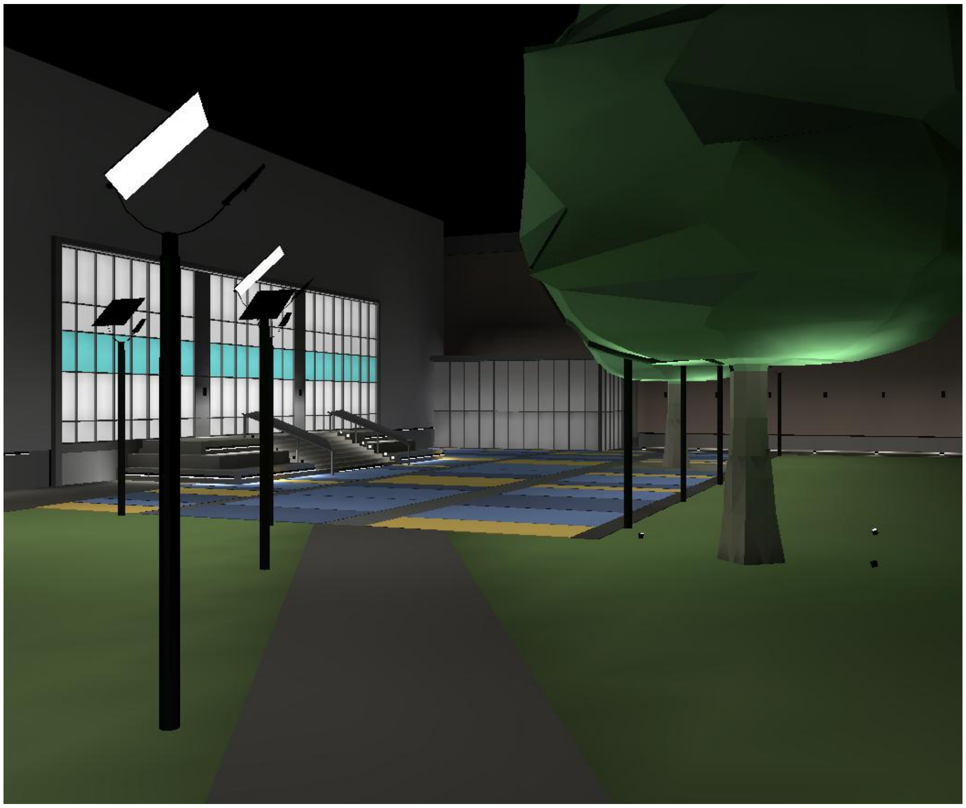


figure 5 – perspective rendering of exterior facing southwest

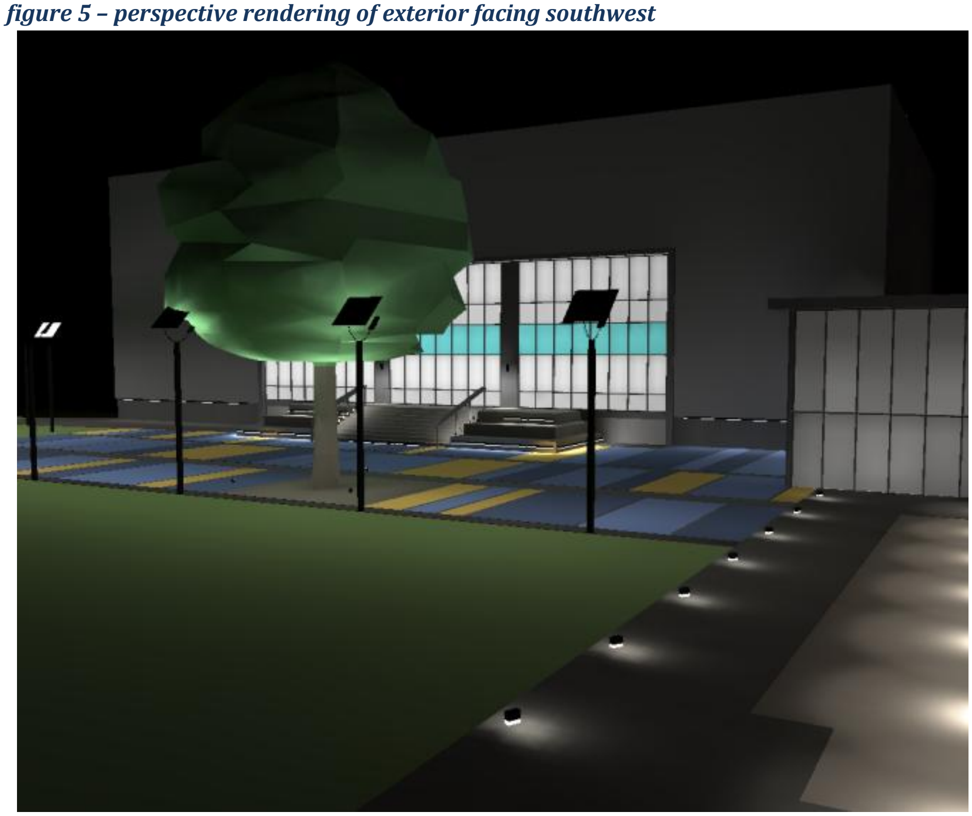


figure 6 – perspective rendering of exterior facing southeast

calculation summary

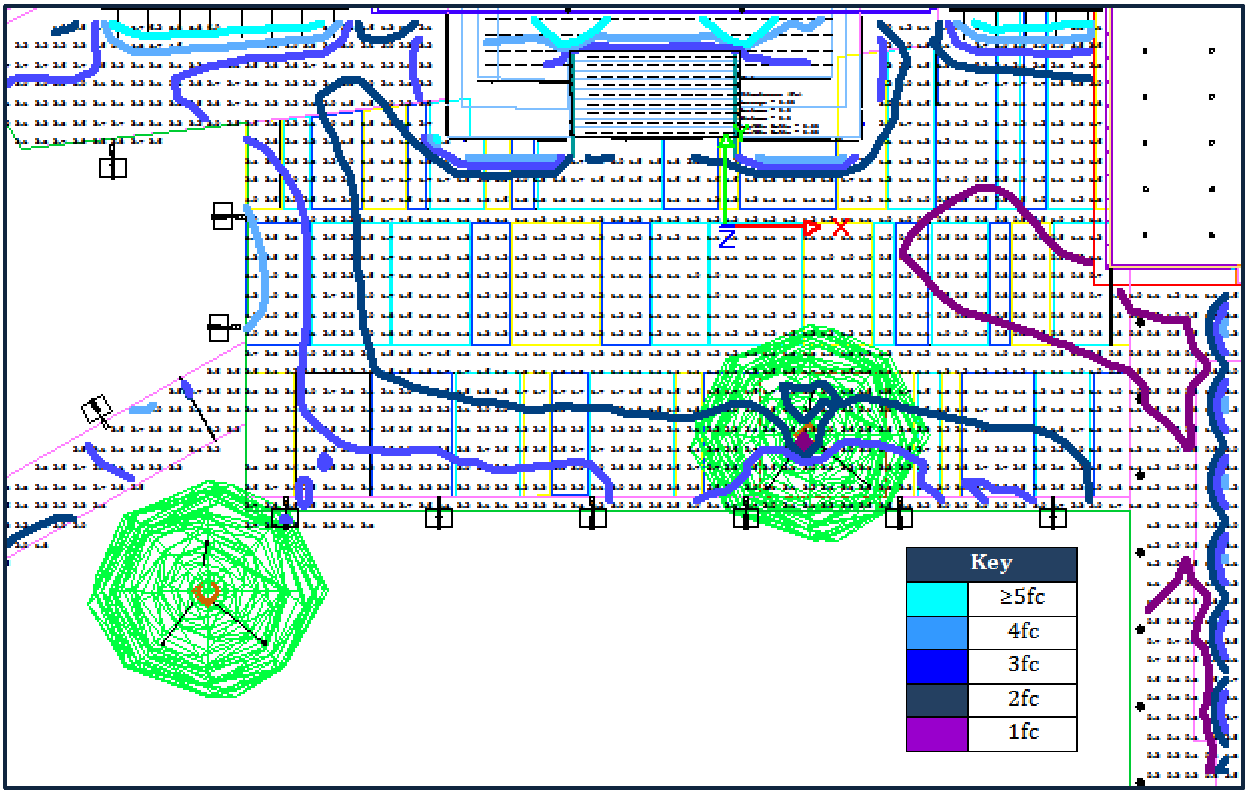


figure 7 – courtyard illuminance values

Courtyard Calculation Summary		
	Ground (0')	**Vertical**
average illuminance	2.13fc	2.09fc
maximum illuminance	6.4fc	3.2fc
minimum illuminance	0.2fc	1.2fc
design criteria	**0.5fc**	**0.3fc**

table 4 – courtyard calculation summary

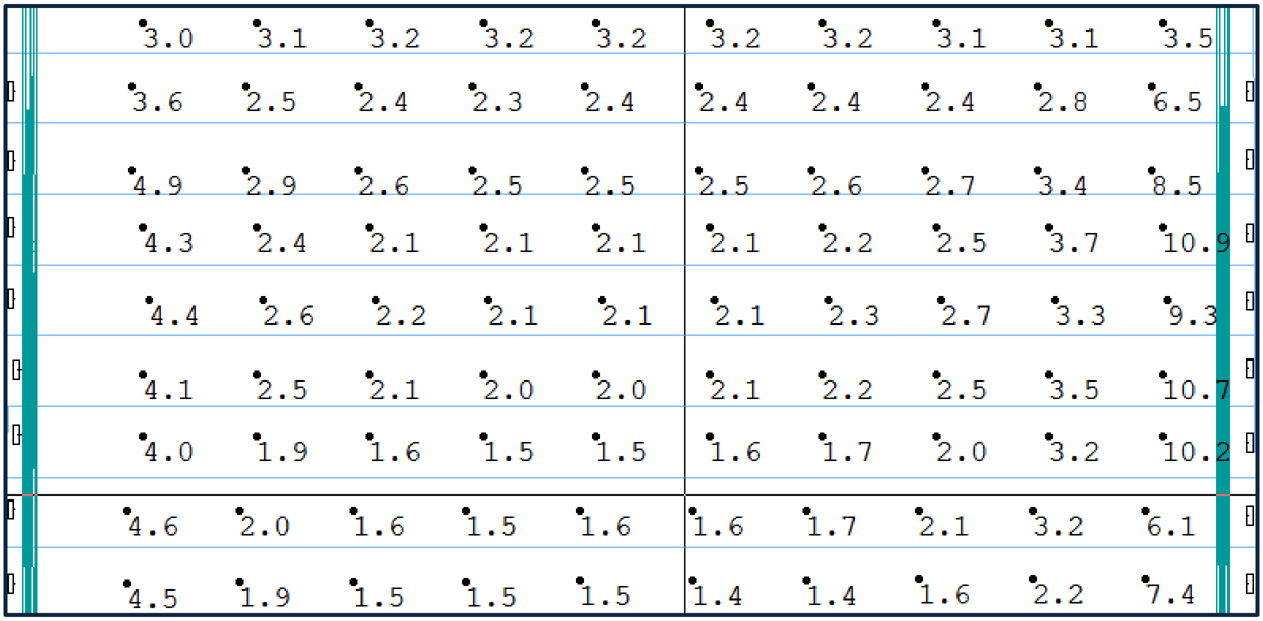


figure 8- staircase illuminance values

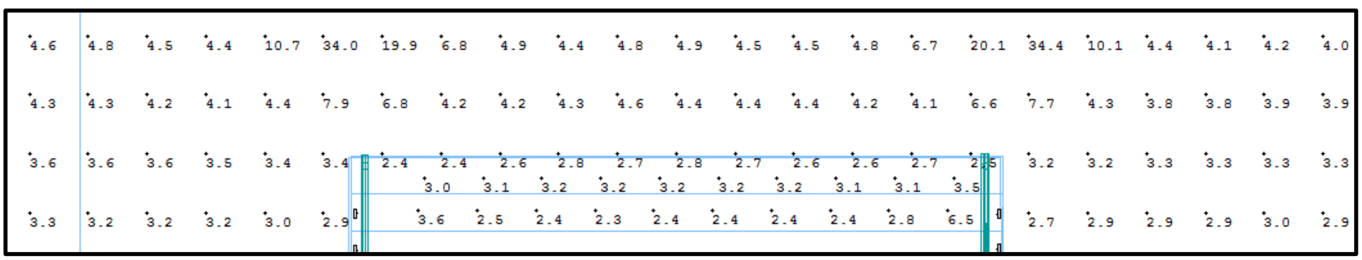


figure 9– entrance illuminance values

Entrance Calculation Summary	
	Ground (0')
average illuminance	5.26fc
maximum illuminance	34.3fc
minimum illuminance	2.6fc
design criteria	**5fc**

table 5 – entrance calculation summary

Stairway Calculation Summary	
	Ground (0')
average illuminance	3.15fc
maximum illuminance	10.9fc
minimum illuminance	1.4fc
design criteria	**1fc**

table 6 – stairway calculation summary

Lighting Power Density			
Fixture Type	Input Wattage	Quantity	Total Watts
M1	78	14	1092
M2	36	7	252
N1	10	17	170
N2	36	24	864
N3	3.9W/ft	52ft	202.8
N4	43	9	387
Z1	17	12	204
Total Watts			3171.8
Selected Lighting Area			16,773ft
Watts/SF			0.18
ASHRAE Std. 90.1 compliance?			**0.2 - yes**

table 7– exterior lighting power density

evaluation

The lighting design in the exterior courtyard successfully creates a visibly engaging, welcoming outdoor space that balances the public feel of the space throughout the day with a private, safe, enjoyable environment created in the evening. Indirect pole mounted fixtures enhance a feeling of safety and security by enabling high levels of vertical footcandles for facial recognition. The perimeter of the rubber courtyard is illuminated to higher levels, creating layers of light that guide the pedestrians through the space without obstructing the central activity space with fixtures. The design reinforces that the first layer of light to the pathway comes from the building itself, from the steplights and cove fixture and also from the gymnasium and vestibule themselves. The very directional fixtures that are mounted on the building, as well as the LED fixtures uplighting the trees create visual interest in the space. Visitors can enjoy the space while either traveling through the courtyard or entering the secondary Hall of Fame entrance.

A cooler color temperature was used for this space both because of the exterior nature of the courtyard but additionally to tie in with the 4100CCT used throughout the building to compliment the cool cement gray and ice blue color scheme within the fitness center. The design is compliant to both the IESNA recommended light levels for horizontal and vertical illuminance, and also to ASHRAE's standard for linear power density.

large workspace | fitness center

overall design goals

The fitness area should feel spacious, and help to energize and uplift the occupants during their workouts. Expansive windows in the Drexel fitness center allow lots of daylight into the space, providing bright, uniform light levels throughout the day. The lighting layout can help to create an energetic, uplifting impression. Peripheral emphasis and clean, uncluttered walls will add to an open space that encourages focus. High illuminance levels on the ceiling and on the workplane will reinforce visual clarity. A bright open space also reinforces safety and cleanliness, which are important within a workout facility. This space is where the energy is actually exerted and returned to the building from the occupants, and so where the most dynamic and representative lighting design is actualized.

description

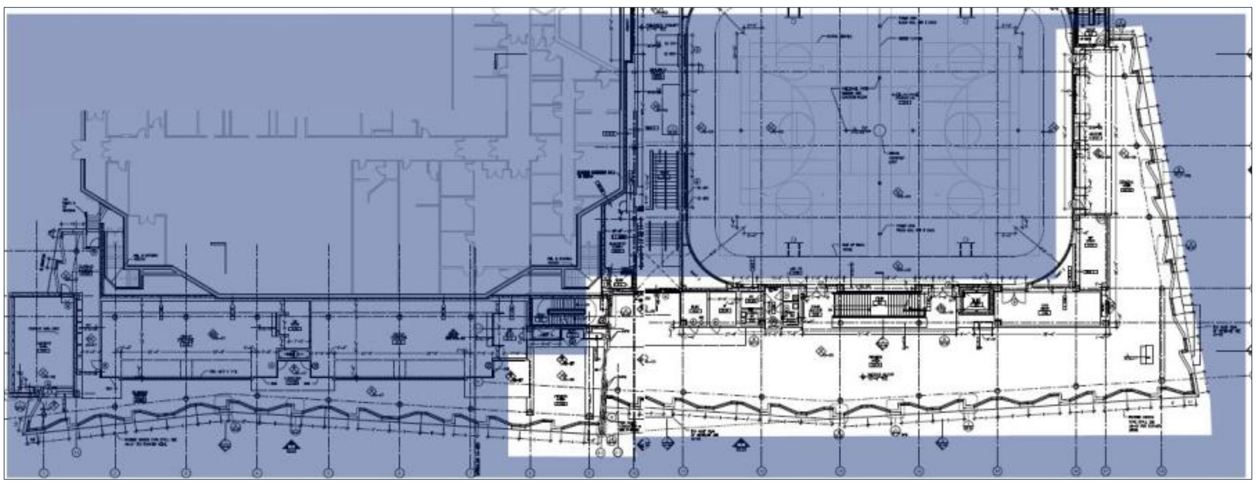


figure 10 – fitness center location in building plan

The fitness and weight lifting areas are located on the second and third floors of the DAC spanning the 140’ southern façade. Sections for free weights and strength machines extend along the Eastern façade of the building. A primary focus of the facility, the floor-to-ceiling windows and 13’ ceiling heights make the space an open, inviting, energizing place for cardio workouts and strength training.

Materials and Finishes		
Surface	**Description**	**Reflectance**
north, east, and west walls	gypsum wall board painted in Sherwin Williams Dovetail	0.6
south wall	gypsum wall board painted in Sherwin Williams Ceiling Bright White	0.8
flooring	Panorama 3/8" rubber tiles	0.20
base	6" Johnsonite rubber base in Moon Rock	0.2
ceiling	exposed concrete	0.60
framing, trim, railings, desk area	Prodema wood veneer paneling in Pale	0.45
glazing	Viracon insulated glazing	t = .46

table 8 – fitness center materials and finishes

Cardio, strength training, and free weight workouts will take place in this space (see figure 11 below for a detailed equipment layout). It also functions as a vertical circulation path from the lower lobby level into the gymnasium, group exercise rooms, rock climbing wall, and various spaces throughout the facility.

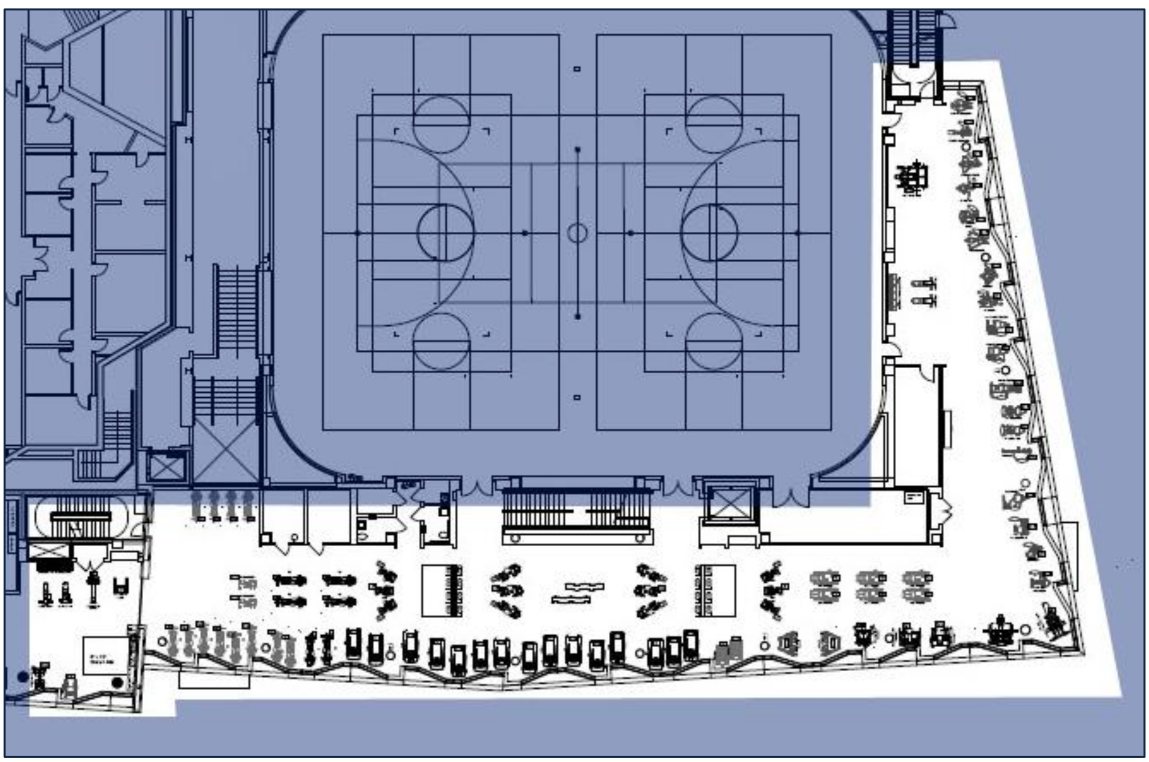


figure 11– fitness equipment layout

design criteria and consideration

desired illuminance levels and design considerations- **IESNA 2000 *Sports and Recreation***

quantity of light

weight training:

horizontal **– 20fc**
vertical **– 2fc**

ASHRAE/IESNA 90.1: Gymnasium/exercise center *playing area* – ***0.9W/sf***

quality of light

Design Considerations

Very Important Criteria

Appearance of Space and Luminaires- The fitness area is entirely visible to Market Street and so is an integral factor in determining the building's initial impression to the public. In addition to the luminaires being completely exposed due to the exposed concrete ceiling, the façade lighting takes place almost entirely from within, making the appearance of both the space and the luminaires crucial in contributing to the sharp lines and strong angles of the glazing and aluminum paneled exterior. Luminaires are consistent with the architectural concepts, with no soft forms or round edges.

The space has an overall appearance of cleanliness and order, and help to encourage activity and efficiency.

Color Appearance (and Color Contrast)- The color appearance throughout all of the workout spaces is consistent to facilitate effortless visual transitions between activities. The fundamental black, white, and grey color scheme would be better accentuated with a cooler color temperature of 4100K. A color rendering index of at least 85 is specified in order to render a pleasant appearance of skin tones and objects with the space to create a more inviting and pleasant place to work out.

Daylighting Integration and Control- A view of the outdoors has positive psychological effects on occupants, and can help to energize those working out during the day. Daylighting used as an overall ambient lighting for the workout space increases overall energy levels and provide a more energetic and dynamic lighting system.

Luminances of Room Surfaces- To reinforce the feelings of spaciousness and energy, brightness levels can be elevated by directly illuminating the ceiling and walls.

Modeling of Faces or Objects- People are continually interacting with both each other and the objects in the fitness area. Objects should be rendered accurately to ensure the safe and proper usage of equipment. Facial recognition as well as visibility of muscles and muscle function is necessary for spotting and correct performance of various exercises.

Important Criteria

Direct and Reflected Glare- Glare is a particular issue in this space because the occupants will have a variable line of site throughout their workouts. This not only causes distractions but also can hinder safety as being blinded can inhibit the ability to use equipment correctly. Glare can be avoided by limiting the use of luminaires that aim directly down, instead using perimeter or indirect lighting.

Light Distribution on Surfaces- Distribution of light on the ceiling and walls should be uniform in order to provide both a more energetic and spacious feeling but also to provide a more luminous glow to the exterior at night. The exposed columns are an interesting architectural feature that could be highlighted to provide visual interest.

Light Distribution on Task Plane (Uniformity)- The task plane within the fitness space is variable and can be located on the floor, the treadmill, or at changing heights throughout strengthening routines. This makes the overall uniformity of the light levels throughout the space important for the effective performance of physical fitness tasks.

Source/Task/Eye Geometry- Placement of luminaires needs to be considered in order to enable proper rendering of machinery as well as electronic displays on cardio equipment and to avoid direct light from the source into the range of vision.

fixtures and equipment

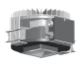
Luminaire Schedule			
Type		Description	Manufacturer
	A1	3”x4’ recessed linear fluorescent luminaire with extruded aluminum finish and frosted acrylic flush lens.	Focal Point
	C1	4” square 4100K LED downlight with remote phosphor lens, color mixing chamber, and integrated heat sink and power supply.	Indy
	J1	Flexible RGB LED colortape with RGB LEDs integrated into each LED package mounted on self-adhesive tape. See figure below for mounting details.	Osram
	P4-16	3” wide direct/indirect continuous linear fluorescent luminaire with titanium silver finish, flush satin lens and integrated daylighting sensor. Luminaire length indicated in type and on drawings (I.E. P4 = 4’-0” long).	Focal Point

table 9 – fitness center luminaire schedule

**Note: for full luminaire schedule including lamp and power source information and specification, see Appendix A.*

Light Loss Factors				
Lamp Type	LLD	LDD	BF	Total
A1	0.92	0.92	1.08	0.91
C1	0.70	0.92	-	0.64
P4-16	0.92	0.92	1.0	0.85

table 10 – fitness center light loss factors

**The above light loss factors were calculated using the new method in the 2010 IESNA handbook. The Room Surface Dirt Depreciation (RSDD) was neglected and the Luminaire Dirt Depreciation (LDD) was calculated using the updated calculation outlined in the book. A lamp maintenance schedule of twenty-four months was assumed.*

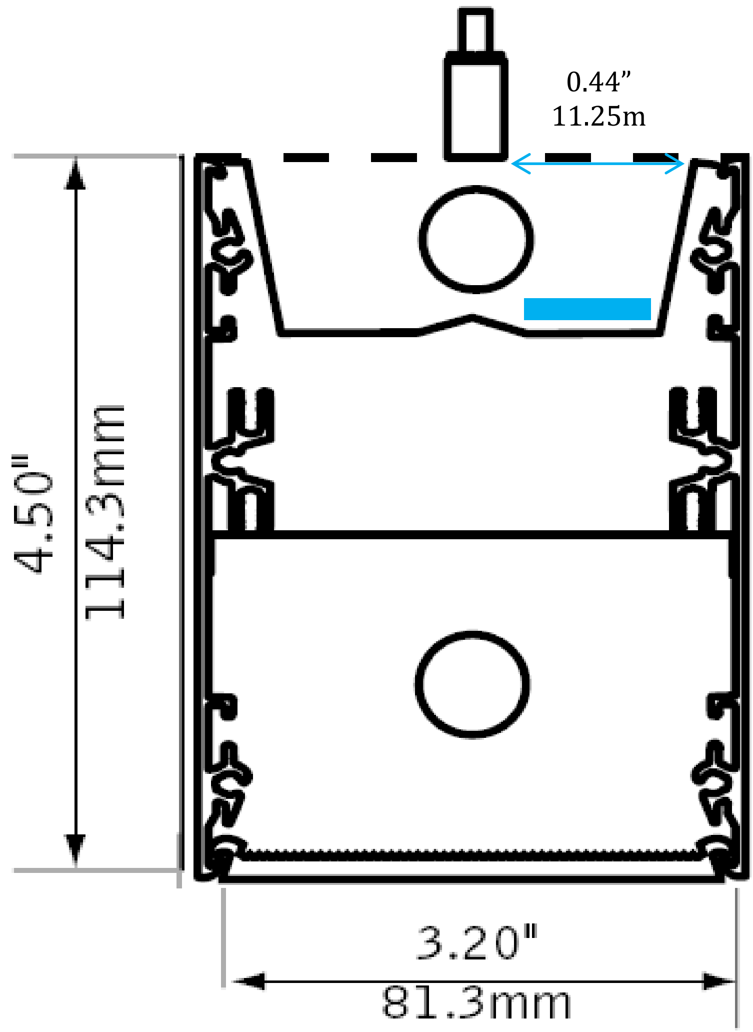


figure 12 - detail of P4-16 with integrated LED light tape

controls

The façade of the Drexel Recreation Center is a product of an extensive energy study to maximize daylighting and minimize solar gain. Since the fenestration faces directly south, desired light levels are met solely with daylight for a majority of the day. The Wattstopper digital lighting management control system will be utilized in the space to enable dimming to 1%, providing energy savings throughout the year. Using natural daylight in place of electric light during the day will not only save energy and money, but will have positive psychological effects on occupants. Daylighting used as an overall ambient lighting for the workout space will increase overall energy levels and provide a more energetic and dynamic lighting system. The selected Focal Point luminaires have been specified to incorporate the available integrated daylight sensor compatible with the Wattstopper controls. The daylighting sensor will be calibrated using a sliding setpoint algorithm in order to maintain the desired minimum of 20fc on the workplane (measured at cardio machine standing level of 1.5’) at all times.

A dynamic component of the lighting in the fitness center is an Osram-Sylvania LED light tape component integrated into each of the linear pendant fixtures. This lighting is not included in the calculations and is strictly an addition to the fluorescent lighting. Power for this component will use the ReRev system to harness kinetic energy generated by the cardio equipment in the space in the form of DC power. The LEDs will use the Osram Sylvania ___________ power modulator to provide consistent voltage to the LED component in each luminaire. This blue strip will create a blue glow to visibly show from the exterior where the power is being generated within the space, and will not be daylight controlled.

Fitness Center Control Schedule			
Type	Manufacturer	Product	Description
LC-100	Wattstopper	Intelligent Power Pack	Power pack delivers 0-10V dimming control to lighting loads.
LMLS-305	Wattstopper	LightSaver Photocell	Closed loop photosensor provides the daylight data necessary for operation.
LMRC-201	Wattstopper	LightSaver Room Dimming Controller	Provides automatic dimming control for fluorescent fixtures. Closed loop control utilizes a photocell for single-zone dimming.
LMSW-100	Wattstopper	LightSaver Wall Switches	Allows occupants to temporarily override the daylighting control systems.

table 11 – fitness center control schedule

Note: for full control schedule see Appendix C.

renderings

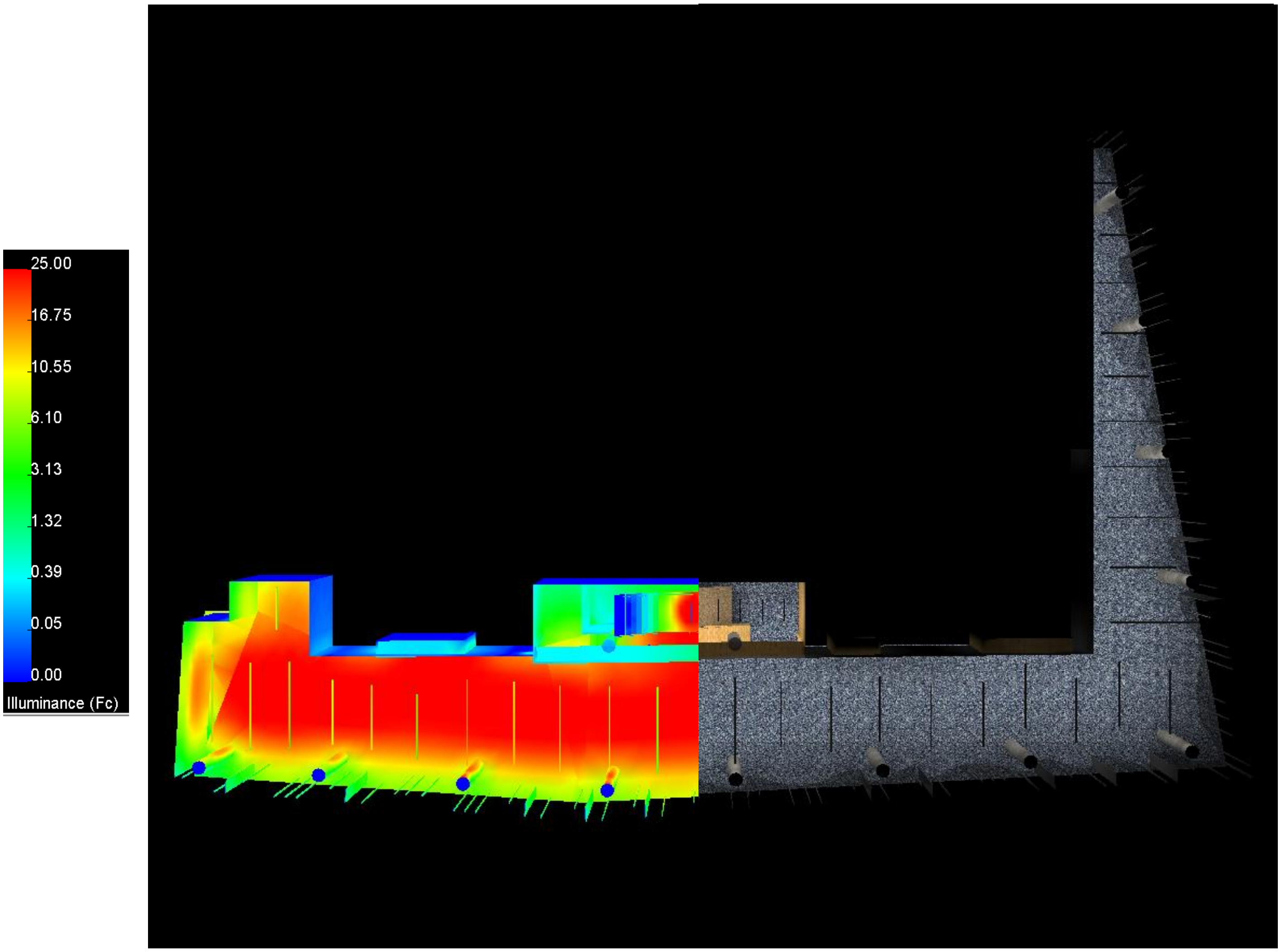


figure 13 - aerial psuedocolor/color rendering of fitness center

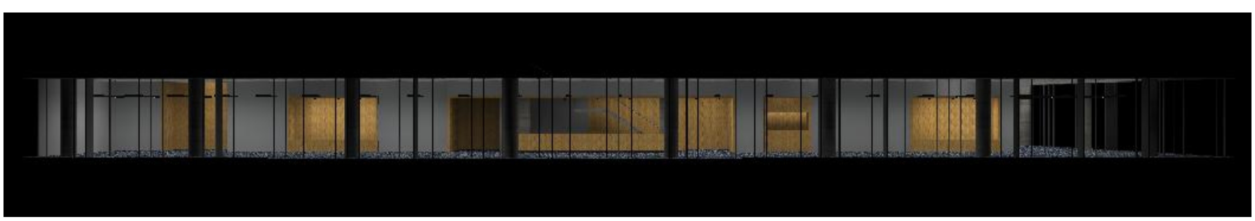


figure 14 - south view of fitness center

figure 15 -perspective view from within fitness center

calculation summary

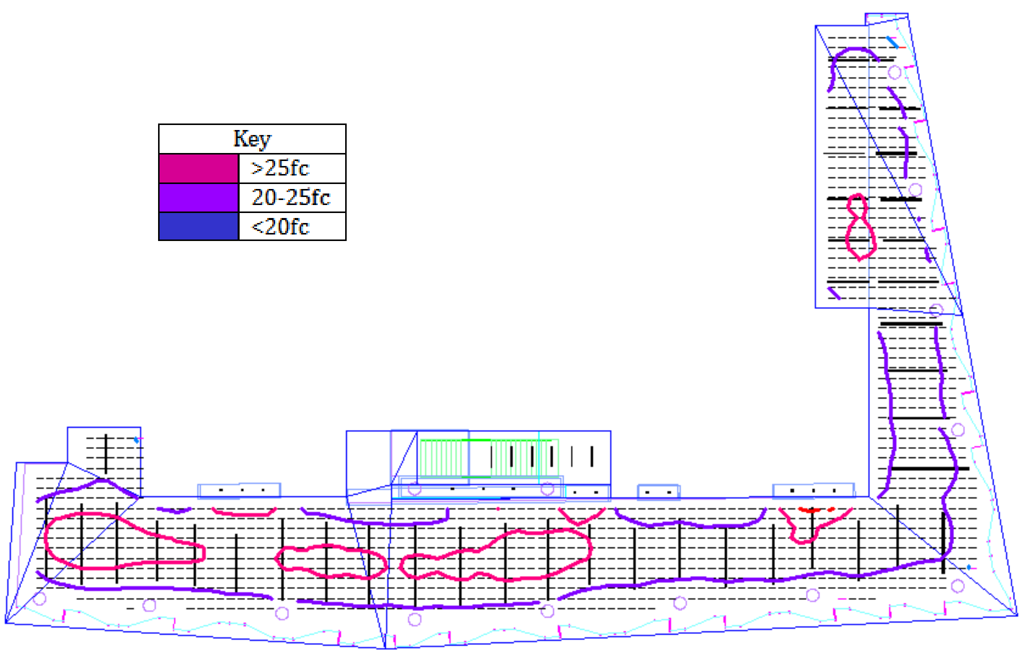


figure 16 - isolines of workplane calculation points (1.5')

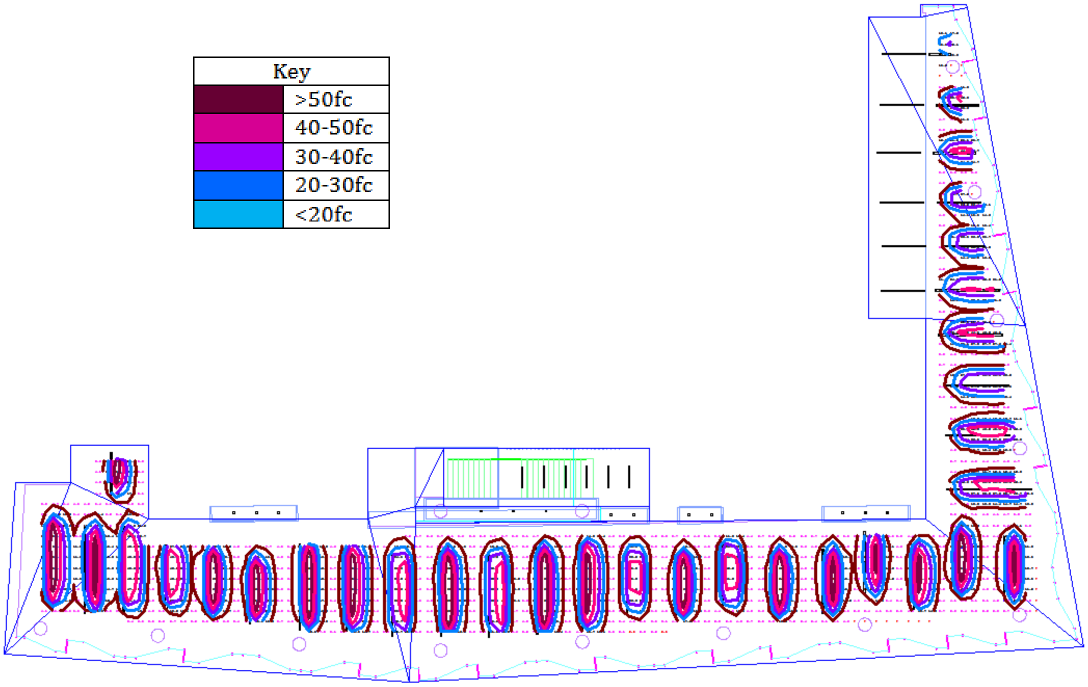


figure 17- isolines of ceiling calculation points for uniformity

Fitness Center Calculation Summary			
	Workplane (1.5')	**Ceiling**	**Vertical**
average illuminance	23.90fc	18.77fc	9.81fc
maximum illuminance	42.4fc	65fc	12.9fc
minimum illuminance	9.4fc	2.0fc	7.5fc
uniformity coefficient	**0.24**	0.89	-
design criteria	**20 fc**	-	**2fc**

table 12 – fitness center calculation summary

Lighting Power Density – 2nd floor			
Fixture Type	Input Wattage	Quantity	Total Watts
A1	36	6	216
C1	33	12	396
P4	63	7	441
P8	126	4	504
P12	189	16	3,024
P16	252	11	2,772
Total Watts			7,353
Selected Lighting Area			8,448sf
Watts/SF			0.86
ASHRAE Std. 90.1 compliance?			**0.9 - yes**

Lighting Power Density – 3rd floor			
Fixture Type	Input Wattage	Quantity	Total Watts
A1	36	6	216
C1	33	12	396
P4	63	7	441
P8	126	4	504
P12	189	16	3,024
P16	252	11	2,772
Total Watts			7,353
Selected Lighting Area			8,448sf
Watts/SF			0.86
ASHRAE Std. 90.1 compliance?			**0.9 - yes**

table 13 and 14 – fitness center lighting power densities

evaluation

The bright, uniform lighting layout gives the fitness center an open, inviting, and energizing place in which to work out. The high, even pattern of illuminance on the ceiling reinforces the already straight lines and angles that enhance the 13' ceiling and give the impressions of cleanliness and focus. The fitness center is lit primarily with daylight through a majority of the day, and the linear fluorescents are dimmed with a WattStopper system to provide maximum energy savings. The LED component makes this space the most interactive element of the building's design, allowing users to both change the way the space appears from the outside, but have tangible evidence of all of the energy that their workout is creating! The uniformity on the floor is interrupted only near the stairwell, where the linear fixtures and LED downlights used for vertical circulation guidance add extra light to call attention to the exit and stair. A high CRI of over 85 is required for the fluorescent fixtures to ensure proper rendering of skintones in the space, and the uplighting component minimizes shadows on the individual, making them not only look better, but work out safer.

This design successfully meets ASHRAE and IESNA standards, and additionally provides a way that the students can give back to their gym, and the environment!

circulation space | lobby

overall design goals

The lobby is the first space that a majority of the people will see, and should reflect the overall design goals of the building. People should have an impression of the public space upon entering the facility, followed by visual clarity and cleanliness. This can be achieved with bright uniformity. Because of the dynamic functions of the building and the precise lines of the space, the lobby should also be visually interesting, playing with punctuations of light. The lobby is also the daylight feature space, and so the LEDs in the ceiling will be switched in order to provide maximum energy savings in the space.

The security desk is an important focus of the space as this is where everyone is either granted or denied access to the rec center. A bright, indirect lighting system avoids shadows and provides the illuminance necessary to perform any tasks necessary.

description

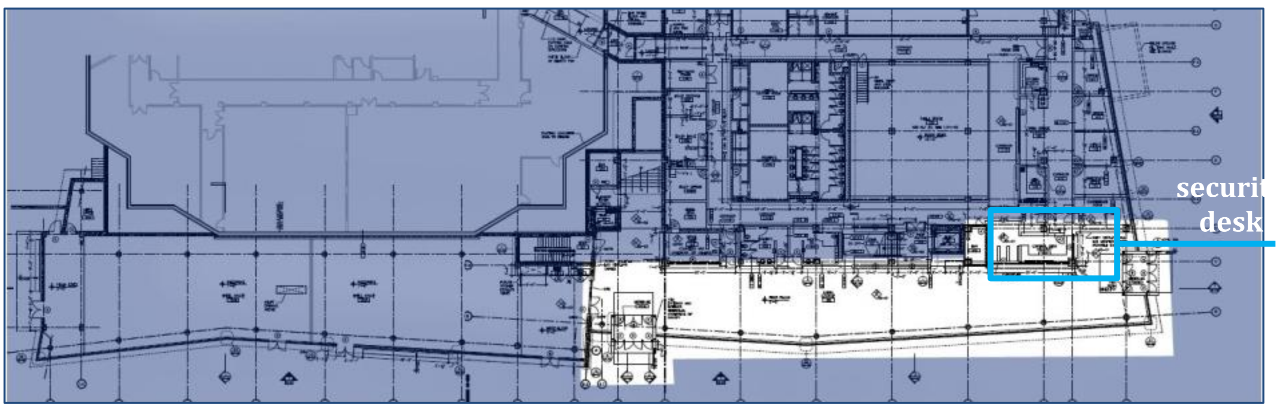


figure 18- orientation of lobby within recreation center

The lobby and main circulation entrance is the daylight feature space of the Drexel Recreation Center. As the initial impression to anyone entering the sporting facility, the lobby orients both to the circulation within the space but also to the feel and aesthetics of the building itself. To check into the athletic facility, visitors must use the key-card accessibility entry past the security desk on the eastern end. The entrance is also accessible from this space at the western side. This makes this corridor the most traveled space in the project. The lobby measures approximately 180' x 20' and has a ceiling height of 13'.

Materials and Finishes - lobby		
Surface	**Description**	**Reflectance**
north, east, and west walls	gypsum wall board painted in Sherwin Williams Dovetail	0.6
south wall	gypsum wall board painted in Sherwin Williams Ceiling Bright White	0.9
accent wall	gypsum wall board painted in Sherwin Williams Blue Bauble	0.69
flooring	1' x 2' Logica stone source tile in Grigio	0.46
base	1" x 1" Dal tile in Suede Grey	0.32
ceiling	exposed concrete	0.60
framing, trim, railings, desk area	Prodema wood veneer paneling in Pale	0.45
glazing	Viracon insulated glazing	t = .46

table 15 – lobby materials and finishes

Materials and Finishes – security desk		
Surface	**Description**	**Reflectance**
back wall	wood veneer Prodema paneling in Pale	0.45
flooring	1' x 2' matte finish porcelain Stone Source tile in Sand Beige	0.46
base	6" Johnsonite rubber base in Moon Rock	0.33
ceiling	Armstrong suspended ceiling tiles in White	0.9

table 16 – security desk materials and finishes

tasks/activities

The main purpose of the corridor is purely circulation, although it does double as a student study/lounge area because of its convenient operating hours and brightness during the daylight hours. Security staff perform administrative duties such as paperwork and camera monitoring, as well as provides services to the students. The northern wall of the lobby has screened windows providing interesting views into the racquetball courts and central staircase.

design criteria and considerations

desired illuminance levels and design criteria- **IESNA 2000*: Lobby Space***

quantity of light

security desk- *lobby: front desk*
horizontal – **30fc**

circulation space- *lobby: general lighting*
horizontal – **10fc**

ASHRAE/IESNA 90.1: *Lobby*- **1.3W/sf**

quality of light

Important
Appearance of Space and Luminaires- Important in every space on the southern side, this is most important in the lobby. In addition to establishing the athletic center's presence on Market Street and on the campus, the lobby is the primary space which presents the architectural concepts to observers. The space should is punctuated with sharp lines and angles of light to complement the sharp dimensions of the façade.

Daylight Integration and Control- The glazing composure of the southern façade makes daylighting a prominent focus of the DAC. The design will need to integrate and respond to the full exposure of daylight to the space during the entirety of the day. Philadelphia is overcast for a good portion of the winter, so photosensors should be incorporated into the system to ensure proper light levels throughout the space in any sky condition.

Direct and Reflected Glare- Transitioning through this space and into the building will be disrupted if occupants experience uncomfortable glare and reflections. The high exposed ceilings will draw eyes upwards and the façade glazing presents a potential for reflected glare. Luminaire position should be considered so that this is avoided. No light should be aimed directly at the glazing.

Light Distribution on Surfaces- The most important surfaces to the occupants are those that will guide them through the space: either through the space to the restaurant or through the security desk and into the fitness center. A uniform light pattern on the walls and ceiling and a non-uniform pattern on the floor will help to direct visitors as well as to reinforce the public aspect of the space.

Luminances of Room Surfaces- The high ceiling should be accentuated by illuminating the perimeter, and high levels of brightness on the walls will help to keep the visual contrast between the walls and the daylight entering through the glazing comfortable.

Design Considerations- *Security Desk*

Very Important

Direct and Reflected Glare- Both direct and reflected glare can limit the ability of workers to read and write, as well as reduce the contrast of computer screens. The monitoring of security cameras, as well as ID scans and other computer work will take place at the security desk. Luminaire placement is not be in line of sight of the eye or directly behind the seats so as not to reflect in the screens.

Modeling of Faces or Objects- Because a majority of the athletic center is controlled access, facial recognition is crucial to maintaining the integrity of the security ID check station. Visible threats need to also be readily identifiable so all aspects of an individual must be clearly rendered.

Important

Appearance of Space and Luminaires- The security desk should present an initially welcoming aesthetic impression followed by one of control and cleanliness. This can be achieved with high illuminance values and an overall uniformly high ambient light level behind the desk.

Light Distribution on Surfaces- The security desk is open on three sides with a dropped ceiling, making uniform distribution of the space difficult. The linear lines on the back wall could be uniformly accented to reinforce the impression of control and cleanliness while still adding visual interest.

Luminances of Room Surfaces- The luminance ratios between the task (in this case the computer or desk) should not exceed 10:1. This is an important consideration for this area because some of the employees directly face the windowed façade while behind their computer. This can cause unnecessary eye strain and lower productivity in the space.

Source/Eye/Task Geometry- The majority of the work at this desk takes place on computers, making luminaire placement an important aspect of design. Luminaires should be placed to the sides of rather than behind to limit reflections.

fixtures and equipment

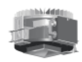
Luminaire Schedule			
Type		Description	Manufacturer
	C1	4" square 4100K LED downlight with remote phosphor lens, color mixing chamber, and integrated heat sink and power supply.	Indy
	C2	8" square surface mounted 4000K Energy Star qualified LED downlight with aluminum housing, 2" square luminous area and 65`° beam spread.	Color Kinetics
	J2A	2x2 3form Chroma® square suspended custom LED luminaire with HF² Narrow Stick LEDs and aluminum housing. Color: chroma white out.	Osram/3form
	J2B	2x2 3form Chroma® square suspended custom LED luminaire with HF² Narrow Stick LEDs and aluminum housing. Color: chroma surf.	Osram/3form
	J2C	2x2 3form Chroma® square suspended custom LED luminaire with HF2 Narrow Stick LEDs and aluminum housing. Color: chroma cobalt.	Osram/3form
	S1	2'x2' tubular fluorescent suspended fixture with textile lensing for symmetrical distribution, PVC base and steel housing.	DeltaLight

table 17 – lobby luminaire schedule

**Note: for full luminaire schedule including lamp and power source information and specification, see Appendix A.*

Light Loss Factors				
Lamp Type	**LLD**	**LDD**	**BF**	**Total**
C1	0.70	0.92	-	0.64
C2	0.70	0.92	-	0.64
S1	.95	0.92	1.0	.87

table 18 – lobby light loss factors

**The above light loss factors were calculated using the new method in the 2010 IESNA handbook. The Room Surface Dirt Depreciation (RSDD) was neglected and the Luminaire Dirt Depreciation (LDD) was calculated using the updated calculation outlined in the book. A lamp maintenance schedule of twenty-four months was assumed.*

controls

The façade of the Drexel Recreation Center is a product of an extensive energy study to maximize daylighting and minimize solar gain. The lobby is the daylighting feature space of the rec center, and so is provided with consistent levels of daylight throughout the day, especially given the low lighting level requirement of 10fc. For a more consistent lighting level and in order to minimize possible issues involved with dimming the LEDs, the Wattstopper switching control system will be used on the LEDs, with dimming taking place only over the security desk. The daylighting sensor will be calibrated in order to maintain the desired minimum of 10fc on the ground at all times.

Fitness Center Control Schedule			
Type	Manufacturer	Product	Description
LC-100	Wattstopper	Intelligent Power Pack	Power pack delivers 0-10V dimming control to lighting loads.
LMLS-305	Wattstopper	LightSaver Photocell	Closed loop photosensor provides the daylight data necessary for operation.
LMRC-202	Wattstopper	LightSaver Room Dimming Controller	Provides automatic step-dimming control for LED fixtures. Closed loop control utilizes a single photocell for dual –channel dimming.
LMSW-100	Wattstopper	LightSaver Wall Switches	Allows occupants to temporarily override the daylighting control systems.

table 19 – lobby control schedule

renderings

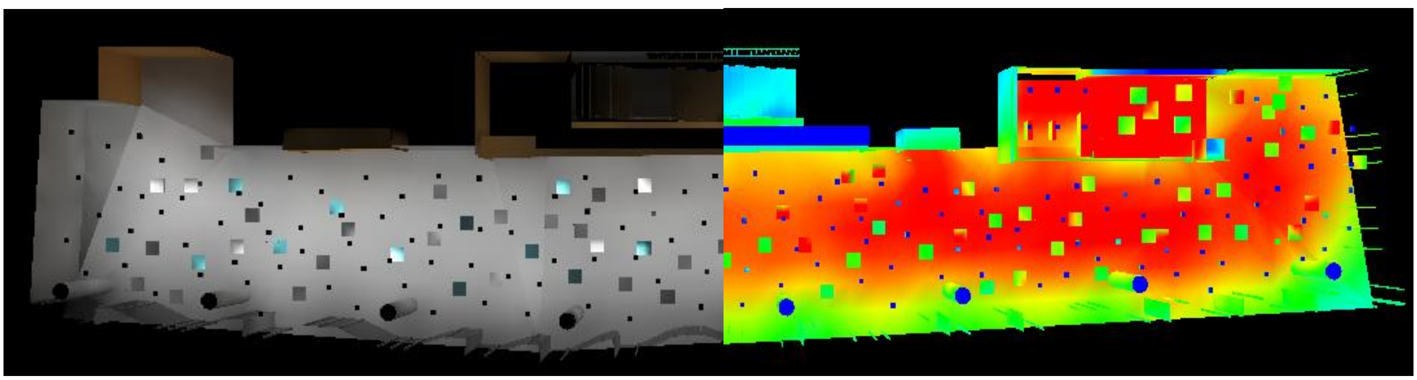


figure 19 – aerial color/psuedocolor rendering of lobby

figure 20 – southern elevation of lobby

figure 21 – perspective view of lobby

calculation summary

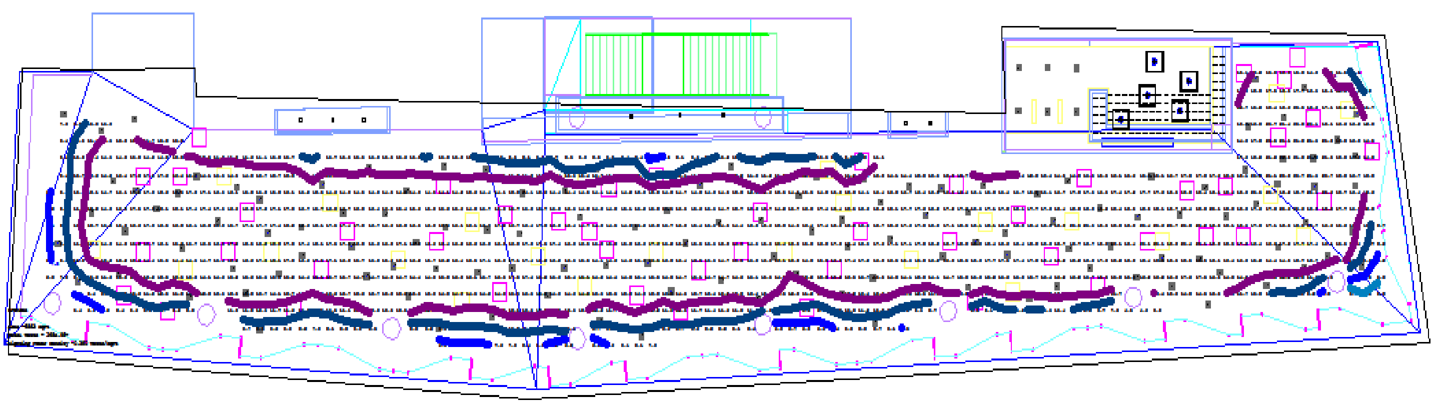


figure 22 – lobby isoline calculation

Lobby Calculation Summary	
	Workplane (0')
average illuminance	14.64fc
maximum illuminance	21.9fc
minimum illuminance	7.2fc
uniformity coefficient	**2.03**
design criteria	**10 fc**

table 20 – lobby calculation summary

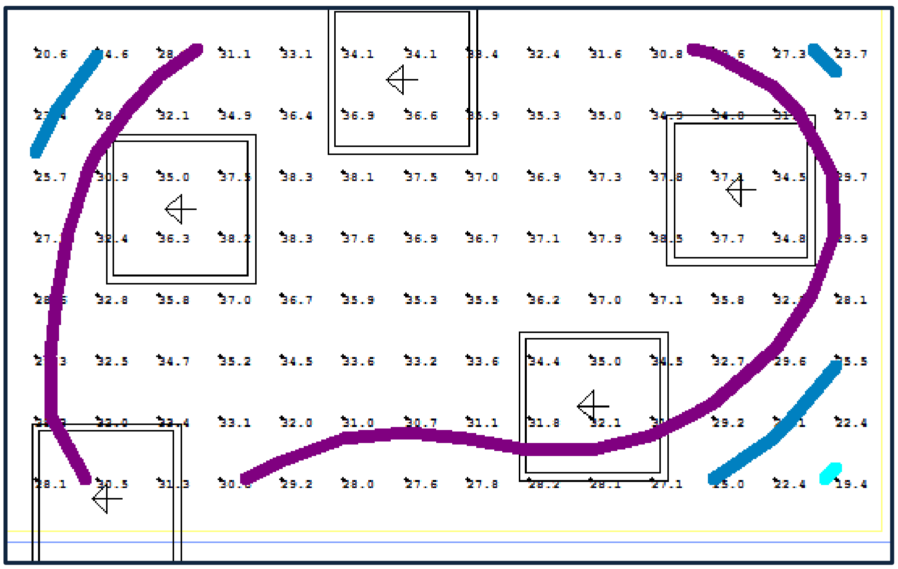


figure 23 – security desk isoline diagram

Security Desk Calculation Summary	
	Workplane (2.5')
average illuminance	32.33fc
maximum illuminance	38.5fc
minimum illuminance	19.4fc
uniformity coefficient	**1.20**
design criteria	**30 fc**

table 21 – security desk calculation summary

Lighting Power Density			
Fixture Type	Input Wattage	Quantity	Total Watts
C1	33	8	264
C2	15	147	2,205
J2	10.6	73	773.8
S1	108	5	540
Total Watts			3,782.8
Selected Lighting Area			8,448sf
Watts/SF			0.45
ASHRAE Std. 90.1 compliance?			**1.3 - yes**

table 22 – lobby lighting power density

evaluation

The design for the lobby took into consideration not only the lobby design goals and criteria, but also the need to be complimentary both to the façade of the building and to the lighting design in the fitness center. Uniform light levels are present on the floor, with the LED fixtures blending into the exposed concrete ceiling to create the impression of floating spots of light. To counteract the closing effect that downlighting can have on a space, the custom LED and Chroma fixtures give the desired impression of a high, evenly luminous ceiling while harmonizing with the angles on the façade. To blend with the design in the lobby and also to provide comfortable indirect lighting for those working the security desk, an evenly luminous cube fixture creates a bright glow in the security desk, both calling attention to it as the space is entered and sufficiently lighting the key area to the building.

Through a majority of the day, the electric light will be switched off, controlled by photosensors within the space. This, coupled with the extremely low linear power density make this the perfect complement to the energy efficient and highly visual presence that Drexel wanted for the Rec Center.

special purpose space | restaurant

overall design goals

The sports bar and restaurant is a multi-faceted space that can be an exciting, engaging place to watch a football game or can be a more relaxing, intimate place to take a break and enjoy dinner and drinks with friends. The lighting throughout the space needs to be adjustable in order to establish the desired atmosphere and impression for specific events. In either mode, a restaurant/lounge area should utilize a non-uniform lighting design with lower light levels immediately surrounding the guest with higher levels away from the guest, providing a sensation of watching without being watched. A highlight or focal point is beneficial in creating this impression.

The sports bar should create intimacy between sports fans, so the guests feel connected to those around them and also to help encourage new relationships between those drinking at the bar. The restaurant portion of the space should create the feeling of a private dinner while still being connected to the other surrounding tables. In contrast to the rest of the fitness center, the lighting can help to differentiate the function and ambience of the restaurant by using a non-uniform lighting mode and warmer temperature lamps while still bringing in the design concepts of minimalist fixtures and the exposed core energy of the building.

description

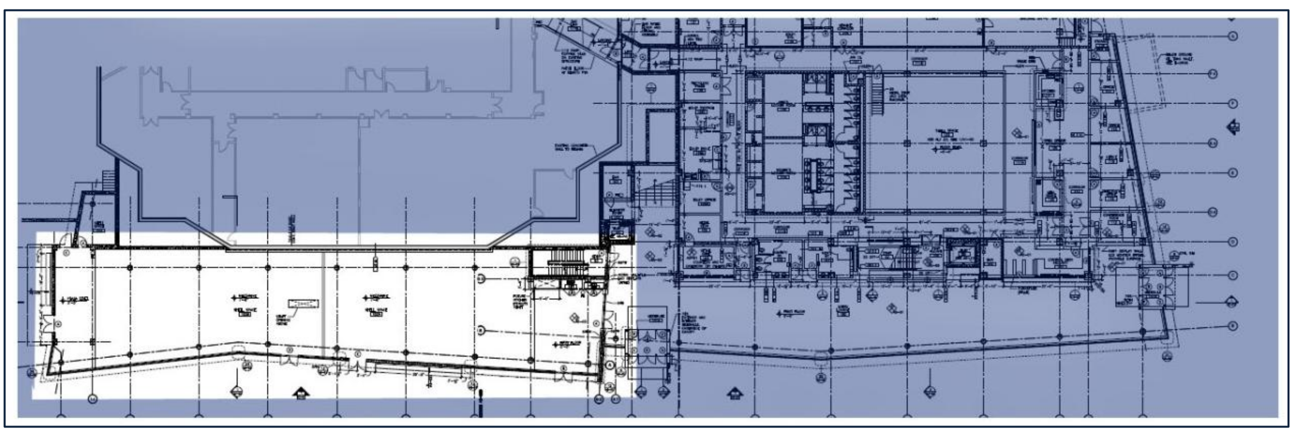


figure 24 – orientation of restaurant within rec center

Centrally located in the heart of Drexel's campus, the Daskalakis Athletic Center dedicated the western half of their southern Market Street façade to a restaurant and sports bar. Windows extending to the ceiling provide a street view to almost every table in the restaurant, with flat screen TVs located throughout facing all directions. A full bar spans the north wall of the main restaurant space, creating a concealed space for an intimate dinner experience shielded from the commotion of the sports bar.

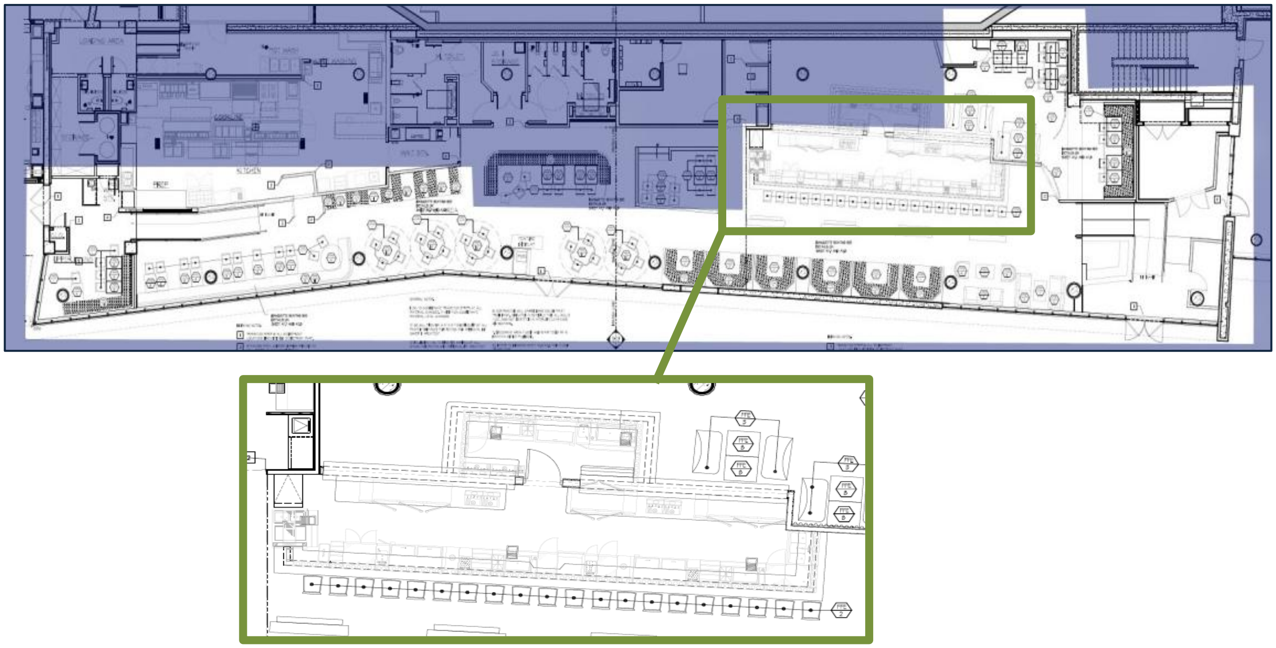


figure 25 – enlarged bar plan

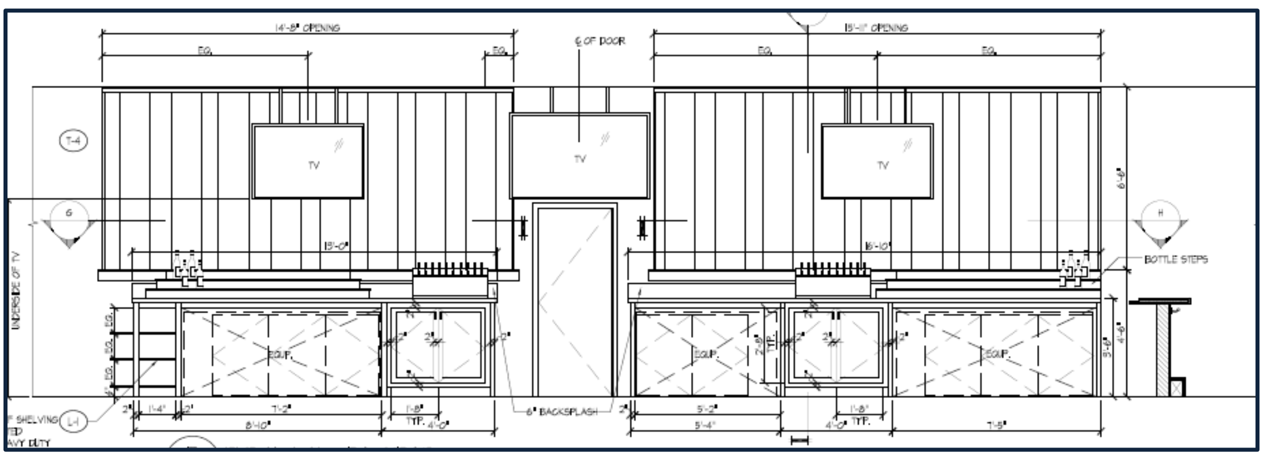


figure 26 – bar elevation

Materials and Finishes		
Surface	**Description**	**Reflectance**
walls	GWB painted Benjamin Moore Soft Chamois	0.8
wall accent strips	back painted tempered glass in Yellow Rain Coat	0.68
flooring	18” x 18” Spartan Surfaces Carpet Tile in Cork	0.22
ceiling	2’x4’ USG ATC ceiling tile in Flat Black	0.05
ceiling soffits/columns	GWB painted Benjamin Moore Soft Chamois	0.8
glazing	insulating laminated Viracon glazing	t = .46

table 23 – restaurant materials and finishes

design criteria and consideration

desired illuminance levels and design considerations – **IESNA Handbook 2000: *Entertainment and food service spaces***

quantity of light

dining/bar:
horizontal – **10fc**

ASHRAE/IESNA 90.1: Dining Area *for bar lounge/leisure area-* **1.4W/sf**

An increase in the interior lighting power allowance for spaces in which lighting is specified to be installed in addition to the general lighting for the purpose of decorative appearance, such as chandelier-type luminaires… provided that the additional lighting power shall not exceed **1.0W/sf of such spaces.*

quality of light

Very Important Criteria

Color Appearance (and Color Contrast)- The use of lighting with a high CRI is essential to the task of desirable and appetizing food and drinks, especially with the low lighting levels typical of a bar or late-night restaurant. The appearance and rendering of skin tones is particularly important in a social setting where dating and intermingling with the opposite sex occur. The restaurant is the should be a consistent color temperature as the rest of the project in order to present a uniform façade front during evening hours.

Point(s) of Interest- There are several points of interest in the bar and restaurant. The color intensive accent walls along the northern side of the space as well as behind the bar should be accented, including the patterned decorative panels on the northern side of the private lounge area. The custom luminaires throughout the space are currently a focal point, and the televisions located throughout the bar need to be considered when placing light within the space. The columns and ceiling soffits are interesting architectural features that should be additionally highlighted.

Important Criteria

Appearance of Space and Luminaires- As one of the only venues located directly on Drexel's campus, the appearance of the bar is especially important given the total exposure to Market Street. Guests walking by should see the space and be drawn inside to watch the game or have a drink. The bold colors within should be effectively portrayed, and the luminaires should highlight the lines of the building.

Direct and Reflected Glare- Direct and reflected glare can make guests inadvertently anxious and uncomfortable. No one wants light reflected in their eyes when trying to interact with others. Glare can also be a significant issue by causing veiling reflections when attempting to read a menu in low light levels.

Sparkle/Desirable Reflected Highlights- Sparkle is desirable on glassware, silverware, and decorative objects worn by guests to draw attention such as jewelry.

fixtures and equipment

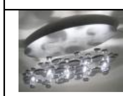
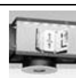
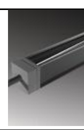
Luminaire Schedule			
Type		Description	Manufacturer
	B1	24' x 8' ceiling mounted decorative indirect halogen over-bar fixture with polished chrome finish.	Artemide
	C3	2" low voltage halogen adjustable directional flush mount pinhole downlight with 40° beam spread.	Kurt Versen
	D1	Linear fluorescent high performance perimeter open wall wash fixture with extruded aluminum finish and reflector.	Focal Point
	F1	Low voltage halogen cable light system with adjustable ring mounting, integral louver, and satin aluminum finish.	Tech Lighting
	J3	.75" linear surface mounted LED accent fixture with aluminum housing and 45° beam spread.	Cooper io
	J4	1.3" linear LED cove fixture with 130° beam spread, extruded aluminum body and nylon mount clip.	Winona

table 24 – restaurant luminaire schedule

**Note: for full luminaire schedule including lamp and power source information and specification, see Appendix A.*

Light Loss Factors				
Lamp Type	**LLD**	**LDD**	**BF**	**Total**
B1	.94	0.85	-	0.80
C3	.90	0.92	-	0.83
D1	.95	0.85	0.95	.87
F1	.90	0.92	-	.83
J3	0.70	0.92	0.90	.64
J4	0.70	0.92	0.90	.64

**The above light loss factors were calculated using the new method in the 2010 IESNA handbook. The Room Surface Dirt Depreciation (RSDD) was neglected and the Luminaire Dirt Depreciation (LDD) was calculated using the updated calculation outlined in the book. A lamp maintenance schedule of twenty-four months was assumed.*

controls

The bar and lounge are open for both lunch and dinner, as well as for sporting events and off-evenings. The lighting needs to have different scenes, as well as be highly reactive to the daylight that will influence the space through the glazing that makes up almost the entirety of the southern façade. An additional scene with high light levels needs to exist in order to facilitate the wait staff' in cleaning up at the end of the night.

Restaurant Control Schedule			
Type	Manufacturer	Product	Description
LMLS-305	Wattstopper	LightSaver Photocell	Closed loop photosensor provides the daylight data necessary for operation.
LMRC-301	Wattstopper	LightSaver Room Dimming Controller	Provides automatic dimming control for multi-zone dimming control.
LMSW-105	Wattstopper	LightSaver Digital 5-Button Scene Switch	Allows occupant control by accessing four of the 16 scenes available on the local DLM network.

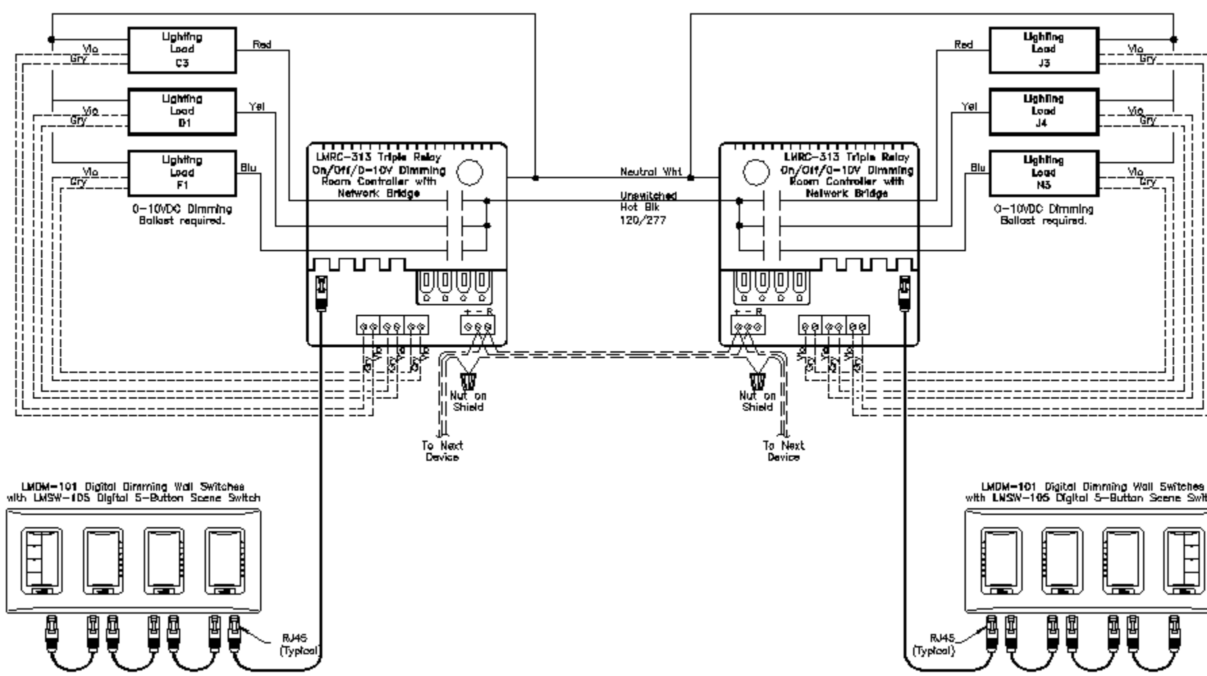


figure 26 – restaurant control diagram

renderings

figure 27 – greyscale southern elevation of restaurant

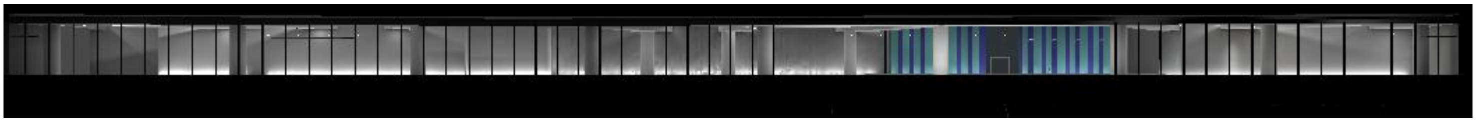


figure 28 – color southern elevation of restaurant

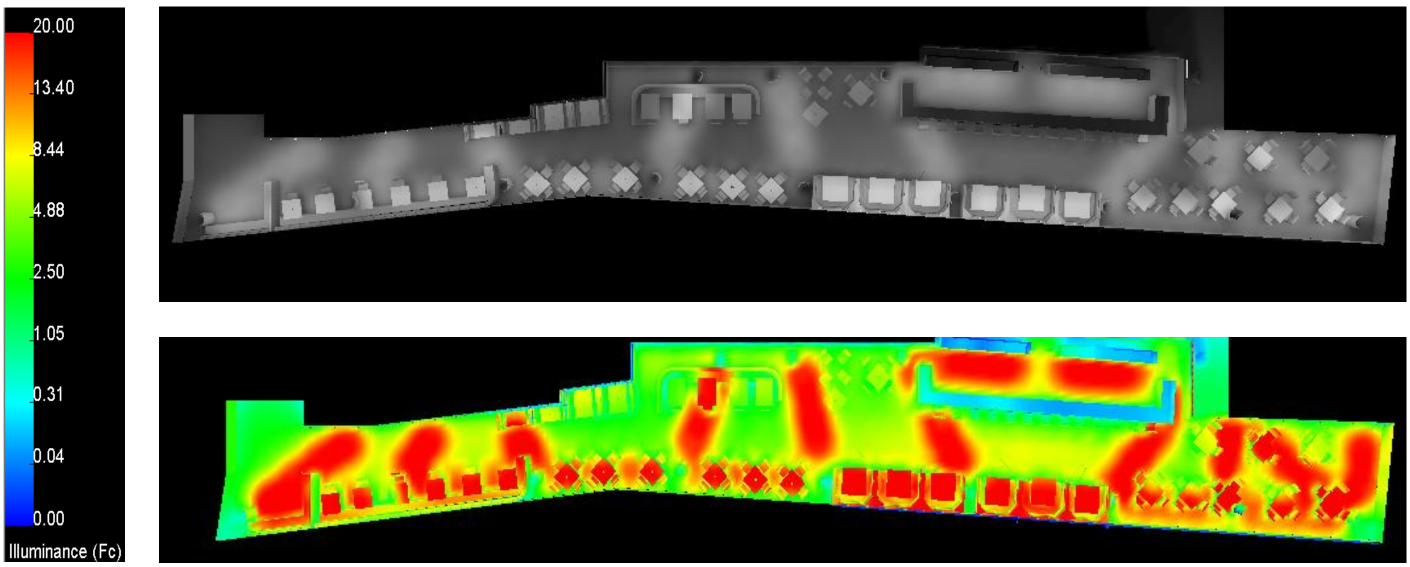


figure 29 – greyscale and psuedocolor aerial views of restaurant

figure 30 – perspective view of restaurant facing east

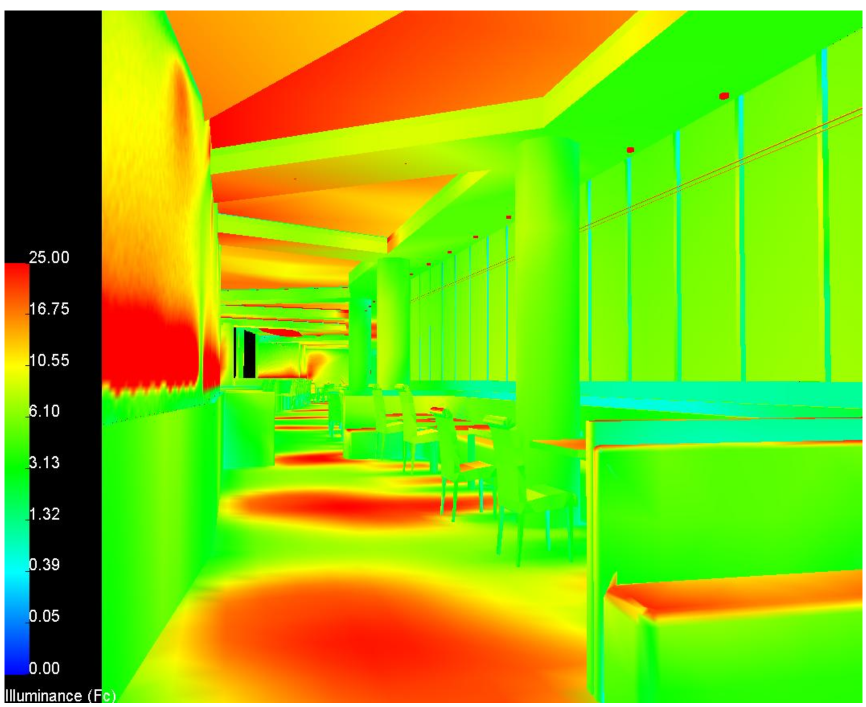


figure 31 – perspective psuedocolor of restaurant facing east

figure 32 –perspective view of restaurant facing west

calculation summary

Restaurant Calculation Summary		
	Workplane (0')	**Tables**
average illuminance	13.83fc	fc
maximum illuminance	41fc	12.9fc
minimum illuminance	2.5fc	7.5fc
uniformity coefficient	**0.60**	-
design criteria	**10 fc**	**2fc**

table 25 – restaurant calculation summary

Lighting Power Density			
Fixture Type	Input Wattage	Quantity	Total Watts
B1	1,200	1	1,200
C3	50	39	1,950
D1	36	38	1,368
F1	35	48	1,680
J3	5.3W/ft	50ft	265
J4	4.5W/ft	595ft	2,677.5
Total Watts			9,140.5
Selected Lighting Area			8,448sf
Watts/SF			1.08
ASHRAE Std. 90.1 compliance?			**1.4 - yes**

table 26 – lighting power density

evaluation

Flexibility is of utmost importance in a hospitality environment, and the controllability and color rendering of halogen fixtures makes them the ideal choice for lighting the restaurant. Power density is met by using LED and fluorescent coves to highlight the architectural ceiling was well as to wash the exposed concrete walls, which simultaneously creates an impression of intimacy and relaxation while tying into the overall building concept of exposed industrial materials, strong lines and angles, and exposed core energy. The LED cove highlighting the ceiling soffit makes the light appear to come from within the building itself. The chrome polished fixture over the bar and the blue frosted glass grazed by hidden linear LEDs create a focal point behind the bar. The warmer color temperature of 3000K helps to delineate the restaurant from the high energy fitness center, and the nonuniform lighting levels and round, soft light created by what are still industrial, clean fixtures completes the effect.

electrical depth

introduction

The electric depth includes a modification of the branch circuit distribution for four spaces in response to the lighting redesign. These spaces include the exterior courtyard, lobby, fitness center, and restaurant. The redesign of the lighting for each space required a recalculation of the loads on each circuit, resulting in the resizing of the affected lighting circuits, panelboards, and feeders. A protective device coordination study is included along with a short circuit analysis.

The electrical depths consist of a system design to retrofit existing cardio equipment to convert kinetic energy from the cardio machines into power for LED lighting, as well as a cost comparison of MC cable trays as an alternative to the existing PVC conduit distribution system located within the poured concrete slab.

The following table highlights which panels in the Drexel Recreation Center were affected by the lighting redesign.

Modified Panelboards						
Panel Tag	**Voltage**	**Normal/ Emergency**	**Courtyard**	**Fitness**	**Lobby**	**Restaurant**
ELP-1-1	480Y/277V, 3P, 4W	Emergency	X		X	
ELP-2-1	480Y/277V, 3P, 4W	Emergency		X		
GDP-L	208/120V, 3P, 4W	Emergency				X
LP-1-1	480Y/277V, 3P, 4W	Normal	X		X	
LP-2-1	480Y/277V, 3P, 4W	Normal		X		
NDP-L	208/120, 3P, 4W	Normal				X

exterior space | courtyard

lighting redesign

The exterior lighting is designed to reinforce the lighting concept of exposed core energy while highlighting the lines and angles of the space and promoting a feeling of safety. The daytime uses of the plaza restrict the placement of luminaires on the rubber tiles, and so following the core energy representation the steplights and linear cove feature add to the impression of a glowing building. The indirect pole-top luminaires highlight facial recognition and add a comfortable feel to the plaza, separating the walkway area to enhance a feeling of separation and creating a sense of space.

electrical redesign

Both the emergency and normal lighting panels that serve the exterior lighting are 480Y/277V 3-phase 4-wire panels, with the emergency sized at 60A and the normal sized at 80A. The addition of energy efficient LED, HID, and fluorescent lighting fixtures in bollard, landscape lighting, and steplighting applications greatly increases the load to the space, therefore increasing the loading to the panelboards.

controls

All of the exterior lighting utilizes controllable breakers by photocell.

panelboards

existing

On the following pages are the existing panelboard schedules for 480Y/277V normal lighting panel LP-1-1 and 480Y/277V emergency lighting panel ESLP-1-1. LP-1-1 is located on the first floor of the DRC in Electrical Switchgear Room 132, and ESLP-1-1 is located on the first floor in the Emergency Generator Room 133. Modified circuits are indicated with a pink box.

PANEL: LP-1-1
SECTION: 1 OF 1
LOCATION: ELEC. SWITCHGEAR ROOM 132, FIRST FLOOR
VOLTAGE: 480/277V
PHASE & WIRE: 3 PH, 4W
MAIN (AMPS): 60A, M.C.B.
[X] NEW [ ] EXISTING
KAIC RATING: 35
POLES: 30

NOTES	CKT NO.	C.B. A	C.B. P	DESCRIPTION	LOAD (KVA)	A	B	C	LOAD (KVA)	DESCRIPTION	C.B. A	C.B. P	CKT NO.	NOTES
2	1	20	1	LTG - LOBBY 100 UPLIGHTS	1.88	3.67			1.79	LTG - LOCKER ROOMS	20	1	2	1
2	3	20	1	LTG - LOBBY 100 DOWNLIGHTS	1.88		2.01		0.13	LTG - RETAIL CAFÉ 104	20	1	4	1
	5	20	1	LTG - OC SENSORS	2.33			2.77	0.45	LTG - GEN. STORAGE 130	20	1	6	1
1	7	20	1	LTG - SECURITY RM 110	0.29	0.68			0.38	LTG - ELEC. RM 132	20	1	8	1
1	9	20	1	LTG - COR 111, 112, RM 108, 120	2.90		3.09		0.19	LTG - SHELL SPACE 122/SQ CT	20	1	10	1
1	11	20	1	LTG - FUT. CHILLER RM 137	0.51			1.09	0.58	LTG - BOILER RM 136	20	1	12	1
3	13	20	1	LTG - EXTERIOR BENCHES	1.00	2.50			1.50	LTG - SITE	20	1	14	3
	15	20	1	SPARE			0.00			SPARE	20	1	16	
	17	20	1	SPARE				0.00		SPARE	20	1	18	
	19	20	1	SPARE		0.00				SPARE	20	1	20	
	21	20	1	SPARE			0.00			SPARE	20	1	22	
	23	20	1	SPARE				0.00		SPARE	20	1	24	
	25			SPACE		0.00				SPACE			26	
	27			SPACE			0.00			SPACE			28	
	29			SPACE				0.00		SPACE			30	
				LOAD SUMMARY PER PHASE (KVA)		6.85	5.10	3.86						
				TOTAL CONNECTED LOAD (KVA)		15.81								

OPTIONS AND ACCESSORIES - (X) INDICATES SELECTION

[ ] MULTIPLE SECTION PANEL
[ ] RECESSED
[X] SURFACE
[ ] 200% RATED NEUTRAL
[ ] ISOLATED GROUND BUS
CONTACTOR CONTROLLED [ ]
FEED THRU LUGS [ ]
SUB FEED MAIN LUGS (DOUBLE LUGS) [ ]
CONTROLLABLE CIRCUIT BREAKER PANEL [X]
OTHER [ ]

NOTES:
1. CONTROLLABLE BREAKER
2. CONTROLLABLE BREAKER CONTROLLED BY PHOTOCELL
3. CONTROLLABLE BREAKER CONTROLLED BY ROOF TOP PHOTOCELL

PANEL: ESLP-1-1
SECTION: 1 OF 1
LOCATION: EMERGENCY GENERATOR ROOM 133, FIRST FLOOR
VOLTAGE: 480/277V
PHASE & WIRE: 3 PH, 4W
MAIN (AMPS): 60A, M.L.O.
[X] NEW [ ] EXISTING
KAIC RATING: 35
POLES: 30

NOTES	CKT NO.	C.B. A	C.B. P	DESCRIPTION	LOAD (KVA)	A	B	C	LOAD (KVA)	DESCRIPTION	C.B. A	C.B. P	CKT NO.	NOTES
	1	20	1	EMR. LTG- LOB 100 EXT SNS	0.52	1.39			0.87	EMR LTG- LOBBY 100 UPLGHTS	20	1	2	2
	3	20	1	EMR. LTG- STR S3, RM 102, 103	0.29		1.16		0.87	EMR LTG- LOBBY 100 DWNLGHTS	20	1	4	2
	5	20	1	EMR. LTG- CORR, RM 108-110, 122	1.89			2.41	0.51	EMR LTG- LKR RM, BTHRMS	20	1	6	
	7	20	1	EMR. LTG- ELEC/MECH RMS	1.88	2.66			0.79	EMR LTG- SHELL SPACE	20	1	8	
1	9	20	1	EMR. LTG- EXTERIOR	1.60		1.60			SPARE	20	1	10	
	11	20	1	SPARE				0.00		SPARE	20	1	12	
	13	20	1	SPARE		0.00				SPARE	20	1	14	
	15	20	1	SPARE			0.00			SPARE	20	1	16	
	17	20	1	SPARE				0.00		SPARE	20	1	18	
	19	20	1	SPARE		0.00				SPARE	20	1	20	
	21	20	1	SPARE			0.00			SPARE	20	1	22	
	23	20	1	SPARE				0.00		SPARE	20	1	24	
	25			SPACE		0.00				SPACE			26	
	27			SPACE			0.00			SPACE			28	
	29			SPACE				0.00		SPACE			30	
				LOAD SUMMARY PER PHASE (KVA)		4.06	2.76	2.41						
				TOTAL CONNECTED LOAD (KVA)		9.22								

OPTIONS AND ACCESSORIES - (X) INDICATES SELECTION

[ ] MULTIPLE SECTION PANEL
[ ] RECESSED
[X] SURFACE
[ ] 200% RATED NEUTRAL
[ ] CONTROLLABLE CIRCUIT BREAKER
CONTACTOR CONTROLLED [ ]
FEED THRU LUGS [ ]
SUB FEED MAIN LUGS (DOUBLE LUGS) [ ]
CONTROLLABLE CIRCUIT BREAKER PANEL [X]
OTHER [ ]

NOTES:
1. CONTROLLABLE BREAKER BY PHOTOCELL.
2. CONTROLLABLE BREAKER BY ROOFTOP PHOTOCELL.

circuiting calculations

Each circuit was recalculated based on the new lighting load. For a voltage of 277 on 20A circuits, recommended engineering practice designates 3.55 KVA per circuit. All three of the exterior circuits adhere to these guidelines.

Emergency Lighting Panel ELP-1-1			
Circuit #	Type	Quantity	KVA
9	M1	14	1.11
9	M2	7	.25
9	N1	16	.39
9	N4	9	.16
Total KVA			1.91

Normal Lighting Panel LP-1-1			
Circuit #	Type	Quantity	KVA
13	M2	7	.25
13	N1	16	.39
13	N2	24	.91
13	N3	52ft	.25
13	N4	9	.16
Total KVA			1.91
14	M1	14	1.11
14	Z1	15	.26
Total KVA			1.37

The redesigned panelboard schedule for Panels LP-1-1 and ESLP-1-1 are provided below with their corresponding panelboard sizing worksheets. Modified circuits are indicated with a pink box.

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W SIZE/TYPE BUS: 80A SIZE/TYPE MAIN: 80A/3P C/B	PANEL TAG: LP-1-1 PANEL LOCATION: ELEC. SWTCHGR RM. 132 PANEL MOUNTING: SURFACE	MIN. C/B AIC: 10K OPTIONS: PROVIDE FEED THROUGH LUGS FOR PANELBOARD 1L1B

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
LINEAR UPLTS	LOBBY	1786	20A/1P	1	*			2	20A/1P	1701	LKR RMS	FLUORESCENT
LINEAR DWNLTS	LOBBY	1786	20A/1P	3		*		4	20A/1P	124	RETAIL	DWNLTS
OC SENSOR	1ST FL	2214	20A/1P	5			*	6	20A/1P	428	STOR 130	INDUSTRIAL
FLUORESCENT	SEC 110	276	20A/1P	7	*			8	20A/1P	361	ELEC 132	INDUSTRIAL
DWNLTS	CORR	2755	20A/1P	9		*		10	20A/1P	181	SHELL 122	INDUSTRIAL
INDUSTRIAL	CHILL 137	485	20A/1P	11			*	12	20A/1P	551	BLR 136	INDUSTRIAL
LED/CFL	EXTR	1853	20A/1P	13	*			14	20A/1P	1343	EXTR	POLES
SPARE	-	2375	20A/1P	15		*		16	20A/1P	2375	-	SPARE
SPARE	-	2375	20A/1P	17			*	18	20A/1P	2375	-	SPARE
SPARE	-	2375	20A/1P	19	*			20	20A/1P	2375	-	SPARE
SPARE	-	2375	20A/1P	21		*		22	20A/1P	2375	-	SPARE
SPARE	-	2375	20A/1P	23			*	24	20A/1P	2375	-	SPARE
SPACE	-	0	20A/1P	25	*			26	20A/1P	0	-	SPACE
SPACE	-	0	20A/1P	27		*		28	20A/1P	0	-	SPACE
SPACE	-	0	20A/1P	29			*	30	20A/1P	0	-	SPACE

CONNECTED LOAD (KW) - A Ph.	12.07	TOTAL DESIGN LOAD (KW)	49.49
CONNECTED LOAD (KW) - B Ph.	14.35	POWER FACTOR	0.95
CONNECTED LOAD (KW) - C Ph.	13.18	TOTAL DESIGN LOAD (AMPS)	63

PANELBOARD SIZING WORKSHEET

Panel Tag------------------------->	LP-1-1	Panel Location:	ELEC. SWTCHGR RM. 132
Nominal Phase to Neutral Voltage------->	277	Phase:	3
Nominal Phase to Phase Voltage-------->	480	Wires:	4

Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks
1	A	LINEAR UPLTS	1	LOBBY	1.88	KVA	0.95	1786	1880	
2	A	FLUORESCENT	1	LKR RMS	1.79	KVA	0.95	1701	1790	
3	B	LINEAR DWNLTS	1	LOBBY	1.88	KVA	0.95	1786	1880	
4	B	DWNLTS	1	RETAIL	0.13	KVA	0.95	124	130	
5	C	OC SENSOR	1	1ST FL	2.33	KVA	0.95	2214	2330	
6	C	INDUSTRIAL	1	STOR 130	0.45	KVA	0.95	428	450	
7	A	FLUORESCENT	1	SEC 110	0.29	KVA	0.95	276	290	
8	A	INDUSTRIAL	1	ELEC 132	0.38	KVA	0.95	361	380	
9	B	DWNLTS	1	CORR	2.9	KVA	0.95	2755	2900	
10	B	INDUSTRIAL	1	SHELL 122	0.19	KVA	0.95	181	190	
11	C	INDUSTRIAL	1	CHILL 137	0.51	KVA	0.95	485	510	
12	C	INDUSTRIAL	1	BLR 136	0.58	KVA	0.95	551	580	
13	A	LED/CFL	1	EXTR	1.91	KVA	0.97	1853	1910	
14	A	POLES	1	EXTR	1.37	KVA	0.98	1343	1370	
15	B	SPARE	2		2.5	KVA	0.95	2375	2500	
16	B	SPARE	2		2.5	KVA	0.95	2375	2500	
17	C	SPARE	2		2.5	KVA	0.95	2375	2500	
18	C	SPARE	2		2.5	KVA	0.95	2375	2500	
19	A	SPARE	2		2.5	KVA	0.95	2375	2500	
20	A	SPARE	2		2.5	KVA	0.95	2375	2500	
21	B	SPARE	2		2.5	KVA	0.95	2375	2500	
22	B	SPARE	2		2.5	KVA	0.95	2375	2500	
23	C	SPARE	2		2.5	KVA	0.95	2375	2500	
24	C	SPARE	2		2.5	KVA	0.95	2375	2500	
25	A	SPACE	3		0	W	1.00	0	0	
26	A	SPACE	3		0	W	1.00	0	0	
27	B	SPACE	3		0	W	1.00	0	0	
28	B	SPACE	3		0	W	1.00	0	0	
29	C	SPACE	3		0	W	1.00	0	0	
30	C	SPACE	3		0	W	1.00	0	0	
PANEL TOTAL								39.6	41.6	Amps= 50.0

PHASE LOADING							kW	kVA	%	Amps
PHASE TOTAL		A					12.1	12.6	30%	15.2
PHASE TOTAL		B					14.3	15.1	36%	18.2
PHASE TOTAL		C					13.2	13.9	33%	16.7
LOAD CATEGORIES			Connected			Demand				Ver. 1.04
			kW	kVA	DF	kW	kVA	PF		
1	LIGHTING		15.8	16.6		15.8	16.6	0.95		
2	SPARE		23.8	25.0		23.8	25.0	0.95		
3	SPACE		0.0	0.0		0.0	0.0			
Total Demand Loads						39.6	41.6			
Spare Capacity			25%			9.9	10.4			
Total Design Loads						49.5	52.0	0.95	Amps=	62.6

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W	PANEL TAG: ESLP-1-1	MIN. C/B AIC: 10K
SIZE/TYPE BUS: 60A	PANEL LOCATION: EMER. GEN. RM. 133	OPTIONS: PROVIDE FEED THROUGH LUGS FOR PANELBOARD 1L1B
SIZE/TYPE MAIN: 60A/3P C/B	PANEL MOUNTING: SURFACE	

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
FLUOR/EXIT SGNS	LOBBY	494	20A/1P	1	*			2	20A/1P	827	LOBBY	LINEAR UPLTS
FLUOR	STR, 102, 103	276	20A/1P	3		*		4	20A/1P	827	LOBBY	LINEAR DWNLTS
DWNLTS	CORR,108-10	1796	20A/1P	5			*	6	20A/1P	485	LKR/REST	FLUORESCENT
INDUSTRIAL	ELEC/MECH	1786	20A/1P	7	*			8	20A/1P	361	ELEC 132	INDUSTRIAL
INDUSTRIAL	SHELL 122	751	20A/1P	9		*		10	20A/1P	1853	EXTR	POLES
SPARE	-	1425	20A/1P	11			*	12	20A/1P	1425	-	SPARE
SPARE	-	1425	20A/1P	13	*			14	20A/1P	1425	-	SPARE
SPARE	-	1425	20A/1P	15		*		16	20A/1P	1425	-	SPARE
SPARE	-	1425	20A/1P	17			*	18	20A/1P	1425	-	SPARE
SPARE	-	1425	20A/1P	19	*			20	20A/1P	1425	-	SPARE
SPARE	-	1425	20A/1P	21		*		22	20A/1P	1425	-	SPARE
SPARE	-	1425	20A/1P	23			*	24	20A/1P	1425	-	SPARE
SPACE	-	0	20A/1P	25	*			26	20A/1P	0	-	SPACE
SPACE	-	0	20A/1P	27		*		28	20A/1P	0	-	SPACE
SPACE	-	0	20A/1P	29			*	30	20A/1P	0	-	SPACE

CONNECTED LOAD (KW) - A Ph.	9.17	TOTAL DESIGN LOAD (KW)	36.75
CONNECTED LOAD (KW) - B Ph.	9.41	POWER FACTOR	0.95
CONNECTED LOAD (KW) - C Ph.	10.83	TOTAL DESIGN LOAD (AMPS)	46

PANELBOARD SIZING WORKSHEET

Panel Tag-------------------------->	ESLP-1-1	Panel Location:	EMER. GEN. RM. 133	
Nominal Phase to Neutral Voltage------->	277	Phase:	3	
Nominal Phase to Phase Voltage-------->	480	Wires:	4	

Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks
1	A	FLUOR/EXIT SGNS	1	LOBBY	0.52	KVA	0.95	494	520	
2	A	LINEAR UPLTS	1	LOBBY	0.87	KVA	0.95	827	870	
3	B	FLUOR	1	STR, 102, 103	0.29	KVA	0.95	276	290	
4	B	LINEAR DWNLTS	1	LOBBY	0.87	KVA	0.95	827	870	
5	C	DWNLTS	1	CORR,108-10	1.89	KVA	0.95	1796	1890	
6	C	FLUORESCENT	1	LKR/REST	0.51	KVA	0.95	485	510	
7	A	INDUSTRIAL	1	ELEC/MECH	1.88	KVA	0.95	1786	1880	
8	A	INDUSTRIAL	1	ELEC 132	0.38	KVA	0.95	361	380	
9	B	INDUSTRIAL	1	SHELL 122	0.79	KVA	0.95	751	790	
10	B	POLES	1	EXTR	1.91	KVA	0.97	1853	1910	
11	C	SPARE	1		1.5	KVA	0.95	1425	1500	
12	C	SPARE	1		1.5	KVA	0.95	1425	1500	
13	A	SPARE	1		1.5	KVA	0.95	1425	1500	
14	A	SPARE	1		1.5	KVA	0.95	1425	1500	
15	B	SPARE	2		1.5	KVA	0.95	1425	1500	
16	B	SPARE	2		1.5	KVA	0.95	1425	1500	
17	C	SPARE	2		1.5	KVA	0.95	1425	1500	
18	C	SPARE	2		1.5	KVA	0.95	1425	1500	
19	A	SPARE	2		1.5	KVA	0.95	1425	1500	
20	A	SPARE	2		1.5	KVA	0.95	1425	1500	
21	B	SPARE	2		1.5	KVA	0.95	1425	1500	
22	B	SPARE	2		1.5	KVA	0.95	1425	1500	

23	C	SPARE	2		1.5	KVA	0.95	1425	1500		
24	C	SPARE	2		1.5	KVA	0.95	1425	1500		
25	A	SPACE	3		0	W	1.00	0	0		
26	A	SPACE	3		0	W	1.00	0	0		
27	B	SPACE	3		0	W	1.00	0	0		
28	B	SPACE	3		0	W	1.00	0	0		
29	C	SPACE	3		0	W	1.00	0	0		
30	C	SPACE	3		0	W	1.00	0	0		
PANEL TOTAL								29.4	30.9	Amps=	37.2
PHASE LOADING								kW	kVA	%	Amps
PHASE TOTAL			A					9.2	9.7	31%	11.6
PHASE TOTAL			B					9.4	9.9	32%	11.9
PHASE TOTAL			C					10.8	11.4	37%	13.7
LOAD CATAGORIES				Connected			Demand				Ver. 1.04
				kW	kVA	DF	kW	kVA	PF		
1	LIGHTING			15.2	15.9		15.2	15.9	0.95		
2	SPARE			14.3	15.0		14.3	15.0	0.95		
3	SPACE			0.0	0.0		0.0	0.0			
Total Demand Loads							29.4	30.9			
Spare Capacity				25%			7.4	7.7			
Total Design Loads							36.8	38.6	0.95	Amps=	46.5

feeder sizing

LP-1-1	
Voltage	480Y/277
Design Load (KW)	49.5
Power Factor	0.95
Calculated Design Load (Amps)	63
Feeder Protection Size (Amps)	80
Sets	1
Wire Sizes	
Phase	6
Neutral	6
Ground	8
Conduit Size	1”

ESLP-1-1	
Voltage	480Y/277
Design Load (KW)	36.8
Power Factor	0.95
Calculated Design Load (Amps)	46
Feeder Protection Size (Amps)	60
Sets	1
Wire Sizes	
Phase	6
Neutral	6
Ground	10
Conduit Size	1”

voltage drop calculations

VOLTAGE DROP – LP-1-1	
Voltage (V)	480
Ampacity (I)	85
Power Factor (See Note 1)	.95
Wire Size (14,12,10 ... 1/0, 2/0 ... 250,350)	3
# of conductors per phase	1
Type Conductor (A=Aluminum C=Copper)	C
Type Conduit (P=PVC; A=Aluminum S=Steel)	S
Length of Run (ft)	172
Voltage Drop	*1.06*
% Drop	*0.22*

VOLTAGE DROP – ESLP-1-1	
Voltage (V)	480
Ampacity (I)	65
Power Factor (See Note 1)	.95
Wire Size (14,12,10 ... 1/0, 2/0 ... 250,350)	6
# of conductors per phase	1
Type Conductor (A=Aluminum C=Copper)	C
Type Conduit (P=PVC; A=Aluminum S=Steel)	S
Length of Run (ft)	39
Voltage Drop	*2.13*
% Drop	*0.44*

large work space | fitness center

lighting redesign

The primary goal of the lighting design in the fitness center is to expose the core energy of the building with the RGB LED component in the linear fixtures. This interactive element is fed directly by the cardio equipment kinetic generation system and does not affect the electrical redesign. The fluorescent ambient/task lighting is provided by a minimalist, clean linear fixture. Architectural wall features are highlighted by recessed LED square downlights, and the space is lit primarily with daylight for a majority of day.

electrical redesign

Both the emergency and normal lighting panels that serve the fitness center are 480Y/277V 3 phase 4 wire panels, with the emergency sized at 60A and the normal sized at 80A. The use of energy efficient fluorescent and LED lighting keeps the overall load on the panel relatively consistent, although the circuiting has been adjusted for photocell control.

controls

The façade of the Drexel Recreation Center is a product of an extensive energy study to maximize daylighting and minimize solar gain. Since the fenestration faces directly south, desired light levels are met solely with daylight for a majority of the day. The Wattstopper digital lighting management control system will be utilized in the space to enable dimming to 1%, providing energy savings throughout the year. Using natural daylight in place of electric light during the day will not only save energy and money, but will have positive psychological effects on occupants. Daylighting used as an overall ambient lighting for the workout space will increase overall energy levels and provide a more energetic and dynamic lighting system. The selected Focal Point luminaires have been specified to incorporate the available integrated daylight sensor compatible with the Wattstopper controls. The daylighting sensor will be calibrated using a sliding setpoint algorithm in order to maintain the desired minimum of 20fc on the workplane (measured at cardio machine standing level of 1.5’) at all times.

A dynamic component of the lighting in the fitness center is an Osram-Sylvania LED light tape component integrated into each of the linear pendant fixtures. This lighting is not included in the calculations and is strictly an addition to the fluorescent lighting. Power for this component will use the ReRev system to harness kinetic energy generated by the cardio equipment in the space in the form of DC power. The LEDs will use the Osram Sylvania __________ power modulator to provide consistent voltage to the LED component in each luminaire. This blue strip will create a blue glow to visibly show from the exterior where the power is being generated within the space, and will not be daylight controlled.

Fitness Center Control Schedule			
Type	Manufacturer	Product	Description
LMLS-305	Wattstopper	LightSaver Photocell	Closed loop photosensor provides the daylight data necessary for operation.
LMRC-201	Wattstopper	LightSaver Room Dimming Controller	Provides automatic dimming control for fluorescent fixtures. Closed loop control utilizes a photocell for single-zone dimming.
LMSW-100	Wattstopper	LightSaver Wall Switches	Allows occupants to temporarily override the daylighting control systems.

panelboards

existing

Below are the existing panelboard schedules for 480Y/277V normal lighting panels LP-2-1 and LP-3-1 and 480Y/277V emergency lighting panel ESLP-3-1. LP-2-1 is located on the second floor of the DRC in Electrical Room 202, and ESLP-3-1 is located on the first floor in the Emergency Generator Room 133. Modified circuits are indicated with a purple box.

PANEL: LP-2-1
SECTION: 1 OF 1
LOCATION: ELEC. ROOM 202, SECOND FLOOR

VOLTAGE: 480/277V
PHASE & WIRE: 3 PH, 4W
MAIN (AMPS): 60A, M.C.B.

[X] NEW
[ ] EXISTING
KAIC RATING: 14
POLES: 30

NOTES	CKT NO.	C.B. A	C.B. P	DESCRIPTION	LOAD (KVA)	A	B	C	LOAD (KVA)	DESCRIPTION	C.B. A	C.B. P	CKT NO.	NOTES
1	1	20	1	LTG- UPLTS RM 215A, C, 201A, B	3.33	4.13			0.79	LTG- CLIMBING ROOM	20	1	2	2
1	3	20	1	LTG- DNLTS RM 215A, C, 201A, B	3.33		4.73		1.40	LTG- STR, COR NOT ON PC	20	1	4	2
2	5	20	1	LTG- GROUP EXERCISE ROOMS	3.26			4.09	0.83	LTG- ATHL. GALL. COVE	20	1	6	1
	7	20	1	SPARE		1.09			1.09	LTG- ATHL. GALL. PNDNTS	20	1	8	1
2	9	20	1	LTG- GYMNASIUM - UNDER TRACK	1.98		1.98			SPARE	20	1	10	
	11	20	1	SPARE				0.00		SPARE	20	1	12	
	13	20	1	SPARE		0.00				SPARE	20	1	14	
	15	20	1	SPARE			0.00			SPARE	20	1	16	
	17	20	1	SPARE				0.00		SPARE	20	1	18	
	19	20	1	SPARE		0.00				SPARE	20	1	20	
	21	20	1	SPARE			0.00			SPARE	20	1	22	
	23	20	1	SPARE				0.00		SPARE	20	1	24	
	25			SPACE		0.00				SPACE			26	
	27			SPACE			0.00			SPACE			28	
	29			SPACE				0.00		SPACE			30	
				SECTION 1 LOAD SUMMARY PER PHASE (KVA)		5.22	6.72	4.09						
				TOTAL CONNECTED LOAD (KVA)		16.02								

OPTIONS AND ACCESSORIES - (X) INDICATES SELECTION

[X] MULTIPLE SECTION PANEL
[ ] RECESSED
[X] SURFACE
[ ] 200% RATED NEUTRAL

CONTACTOR CONTROLLED [ ]
FEED THRU LUGS [ ]
SUB FEED MAIN LUGS (DOUBLE LUGS) [ ]
CONTROLLABLE CIRCUIT BREAKER PANEL [X]
OTHER [ ]

PANEL: LP-3-1
SECTION: 1 OF 1
LOCATION: ELEC.ROOM 302
THIRD FLOOR

VOLTAGE: 480/277V
PHASE & WIRE: 3 PH, 4W
MAIN (AMPS): 60A, M.C.B.

[X] NEW
[ ] EXISTING
KAIC RATING: 14
POLES: 30

NOTES	CKT NO.	C.B. A	C.B. P	DESCRIPTION	LOAD (KVA)	A	B	C	LOAD (KVA)	DESCRIPTION	C.B. A	C.B. P	CKT NO.	NOTES
1	1	20	1	LTG - FITNESS 301 UPLIGHTS	1.88	3.88			2.00	LTG - GYMNASIUM	20	1	2	2
1	3	20	1	LTG - FITNESS 301 DOWNLIGHTS	1.88		3.88		2.00	LTG - GYMNASIUM	20	1	4	2
1	5	20	1	LTG - OC SENSORS LEVEL 3	2.26			4.26	2.00	LTG - GYMNASIUM	20	1	6	2
2	7	20	1	LTG - LEVEL 3 GENERAL	0.50	2.50			2.00	LTG - GYMNASIUM	20	1	8	2
2	9	20	1	LTG - GYM UPPER TRACK	2.00		2.00			SPARE	20	1	10	
	11	20	1	SPARE				0.00		SPARE	20	1	12	
	13	20	1	SPARE		0.00				SPARE	20	1	14	
	15	20	1	SPARE			0.00			SPARE	20	1	16	
	17	20	1	SPARE				0.00		SPARE	20	1	18	
	19	20	1	SPARE		0.00				SPARE	20	1	20	
	21	20	1	SPARE			0.00			SPARE	20	1	22	
	23	20	1	SPARE				0.00		SPARE	20	1	24	
	25			SPACE		0.00				SPACE			26	
	27			SPACE			0.00			SPACE			28	
	29			SPACE				0.00		SPACE			30	
				LOAD SUMMARY PER PHASE (KVA)		6.38	5.88	4.26						
				TOTAL CONNECTED LOAD (KVA)		16.52								

OPTIONS AND ACCESSORIES - (X) INDICATES SELECTION

- [ ] MULTIPLE SECTION PANEL
- [ ] RECESSED
- [X] SURFACE
- [ ] 200% RATED NEUTRAL
- [ ] ISOLATED GROUND BUS
- [2] CONTROLLABLE CIRCUIT BREAKER
- [ ] CONTACTOR CONTROLLED
- [ ] FEED THRU LUGS
- [ ] SUB FEED MAIN LUGS (DOUBLE LUGS)
- [X] CONTROLLABLE CIRCUIT BREAKER PANEL
- [ ] OTHER
- [1] CONTROLLABLE CB BY PHOTOCELL

PANEL: ESLP-3-1
SECTION: 1 OF 1
LOCATION: ELEC. ROOM 302
THIRD FLOOR

VOLTAGE: 480/277V
PHASE & WIRE: 3 PH, 4W
MAIN (AMPS): 60A, M.C.S.

[X] NEW
[ ] EXISTING
KAIC RATING: 14
POLES: 30

NOTES	CKT NO.	C.B. A	C.B. P	DESCRIPTION	LOAD (KVA)	A	B	C	LOAD (KVA)	DESCRIPTION	C.B. A	C.B. P	CKT NO.	NOTES
2	1	20	1	EMERG LTG - ATH GALL, FITNESS	2.00	4.00			2.00	EMERG LTG - FITNESS 201 UP LIGHTS	20	1	2	1
2	3	20	1	EMERG LTG - GYMNASIUM 212 - TRACK	2.00		4.00		2.00	EMERG LTG - FITNESS 201 DWN LIGHTS	20	1	4	1
	5	20	1	EMERG LTG - ELEC/IT/2ND & 3RD FLRS	2.00			3.00	1.00	EMERG LTG - FITNESS 301 UP LIGHTS	20	1	6	1
2	7	20	1	EMERG LTG - GYMNASIUM	1.00	2.00			1.00	EMERG LTG - FITNESS 301 DWN LIGHTS	20	1	8	1
2	9	20	1	EMERG LTG - GYMNASIUM	1.00		1.00			EMERG LTG - THIRD FLOOR	20	1	10	
2	11	20	1	EMERG LTG - GYMNASIUM	1.00			2.00	1.00	ROOF LIGHTING	20	1	12	3
2	13	20	1	EMERG LTG - GYMNASIUM	1.00	1.00				SPARE	20	1	14	
	15	20	1	SPARE			0.00			SPARE	20	1	16	
	17	20	1	SPARE				0.00		SPARE	20	1	18	
	19	20	1	SPARE		0.00				SPARE	20	1	20	
	21	20	1	SPARE			0.00			SPARE	20	1	22	
	23	20	1	SPARE				0.00		SPARE	20	1	24	
	25			SPACE		0.00				SPACE			26	
	27			SPACE			0.00			SPACE			28	
	29			SPACE				0.00		SPACE			30	
				LOAD SUMMARY PER PHASE (KVA)		7.00	5.00	5.00						
				TOTAL CONNECTED LOAD (KVA)		17.00								

OPTIONS AND ACCESSORIES - (X) INDICATES SELECTION

- [ ] MULTIPLE SECTION PANEL
- [ ] RECESSED
- [X] SURFACE
- [ ] 200% RATED NEUTRAL
- [ ] ISOLATED GROUND BUS
- [2] CONTROLLABLE CIRCUIT BREAKER
- [ ] CONTACTOR CONTROLLED
- [ ] FEED THRU LUGS
- [ ] SUB FEED MAIN LUGS (DOUBLE LUGS)
- [X] CONTROLLABLE CIRCUIT BREAKER PANEL
- [3] CONTROLLABLE CB BY ROOFTOP PHOTOCELL
- [1] CONTROLLABLE CB BY PHOTOCELL

The redesigned panelboard schedule for Panels LP-2-1, LP-3-1 and ESLP-3-1 are provided below with their corresponding panelboard sizing worksheets. Modified circuits are indicated with a purple box.

Normal Lighting Panel LP-2-1			
Circuit #	Type	Quantity	KVA
1	P12	3	.611
1	P16	8	2.17
Total KVA			2.78
3	P12	9	1.83
3	P16	2	.54
Total KVA			2.38
7	A1	6	.23
7	P4	1	.07
7	P8	4	.54
7	P12	4	.81
7	P16	1	.27
Total KVA			2.53
9	C1	12	.44
9	P4	6	.41
Total KVA			.85

Normal Lighting Panel LP-3-1			
Circuit #	Type	Quantity	KVA
1	P12	3	.611
1	P16	8	2.17
Total KVA			2.78
3	P12	9	1.83
3	P16	2	.54
Total KVA			2.38
10	A1	6	.23
10	P4	1	.07
10	P8	4	.54
10	P12	4	.81
10	P16	1	.27
Total KVA			2.53
11	C1	12	.44
11	P4	6	.41
Total KVA			.85

Emergency Lighting Panel ELP-3-1			
Circuit #	Type	Quantity	KVA
2	P4	2	.14
2	P8	1	.14
2	P12	6	1.22
2	P16	2	.54
Total KVA			2.04
4	P4	2	.14
4	P8	1	.14
4	P12	6	1.22
4	P16	2	.54
Total KVA			2.04

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 80A
SIZE/TYPE MAIN: 80A/3P C/B

PANEL TAG: LP-2-1
PANEL LOCATION: ELEC. ROOM 202
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 10K
OPTIONS: PROVIDE FEED THROUGH LUGS FOR PANELBOARD 1L1B

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
LINEAR FLUOR	FITNESS 201	2641	20A/1P	1	*			2	20A/1P	751	CLIMBING	INDUCTION
LINEAR FLUOR	FITNESS 201	2261	20A/1P	3		*		4	20A/1P	1330	STR. CORR	FLUORESCENT
FLUORESCENT	GRP EXER	3097	20A/1P	5			*	6	20A/1P	789	ATHL GAL	LED/CFL
LINEAR FLUOR	FITNESS 201	1828	20A/1P	7	*			8	20A/1P	1036	ATHL GAL	HID
LED/FLUOR	FITNESS 201	775	20A/1P	9		*		10	20A/1P	2375	0	SPARE
SPARE	0	2375	20A/1P	11			*	12	20A/1P	2375	0	SPARE
SPARE	0	2375	20A/1P	13	*			14	20A/1P	2375	0	SPARE
SPARE	-	2375	20A/1P	15		*		16	20A/1P	2375	-	SPARE
SPARE	-	2375	20A/1P	17			*	18	20A/1P	2375	-	SPARE
SPARE	-	2375	20A/1P	19	*			20	20A/1P	2375	-	SPARE
SPARE	-	2375	20A/1P	21		*		22	20A/1P	2375	-	SPARE
SPARE	-	2375	20A/1P	23			*	24	20A/1P	2375	-	SPARE
SPACE	-	0	20A/1P	25	*			26	20A/1P	0	-	SPACE
SPACE	-	0	20A/1P	27		*		28	20A/1P	0	-	SPACE
SPACE	-	0	20A/1P	29			*	30	20A/1P	0	-	SPACE

CONNECTED LOAD (KW) - A Ph.	15.75	TOTAL DESIGN LOAD (KW)	62.66
CONNECTED LOAD (KW) - B Ph.	16.24	POWER FACTOR	0.95
CONNECTED LOAD (KW) - C Ph.	18.14	TOTAL DESIGN LOAD (AMPS)	79

PANELBOARD SIZING WORKSHEET

Panel Tag-------------------------->	LP-2-1	Panel Location:	ELEC. ROOM 202
Nominal Phase to Neutral Voltage------->	277	Phase:	3
Nominal Phase to Phase Voltage-------->	480	Wires:	4

Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks
1	A	LINEAR FLUOR	1	FITNESS 201	2.78	KVA	0.95	2641	2780	
2	A	INDUCTION	1	CLIMBING	0.79	KVA	0.95	751	790	
3	B	LINEAR FLUOR	1	FITNESS 201	2.38	KVA	0.95	2261	2380	
4	B	FLUORESCENT	1	STR, CORR	1.4	KVA	0.95	1330	1400	
5	C	FLUORESCENT	1	GRP EXER	3.26	KVA	0.95	3097	3260	
6	C	LED/CFL	1	ATHL GAL	0.83	KVA	0.95	789	830	
7	A	LINEAR FLUOR	1	FITNESS 201	1.924	KVA	0.95	1828	1924	
8	A	HID	1	ATHL GAL	1.09	KVA	0.95	1036	1090	
9	B	LED/FLUOR	1	FITNESS 201	0.816	KVA	0.95	775	816	
10	B	SPARE	2		2.5	KVA	0.95	2375	2500	
11	C	SPARE	2		2.5	KVA	0.95	2375	2500	
12	C	SPARE	2		2.5	KVA	0.95	2375	2500	
13	A	SPARE	2		2.5	KVA	0.95	2375	2500	
14	A	SPARE	2		2.5	KVA	0.95	2375	2500	
15	B	SPARE	2		2.5	KVA	0.95	2375	2500	
16	B	SPARE	2		2.5	KVA	0.95	2375	2500	
17	C	SPARE	2		2.5	KVA	0.95	2375	2500	
18	C	SPARE	2		2.5	KVA	0.95	2375	2500	
19	A	SPARE	2		2.5	KVA	0.95	2375	2500	

20	A	SPARE	2		2.5	KVA	0.95	2375	2500		
21	B	SPARE	2		2.5	KVA	0.95	2375	2500		
22	B	SPARE	2		2.5	KVA	0.95	2375	2500		
23	C	SPARE	2		2.5	KVA	0.95	2375	2500		
24	C	SPARE	2		2.5	KVA	0.95	2375	2500		
25	A	SPACE	3		0	W	1.00	0	0		
26	A	SPACE	3		0	W	1.00	0	0		
27	B	SPACE	3		0	W	1.00	0	0		
28	B	SPACE	3		0	W	1.00	0	0		
29	C	SPACE	3		0	W	1.00	0	0		
30	C	SPACE	3		0	W	1.00	0	0		
PANEL TOTAL								50.1	52.8	Amps=	63.5
PHASE LOADING								kW	kVA	%	Amps
PHASE TOTAL			A					15.8	16.6	31%	20.0
PHASE TOTAL			B					16.2	17.1	32%	20.6
PHASE TOTAL			C					18.1	19.1	36%	23.0
LOAD CATEGORIES				Connected			Demand				Ver. 1.04
				kW	kVA	DF	kW	kVA	PF		
1	LIGHTING			14.5	15.3		14.5	15.3	0.95		
2	SPARE			35.6	37.5		35.6	37.5	0.95		
3	SPACE			0.0	0.0		0.0	0.0			
Total Demand Loads							50.1	52.8			
Spare Capacity				25%			12.5	13.2			
Total Design Loads							62.7	66.0	0.95	Amps=	79.4

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W	PANEL TAG: LP-3-1	MIN. C/B AIC: 10K
SIZE/TYPE BUS: 80A	PANEL LOCATION: ELEC. ROOM 302	OPTIONS: PROVIDE FEED THROUGH LUGS FOR PANELBOARD 1L1B
SIZE/TYPE MAIN: 80A/3P C/B	PANEL MOUNTING: SURFACE	

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
LINEAR FLUOR	FITNESS 201	2641	20A/1P	1	*			2	20A/1P	1900	GYMNASIUM	CFL
LINEAR FLUOR	FITNESS 201	2261	20A/1P	3		*		4	20A/1P	1900	GYMNASIUM	CFL
OCC SENSOR	LEVEL 3	3097	20A/1P	5			*	6	20A/1P	1900	GYMNASIUM	CFL
FLUORESCENT	LEVEL 3	475	20A/1P	7	*			8	20A/1P	1900	GYMNASIUM	CFL
CFL DOWN	GYM TRACK	1900	20A/1P	9		*		10	20A/1P	2404	FITNESS 201	FLUORESCENT
LED/FLUOR	FITNESS 201	760	20A/1P	11			*	12	20A/1P	2375	0	SPARE
SPARE	0	2375	20A/1P	13	*			14	20A/1P	2375	0	SPARE
SPARE	-	2375	20A/1P	15		*		16	20A/1P	2375	-	SPARE
SPARE	-	2375	20A/1P	17			*	18	20A/1P	2375	-	SPARE
SPARE	-	2375	20A/1P	19	*			20	20A/1P	2375	-	SPARE
SPARE	-	2375	20A/1P	21		*		22	20A/1P	2375	-	SPARE
SPARE	-	2375	20A/1P	23			*	24	20A/1P	2375	-	SPARE
SPACE	-	0	20A/1P	25	*			26	20A/1P	0	-	SPACE
SPACE	-	0	20A/1P	27		*		28	20A/1P	0	-	SPACE
SPACE	-	0	20A/1P	29			*	30	20A/1P	0	-	SPACE

CONNECTED LOAD (KW) - A Ph.	16.42		TOTAL DESIGN LOAD (KW)	65.02
CONNECTED LOAD (KW) - B Ph.	17.96		POWER FACTOR	0.95
CONNECTED LOAD (KW) - C Ph.	17.63		TOTAL DESIGN LOAD (AMPS)	82

PANELBOARD SIZING WORKSHEET

Panel Tag------------------------->	LP-3-1	Panel Location:	ELEC. ROOM 302
Nominal Phase to Neutral Voltage------->	277	Phase:	3
Nominal Phase to Phase Voltage-------->	480	Wires:	4

Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks
1	A	LINEAR FLUOR	1	FITNESS 201	2.78	KVA	0.95	2641	2780	
2	A	CFL	1	GYMNASIUM	2	KVA	0.95	1900	2000	
3	B	LINEAR FLUOR	1	FITNESS 201	2.38	KVA	0.95	2261	2380	
4	B	CFL	1	GYMNASIUM	2	KVA	0.95	1900	2000	
5	C	OCC SENSOR	1	LEVEL 3	3.26	KVA	0.95	3097	3260	
6	C	CFL	1	GYMNASIUM	2	KVA	0.95	1900	2000	
7	A	FLUORESCENT	1	LEVEL 3	0.5	KVA	0.95	475	500	
8	A	CFL	1	GYMNASIUM	2	KVA	0.95	1900	2000	
9	B	CFL DOWN	1	GYM TRACK	2	KVA	0.95	1900	2000	
10	B	FLUORESCENT	1	FITNESS 201	2.53	KVA	0.95	2404	2530	
11	C	LED/FLUOR	1	FITNESS 201	0.8	KVA	0.95	760	800	
12	C	SPARE	2		2.5	KVA	0.95	2375	2500	
13	A	SPARE	2		2.5	KVA	0.95	2375	2500	
14	A	SPARE	2		2.5	KVA	0.95	2375	2500	
15	B	SPARE	2		2.5	KVA	0.95	2375	2500	
16	B	SPARE	2		2.5	KVA	0.95	2375	2500	
17	C	SPARE	2		2.5	KVA	0.95	2375	2500	
18	C	SPARE	2		2.5	KVA	0.95	2375	2500	
19	A	SPARE	2		2.5	KVA	0.95	2375	2500	
20	A	SPARE	2		2.5	KVA	0.95	2375	2500	
21	B	SPARE	2		2.5	KVA	0.95	2375	2500	
22	B	SPARE	2		2.5	KVA	0.95	2375	2500	
23	C	SPARE	2		2.5	KVA	0.95	2375	2500	
24	C	SPARE	2		2.5	KVA	0.95	2375	2500	
25	A	SPACE	3		0	W	1.00	0	0	
26	A	SPACE	3		0	W	1.00	0	0	
27	B	SPACE	3		0	W	1.00	0	0	
28	B	SPACE	3		0	W	1.00	0	0	
29	C	SPACE	3		0	W	1.00	0	0	
30	C	SPACE	3		0	W	1.00	0	0	
PANEL TOTAL								52.0	54.8	Amps= 65.9

PHASE LOADING		kW	kVA	%	Amps
PHASE TOTAL	A	16.4	17.3	32%	20.8
PHASE TOTAL	B	18.0	18.9	35%	22.8
PHASE TOTAL	C	17.6	18.6	34%	22.3

LOAD CATEGORIES		Connected			Demand				Ver. 1.04
		kW	kVA	DF	kW	kVA	PF		
1	LIGHTING	21.1	22.3		21.1	22.3	0.95		
2	SPARE	30.9	32.5		30.9	32.5	0.95		
3	SPACE	0.0	0.0		0.0	0.0			
Total Demand Loads					52.0	54.8			
Spare Capacity		25%			13.0	13.7			
Total Design Loads					65.0	68.4	0.95	Amps=	82.4

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W SIZE/TYPE BUS: 80A SIZE/TYPE MAIN: 80A/3P C/B	PANEL TAG: ESLP-3-1 PANEL LOCATION: ELEC. ROOM 302 PANEL MOUNTING: SURFACE	MIN. C/B AIC: 10K OPTIONS: PROVIDE FEED THROUGH LUGS FOR PANELBOARD 1L1B

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
FLUORESCENT	ATHL GALL	1900	20A/1P	1	*			2	20A/1P	1938	FITNESS 201	LINEAR FLUOR
CFL	GYM TRACK	1900	20A/1P	3		*		4	20A/1P	1938	FITNESS 201	LINEAR FLUOR
INDUSTRIAL	ELEC RMS	3097	20A/1P	5			*	6	20A/1P	2375		SPARE
CFL	GYMNASIUM	950	20A/1P	7	*			8	20A/1P	2375		SPARE
CFL	GYMNASIUM	950	20A/1P	9		*		10	20A/1P	475	LEVEL 3	FLUORESCENT
CFL	GYMNASIUM	950	20A/1P	11			*	12	20A/1P	950	ROOF	EXTERIOR
CFL	GYMNASIUM	950	20A/1P	13	*			14	20A/1P	2375	0	SPARE
SPARE	-	2375	20A/1P	15		*		16	20A/1P	2375	-	SPARE
SPARE	-	2375	20A/1P	17			*	18	20A/1P	2375	-	SPARE
SPARE	-	2375	20A/1P	19	*			20	20A/1P	2375	-	SPARE
SPARE	-	2375	20A/1P	21		*		22	20A/1P	2375	-	SPARE
SPARE	-	2375	20A/1P	23			*	24	20A/1P	2375	-	SPARE
SPACE	-	0	20A/1P	25	*			26	20A/1P	0	-	SPACE
SPACE	-	0	20A/1P	27		*		28	20A/1P	0	-	SPACE
SPACE	-	0	20A/1P	29			*	30	20A/1P	0	-	SPACE

CONNECTED LOAD (KW) - A Ph.	15.24		TOTAL DESIGN LOAD (KW)	58.59
CONNECTED LOAD (KW) - B Ph.	14.76		POWER FACTOR	0.95
CONNECTED LOAD (KW) - C Ph.	16.87		TOTAL DESIGN LOAD (AMPS)	74

PANELBOARD SIZING WORKSHEET

Panel Tag------------------------->	ESLP-3-1	Panel Location:	ELEC. ROOM 302
Nominal Phase to Neutral Voltage------->	277	Phase:	3
Nominal Phase to Phase Voltage-------->	480	Wires:	4

Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks
1	A	FLUORESCENT	1	ATHL GALL	2	KVA	0.95	1900	2000	
2	A	LINEAR FLUOR	1	FITNESS 201	2.04	KVA	0.95	1938	2040	
3	B	CFL	1	GYM TRACK	2	KVA	0.95	1900	2000	
4	B	LINEAR FLUOR	1	FITNESS 201	2.04	KVA	0.95	1938	2040	
5	C	INDUSTRIAL	1	ELEC RMS	3.26	KVA	0.95	3097	3260	
6	C	SPARE	2		2.5	KVA	0.95	2375	2500	
7	A	CFL	1	GYMNASIUM	1	KVA	0.95	950	1000	
8	A	SPARE	2		2.5	KVA	0.95	2375	2500	
9	B	CFL	1	GYMNASIUM	1	KVA	0.95	950	1000	
10	B	FLUORESCENT	1	LEVEL 3	0.5	KVA	0.95	475	500	
11	C	CFL	1	GYMNASIUM	1	KVA	0.95	950	1000	
12	C	EXTERIOR	1	ROOF	1	KVA	0.95	950	1000	
13	A	CFL	1	GYMNASIUM	1	KVA	0.95	950	1000	
14	A	SPARE	2		2.5	KVA	0.95	2375	2500	
15	B	SPARE	2		2.5	KVA	0.95	2375	2500	
16	B	SPARE	2		2.5	KVA	0.95	2375	2500	
17	C	SPARE	2		2.5	KVA	0.95	2375	2500	
18	C	SPARE	2		2.5	KVA	0.95	2375	2500	
19	A	SPARE	2		2.5	KVA	0.95	2375	2500	
20	A	SPARE	2		2.5	KVA	0.95	2375	2500	
21	B	SPARE	2		2.5	KVA	0.95	2375	2500	
22	B	SPARE	2		2.5	KVA	0.95	2375	2500	
23	C	SPARE	2		2.5	KVA	0.95	2375	2500	
24	C	SPARE	2		2.5	KVA	0.95	2375	2500	
25	A	SPACE	3		0	W	1.00	0	0	

26	A	SPACE	3		0	W	1.00	0	0		
27	B	SPACE	3		0	W	1.00	0	0		
28	B	SPACE	3		0	W	1.00	0	0		
29	C	SPACE	3		0	W	1.00	0	0		
30	C	SPACE	3		0	W	1.00	0	0		
PANEL TOTAL								46.9	49.3	Amps=	59.4
PHASE LOADING								kW	kVA	%	Amps
	PHASE TOTAL		A					15.2	16.0	33%	19.3
	PHASE TOTAL		B					14.8	15.5	31%	18.7
	PHASE TOTAL		C					16.9	17.8	36%	21.4
LOAD CATEGORIES				Connected			Demand				Ver. 1.04
				kW	kVA	DF	kW	kVA	PF		
1	LIGHTING			16.0	16.8		16.0	16.8	0.95		
2	SPARE			30.9	32.5		30.9	32.5	0.95		
3	SPACE			0.0	0.0		0.0	0.0			
	Total Demand Loads						46.9	49.3			
	Spare Capacity			25%			11.7	12.3			
	Total Design Loads						58.6	61.7	0.95	Amps=	74.2

feeder sizing

LP-2-1	
Voltage	480Y/277
Design Load (KW)	62.1
Power Factor	0.95
Calculated Design Load (Amps)	79
Feeder Protection Size (Amps)	80
Sets	1
Wire Sizes	
Phase	4
Neutral	4
Ground	8
Conduit Size	1 1/4”

LP-3-1	
Voltage	480Y/277
Design Load (KW)	74.2
Power Factor	0.95
Calculated Design Load (Amps)	94
Feeder Protection Size (Amps)	100
Sets	1
Wire Sizes	
Phase	3
Neutral	3
Ground	8
Conduit Size	1 1/4”

ESLP-3-1	
Voltage	480Y/277
Design Load (KW)	58.6
Power Factor	0.95
Calculated Design Load (Amps)	74
Feeder Protection Size (Amps)	80
Sets	1
Wire Sizes	
Phase	4
Neutral	4
Ground	8
Conduit Size	1 1/4”

voltage drop calculations

VOLTAGE DROP – LP-2-1	
Voltage (V)	480
Ampacity (I)	85
Power Factor (See Note 1)	.95
Wire Size (14,12,10 ... 1/0, 2/0 ... 250,350)	4
# of conductors per phase	1
Type Conductor (A=Aluminum C=Copper)	C
Type Conduit (P=PVC; A=Aluminum S=Steel)	S
Length of Run (ft)	158
Voltage Drop	***7.29***
% Drop	***1.52***

VOLTAGE DROP – LP-3-1	
Voltage (V)	480
Ampacity (I)	85
Power Factor (See Note 1)	.95
Wire Size (14,12,10 ... 1/0, 2/0 ... 250,350)	3
# of conductors per phase	1
Type Conductor (A=Aluminum C=Copper)	C
Type Conduit (P=PVC; A=Aluminum S=Steel)	S
Length of Run (ft)	172
Voltage Drop	***7.62***
% Drop	***1.59***

VOLTAGE DROP – ESLP-3-1	
Voltage (V)	480
Ampacity (I)	85
Power Factor (See Note 1)	.95
Wire Size (14,12,10 ... 1/0, 2/0 ... 250,350)	3
# of conductors per phase	1
Type Conductor (A=Aluminum C=Copper)	C
Type Conduit (P=PVC; A=Aluminum S=Steel)	S
Length of Run (ft)	172
Voltage Drop	***7.47***
% Drop	***1.56***

circulation space | lobby

lighting redesign

The lobby typically provides the initial and final impression of the Rec Center, and the lighting needs to orient someone both to the circulation within the space as well as the feel and aesthetics of the building itself. The task and ambient light levels are provided by an apparently random but intentionally spaced surface mounted LED downlight array. To counteract the closing effect of the downlights, custom LED luminaire fixtures are provided to bring visual interest and the appearance of a bright open ceiling while reinforcing the height of the space. The security desk is lit by the linear fluorescent “flying surface” luminaire to keep continuity through the space while providing the necessary light levels for facial recognition and task performance. Orientational wall features are highlighted by recessed LED square downlights, and the space is lit primarily with daylight for a majority of day.

electrical redesign

Both the emergency and normal lighting panels that serve the fitness center are 480Y/277V 3 phase 4 wire panels, with the emergency sized at 60A and the normal sized at 80A. The replacement of linear fluorescent with even more energy efficient LED lighting to provide the ambient lighting to the space greatly lowers the lighting load on the panels.

controls

The façade of the Drexel Recreation Center is a product of an extensive energy study to maximize daylighting and minimize solar gain. The lobby is the daylighting feature space of the rec center, and so is provided with consistent levels of daylight throughout the day, especially given the low lighting level requirement of 10fc. For a more consistent lighting level and in order to minimize possible issues involved with dimming the LEDs, the Wattstopper switching control system will be used on the LEDs, with dimming taking place only over the security desk. The daylighting sensor will be calibrated in order to maintain the desired minimum of 10fc on the ground at all times.

Fitness Center Control Schedule			
Type	Manufacturer	Product	Description
LC-100	Wattstopper	Intelligent Power Pack	Power pack delivers 0-10V dimming control to lighting loads.
LMLS-305	Wattstopper	LightSaver Photocell	Closed loop photosensor provides the daylight data necessary for operation.
LMRC-201	Wattstopper	LightSaver Room Dimming Controller	Provides automatic dimming control for fluorescent fixtures. Closed loop control utilizes a photocell for single-zone dimming.
LMSW-100	Wattstopper	LightSaver Wall Switches	Allows occupants to temporarily override the daylighting control systems.

panelboards

existing

Below are the existing panelboard schedules for 480Y/277V normal lighting panel LP-1-1 and 480Y/277V emergency lighting panel ESLP-1-1. LP-1-1 is located on the first floor of the DRC in Electrical Switchgear Room 132, and ESLP-1-1 is located on the first floor in the Emergency Generator Room 133. Modified circuits are indicated with an aqua box.

PANEL: LP-1-1
SECTION: 1 OF 1
LOCATION: ELEC. SWITCHGEAR ROOM 132, FIRST FLOOR
VOLTAGE: 480/277V
PHASE & WIRE: 3 PH, 4W
MAIN (AMPS): 60A, M.C.B.
[X] NEW [ ] EXISTING
KAIC RATING: 35
POLES: 30

NOTES	CKT NO.	C.B. A	C.B. P	DESCRIPTION	LOAD (KVA)	A	B	C	LOAD (KVA)	DESCRIPTION	C.B. A	C.B. P	CKT NO.	NOTES
2	1	20	1	LTG - LOBBY 100 UPLIGHTS	1.88	3.67			1.79	LTG - LOCKER ROOMS	20	1	2	1
2	3	20	1	LTG - LOBBY 100 DOWNLIGHTS	1.88		2.01		0.13	LTG - RETAIL CAFÉ 104	20	1	4	1
	5	20	1	LTG - OC SENSORS	2.33			2.77	0.45	LTG - GEN. STORAGE 130	20	1	6	1
1	7	20	1	LTG - SECURITY RM 110	0.29	0.68			0.38	LTG - ELEC. RM 132	20	1	8	1
1	9	20	1	LTG - COR 111, 112, RM 108, 120	2.90		3.09		0.19	LTG - SHELL SPACE 122/SQ CT	20	1	10	1
1	11	20	1	LTG - FUT. CHILLER RM 137	0.51			1.09	0.58	LTG - BOILER RM 136	20	1	12	1
3	13	20	1	LTG - EXTERIOR BENCHES	1.00	2.50			1.50	LTG - SITE	20	1	14	3
	15	20	1	SPARE			0.00			SPARE	20	1	16	
	17	20	1	SPARE				0.00		SPARE	20	1	18	
	19	20	1	SPARE		0.00				SPARE	20	1	20	
	21	20	1	SPARE			0.00			SPARE	20	1	22	
	23	20	1	SPARE				0.00		SPARE	20	1	24	
	25			SPACE		0.00				SPACE			26	
	27			SPACE			0.00			SPACE			28	
	29			SPACE				0.00		SPACE			30	
					LOAD SUMMARY PER PHASE (KVA)	6.85	5.10	3.86						
					TOTAL CONNECTED LOAD (KVA)	15.81								

OPTIONS AND ACCESSORIES - (X) INDICATES SELECTION

- [ ] MULTIPLE SECTION PANEL
- [ ] RECESSED
- [X] SURFACE
- [ ] 200% RATED NEUTRAL
- [ ] ISOLATED GROUND BUS
- CONTACTOR CONTROLLED [ ]
- FEED THRU LUGS [ ]
- SUB FEED MAIN LUGS (DOUBLE LUGS) [ ]
- CONTROLLABLE CIRCUIT BREAKER PANEL [X]
- OTHER [ ]

NOTES:
1. CONTROLLABLE BREAKER
2. CONTROLLABLE BREAKER CONTROLLED BY PHOTOCELL
3. CONTROLLABLE BREAKER CONTROLLED BY ROOF TOP PHOTOCELL

PANEL: ESLP-1-1
SECTION: 1 OF 1
LOCATION: EMERGENCY GENERATOR ROOM 133, FIRST FLOOR
VOLTAGE: 480/277V
PHASE & WIRE: 3 PH, 4W
MAIN (AMPS): 60A, M.L.O.
[X] NEW [ ] EXISTING
KAIC RATING: 35
POLES: 30

NOTES	CKT NO.	C.B. A	C.B. P	DESCRIPTION	LOAD (KVA)	A	B	C	LOAD (KVA)	DESCRIPTION	C.B. A	C.B. P	CKT NO.	NOTES
	1	20	1	EMR. LTG- LOB 100 EXT SNS	0.52	1.39			0.87	EMR LTG- LOBBY 100 UPLGHTS	20	1	2	2
	3	20	1	EMR. LTG- STR S3, RM 102, 103	0.29		1.16		0.87	EMR LTG- LOBBY 100 DWNLGHTS	20	1	4	2
	5	20	1	EMR. LTG- CORR, RM 108-110, 122	1.89			2.41	0.51	EMR LTG- LKR RM, BTHRMS	20	1	6	
	7	20	1	EMR. LTG- ELEC/MECH RMS	1.88	2.66			0.79	EMR LTG- SHELL SPACE	20	1	8	
1	9	20	1	EMR. LTG- EXTERIOR	1.60		1.60			SPARE	20	1	10	
	11	20	1	SPARE				0.00		SPARE	20	1	12	
	13	20	1	SPARE		0.00				SPARE	20	1	14	
	15	20	1	SPARE			0.00			SPARE	20	1	16	
	17	20	1	SPARE				0.00		SPARE	20	1	18	
	19	20	1	SPARE		0.00				SPARE	20	1	20	
	21	20	1	SPARE			0.00			SPARE	20	1	22	
	23	20	1	SPARE				0.00		SPARE	20	1	24	
	25			SPACE		0.00				SPACE			26	
	27			SPACE			0.00			SPACE			28	
	29			SPACE				0.00		SPACE			30	
					LOAD SUMMARY PER PHASE (KVA)	4.06	2.76	2.41						
					TOTAL CONNECTED LOAD (KVA)	9.22								

OPTIONS AND ACCESSORIES - (X) INDICATES SELECTION

- [ ] MULTIPLE SECTION PANEL
- [ ] RECESSED
- [X] SURFACE
- [ ] 200% RATED NEUTRAL
- [ ] CONTROLLABLE CIRCUIT BREAKER
- CONTACTOR CONTROLLED [ ]
- FEED THRU LUGS [ ]
- SUB FEED MAIN LUGS (DOUBLE LUGS) [ ]
- CONTROLLABLE CIRCUIT BREAKER PANEL [X]
- OTHER [ ]

NOTES:
1. CONTROLLABLE BREAKER BY PHOTOCELL.
2. CONTROLLABLE BREAKER BY ROOFTOP PHOTOCELL.

circuiting calculations

Each circuit was recalculated based on the new lighting load. For a voltage of 277 on 20A circuits, recommended engineering practice designates 3.55 KVA per circuit. All three of the lobby circuits adhere to these guidelines.

Emergency Lighting Panel ELP-1-1			
Circuit #	Type	Quantity	KVA
2	C2	22	.35
4	C2	22	.35
Total KVA			.694

Normal Lighting Panel LP-1-1			
Circuit #	Type	Quantity	KVA
1	C2	120	.25
Total KVA			1.89
3	C1	8	.29
3	C2	27	.43
3	S1	6	.65
Total KVA			1.37
4	J2	73	.81
Total KVA			.81

The redesigned panelboard schedule for Panels LP-1-1 and ESLP-1-1 are provided below with their corresponding panelboard sizing worksheets. Modified circuits are indicated with an aqua box.

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W SIZE/TYPE BUS: 80A SIZE/TYPE MAIN: 80A/3P C/B	PANEL TAG: LP-1-1 PANEL LOCATION: ELEC. SWTCHGR RM. 132 PANEL MOUNTING: SURFACE	MIN. C/B AIC: 10K OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
LED	LOBBY	1796	20A/1P	1	*			2	20A/1P	1701	LKR RMS	FLUORESCENT
LED/FL PERIMETER	LOBBY	1302	20A/1P	3		*		4	20A/1P	770	LOBBY	DECORATIVE LED
OC SENSOR	1ST FL	2214	20A/1P	5			*	6	20A/1P	428	STOR 130	INDUSTRIAL
FLUORESCENT	SEC 110	276	20A/1P	7	*			8	20A/1P	361	ELEC 132	INDUSTRIAL
DWNLTS	CORR	2755	20A/1P	9		*		10	20A/1P	181	SHELL 122	INDUSTRIAL
INDUSTRIAL	CHILL 137	485	20A/1P	11			*	12	20A/1P	551	BLR 136	INDUSTRIAL
LED/CFL	EXTR	1853	20A/1P	13	*			14	20A/1P	1343	EXTR	POLES
SPARE	-	2375	20A/1P	15		*		16	20A/1P	2375	-	SPARE
SPARE	-	2375	20A/1P	17			*	18	20A/1P	2375	-	SPARE
SPARE	-	2375	20A/1P	19	*			20	20A/1P	2375	-	SPARE
SPARE	-	2375	20A/1P	21		*		22	20A/1P	2375	-	SPARE
SPARE	-	2375	20A/1P	23			*	24	20A/1P	2375	-	SPARE
SPACE	-	0	20A/1P	25	*			26	20A/1P	0	-	SPACE
SPACE	-	0	20A/1P	27		*		28	20A/1P	0	-	SPACE
SPACE	-	0	20A/1P	29			*	30	20A/1P	0	-	SPACE

CONNECTED LOAD (KW) - A Ph.	12.08	TOTAL DESIGN LOAD (KW)	49.70
CONNECTED LOAD (KW) - B Ph.	14.51	POWER FACTOR	0.95
CONNECTED LOAD (KW) - C Ph.	13.18	TOTAL DESIGN LOAD (AMPS)	63

PANELBOARD SIZING WORKSHEET

Panel Tag------------------------->	LP-1-1	Panel Location:	ELEC. SWTCHGR RM. 132
Nominal Phase to Neutral Voltage------->	277	Phase:	3
Nominal Phase to Phase Voltage-------->	480	Wires:	4

Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks
1	A	LED DWNLTS	1	LOBBY	1.89	KVA	0.95	1796	1890	
2	A	FLUORESCENT	1	LKR RMS	1.79	KVA	0.95	1701	1790	
3	B	LED/FL PERIMETER	1	LOBBY	1.37	KVA	0.95	1302	1370	
4	B	DECORATIVE LED	1	LOBBY	0.81	KVA	0.95	770	810	
5	C	OC SENSOR	1	1ST FL	2.33	KVA	0.95	2214	2330	
6	C	INDUSTRIAL	1	STOR 130	0.45	KVA	0.95	428	450	
7	A	FLUORESCENT	1	SEC 110	0.29	KVA	0.95	276	290	
8	A	INDUSTRIAL	1	ELEC 132	0.38	KVA	0.95	361	380	
9	B	DWNLTS	1	CORR	2.9	KVA	0.95	2755	2900	
10	B	INDUSTRIAL	1	SHELL 122	0.19	KVA	0.95	181	190	
11	C	INDUSTRIAL	1	CHILL 137	0.51	KVA	0.95	485	510	
12	C	INDUSTRIAL	1	BLR 136	0.58	KVA	0.95	551	580	
13	A	LED/CFL	1	EXTR	1.91	KVA	0.97	1853	1910	
14	A	POLES	1	EXTR	1.37	KVA	0.98	1343	1370	
15	B	SPARE	2		2.5	KVA	0.95	2375	2500	
16	B	SPARE	2		2.5	KVA	0.95	2375	2500	
17	C	SPARE	2		2.5	KVA	0.95	2375	2500	
18	C	SPARE	2		2.5	KVA	0.95	2375	2500	
19	A	SPARE	2		2.5	KVA	0.95	2375	2500	
20	A	SPARE	2		2.5	KVA	0.95	2375	2500	
21	B	SPARE	2		2.5	KVA	0.95	2375	2500	
22	B	SPARE	2		2.5	KVA	0.95	2375	2500	
23	C	SPARE	2		2.5	KVA	0.95	2375	2500	
24	C	SPARE	2		2.5	KVA	0.95	2375	2500	
25	A	SPACE	3		0	W	1.00	0	0	
26	A	SPACE	3		0	W	1.00	0	0	
27	B	SPACE	3		0	W	1.00	0	0	
28	B	SPACE	3		0	W	1.00	0	0	
29	C	SPACE	3		0	W	1.00	0	0	
30	C	SPACE	3		0	W	1.00	0	0	
PANEL TOTAL								39.8	41.8	Amps= 50.3

PHASE LOADING		kW	kVA	%	Amps
PHASE TOTAL	A	12.1	12.6	30%	15.2
PHASE TOTAL	B	14.5	15.3	37%	18.4
PHASE TOTAL	C	13.2	13.9	33%	16.7

LOAD CATEGORIES			Connected			Demand			Ver. 1.04
			kW	kVA	DF	kW	kVA	PF	
1	LIGHTING		16.0	16.8		16.0	16.8	0.95	
2	SPARE		23.8	25.0		23.8	25.0	0.95	
3	SPACE		0.0	0.0		0.0	0.0		
Total Demand Loads						39.8	41.8		
Spare Capacity			25%			9.9	10.4		
Total Design Loads						49.7	52.2	0.95	Amps= 62.8

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 60A
SIZE/TYPE MAIN: 60A/3P C/B

PANEL TAG: ESLP-1-1
PANEL LOCATION: EMER. GEN. RM. 133
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 10K
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
FLUOR/EXIT SGNS	LOBBY	494	20A/1P	1	*			2	20A/1P	333	LOBBY	LED DWNLTS
FLUOR	STR, 102, 103	276	20A/1P	3		*		4	20A/1P	333	LOBBY	LED DWNLTS
DWNLTS	CORR,108-10	1796	20A/1P	5			*	6	20A/1P	485	LKR/REST	FLUORESCENT
INDUSTRIAL	ELEC/MECH	1786	20A/1P	7	*			8	20A/1P	361	ELEC 132	INDUSTRIAL
INDUSTRIAL	SHELL 122	751	20A/1P	9		*		10	20A/1P	1853	EXTR	POLES
SPARE	-	1425	20A/1P	11			*	12	20A/1P	1425	-	SPARE
SPARE	-	1425	20A/1P	13	*			14	20A/1P	1425	-	SPARE
SPARE	-	1425	20A/1P	15		*		16	20A/1P	1425	-	SPARE
SPARE	-	1425	20A/1P	17			*	18	20A/1P	1425	-	SPARE
SPARE	-	1425	20A/1P	19	*			20	20A/1P	1425	-	SPARE
SPARE	-	1425	20A/1P	21		*		22	20A/1P	1425	-	SPARE
SPARE	-	1425	20A/1P	23			*	24	20A/1P	1425	-	SPARE
SPACE	-	0	20A/1P	25	*			26	20A/1P	0	-	SPACE
SPACE	-	0	20A/1P	27		*		28	20A/1P	0	-	SPACE
SPACE	-	0	20A/1P	29			*	30	20A/1P	0	-	SPACE

CONNECTED LOAD (KW) - A Ph.	8.67	TOTAL DESIGN LOAD (KW)	35.52
CONNECTED LOAD (KW) - B Ph.	8.91	POWER FACTOR	0.95
CONNECTED LOAD (KW) - C Ph.	10.83	TOTAL DESIGN LOAD (AMPS)	45

PANELBOARD SIZING WORKSHEET

Panel Tag------------------------->	ESLP-1-1	Panel Location:	EMER. GEN. RM. 133
Nominal Phase to Neutral Voltage------->	277	Phase:	3
Nominal Phase to Phase Voltage-------->	480	Wires:	4

Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks
1	A	FLUOR/EXIT SGNS	1	LOBBY	0.52	KVA	0.95	494	520	
2	A	LED DWNLTS	1	LOBBY	0.35	KVA	0.95	333	350	
3	B	FLUOR	1	STR, 102, 103	0.29	KVA	0.95	276	290	
4	B	LED DWNLTS	1	LOBBY	0.35	KVA	0.95	333	350	
5	C	DWNLTS	1	CORR,108-10	1.89	KVA	0.95	1796	1890	
6	C	FLUORESCENT	1	LKR/REST	0.51	KVA	0.95	485	510	
7	A	INDUSTRIAL	1	ELEC/MECH	1.88	KVA	0.95	1786	1880	
8	A	INDUSTRIAL	1	ELEC 132	0.38	KVA	0.95	361	380	
9	B	INDUSTRIAL	1	SHELL 122	0.79	KVA	0.95	751	790	

10	B	POLES	1	EXTR	1.91	KVA	0.97	1853	1910		
11	C	SPARE	1		1.5	KVA	0.95	1425	1500		
12	C	SPARE	1		1.5	KVA	0.95	1425	1500		
13	A	SPARE	1		1.5	KVA	0.95	1425	1500		
14	A	SPARE	1		1.5	KVA	0.95	1425	1500		
15	B	SPARE	2		1.5	KVA	0.95	1425	1500		
16	B	SPARE	2		1.5	KVA	0.95	1425	1500		
17	C	SPARE	2		1.5	KVA	0.95	1425	1500		
18	C	SPARE	2		1.5	KVA	0.95	1425	1500		
19	A	SPARE	2		1.5	KVA	0.95	1425	1500		
20	A	SPARE	2		1.5	KVA	0.95	1425	1500		
21	B	SPARE	2		1.5	KVA	0.95	1425	1500		
22	B	SPARE	2		1.5	KVA	0.95	1425	1500		
23	C	SPARE	2		1.5	KVA	0.95	1425	1500		
24	C	SPARE	2		1.5	KVA	0.95	1425	1500		
25	A	SPACE	3		0	W	1.00	0	0		
26	A	SPACE	3		0	W	1.00	0	0		
27	B	SPACE	3		0	W	1.00	0	0		
28	B	SPACE	3		0	W	1.00	0	0		
29	C	SPACE	3		0	W	1.00	0	0		
30	C	SPACE	3		0	W	1.00	0	0		
PANEL TOTAL								28.4	29.9	Amps=	35.9
PHASE LOADING								kW	kVA	%	Amps
PHASE TOTAL			A					8.7	9.1	31%	11.0
PHASE TOTAL			B					8.9	9.3	31%	11.2
PHASE TOTAL			C					10.8	11.4	38%	13.7
LOAD CATEGORIES				Connected			Demand				Ver. 1.04
				kW	kVA	DF	kW	kVA	PF		
1		LIGHTING		14.2	14.9		14.2	14.9	0.95		
2		SPARE		14.3	15.0		14.3	15.0	0.95		
3		SPACE		0.0	0.0		0.0	0.0			
Total Demand Loads							28.4	29.9			
Spare Capacity				25%			7.1	7.5			
Total Design Loads							35.5	37.3	0.95	Amps=	44.9

feeder sizing

LP-1-1	
Voltage	480Y/277
Design Load (KW)	49.8
Power Factor	0.95
Calculated Design Load (Amps)	62.8
Feeder Protection Size (Amps)	80
Sets	1
Wire Sizes	
Phase	4
Neutral	4
Ground	8
Conduit Size	1 1/4”

ESLP-1-1	
Voltage	480Y/277
Design Load (KW)	44.9
Power Factor	0.95
Calculated Design Load (Amps)	56.9
Feeder Protection Size (Amps)	60
Sets	1
Wire Sizes	
Phase	6
Neutral	6
Ground	10
Conduit Size	1”

voltage drop calculations

VOLTAGE DROP – LP-1-1	
Voltage (V)	480
Ampacity (I)	85
Power Factor (See Note 1)	.95
Wire Size (14,12,10 ... 1/0, 2/0 ... 250,350)	4
# of conductors per phase	1
Type Conductor (A=Aluminum C=Copper)	C
Type Conduit (P=PVC; A=Aluminum S=Steel)	A
Length of Run (ft)	23
Voltage Drop	*1.06*
% Drop	*0.22*

VOLTAGE DROP – ESLP-1-1	
Voltage (V)	480
Ampacity (I)	65
Power Factor (See Note 1)	.95
Wire Size (14,12,10 ... 1/0, 2/0 ... 250,350)	6
# of conductors per phase	1
Type Conductor (A=Aluminum C=Copper)	C
Type Conduit (P=PVC; A=Aluminum S=Steel)	A
Length of Run (ft)	39
Voltage Drop	*1.97*
% Drop	*0.41*

special purpose space | restaurant

lighting redesign

The sports bar and restaurant is a multi-faceted space that can be an exciting, engaging place to watch a football game or can be a more relaxing, intimate place to take a break and enjoy dinner and drinks with friends. The lighting throughout the space needs to be adjustable in order to establish the desired atmosphere and impression for specific events. In either mode, a restaurant/lounge area utilizes a non-uniform lighting design with lower light levels immediately surrounding the guest with higher levels away from the guest, providing a sensation of watching without being watched. The concept of the building's core energy is carried through the restaurant with the energy efficient LED cove. Fluorescent and LED lighting is used for energy efficiency, but halogen sources were used above tables and the above bar for color rendering of food and people.

electrical redesign

Both the emergency and normal lighting dimming panels that serve the restaurant are 208Y/120V 3 phase 4 wire panels, with the emergency and normal each sized at 175A. The removal of inefficient incandescent decorative pendants and excessive amounts of track lighting created space in which the power density was met but sufficient light levels are still present in dining and service areas.

controls

The bar and lounge are open for both lunch and dinner, as well as for sporting events and off-evenings. The lighting needs to have different scenes, as well as be highly reactive to the daylight that will influence the space through the glazing that makes up almost the entirety of the southern façade. An additional scene with high light levels needs to exist in order to facilitate the wait staff' in cleaning up at the end of the night.

Restaurant Control Schedule			
Type	Manufacturer	Product	Description
LMLS-305	Wattstopper	LightSaver Photocell	Closed loop photosensor provides the daylight data necessary for operation.
LMRC-301	Wattstopper	LightSaver Room Dimming Controller	Provides automatic dimming control for multi-zone dimming control.
LMSW-105	Wattstopper	LightSaver Digital 5-Button Scene Switch	Allows occupant control by accessing four of the 16 scenes available on the local DLM network.

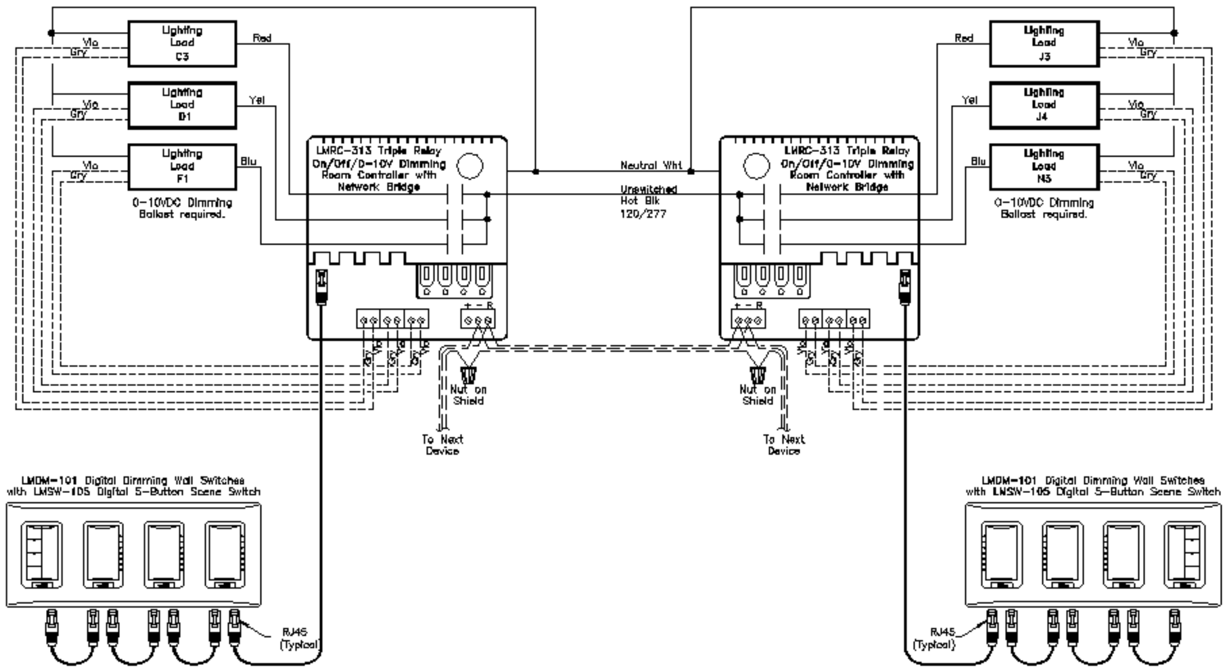


figure 26 – restaurant control diagram

panelboards

Below are the existing panelboard schedules for 208Y/120V normal dimming lighting panel NDP-L and 208Y/120V emergency lighting panel GDP-L. Both panels are located in the first floor restaurant electrical room. Modified circuits are indicated with a green box.

existing

NORMAL DIMMING PANEL SCHEDULE "NDP-L"

VOLTS: 208/120V PHASE: 3 LOCATION: ELECTRICAL ROOM SHORT CIRCUIT RATING: 10 kAIC
AMPS: 175A MLO WIRE: 4 MOUNTING: SURFACE TOTAL CONNECTED LOAD: 11.8 kVA

CIR. NO.	DESCRIPTION	LOAD VOLT AMP	WIRE SIZE	CIRCUIT BKR.		CIRCUIT BKR.		WIRE SIZE	LOAD VOLT AMP	DESCRIPTION	CIR. NO.
				AMPS	POLES	AMPS	POLES				
1	TRACK LIGHTING – ELEC LOW VOLTAGE – PDR BAR	1417	#12	20	1	20	1	#12	1200	EXTERIOR SIGNAGE – SWITCHING ONLY	13
2	PENDANT LIGHTING – INCANDESCENT – UPPER DINING	300	#12	20	1	20	1	#12	1200	EXTERIOR SIGNAGE – SWITCHING ONLY	14
3	DOWN LIGHTING – ELEC LOW VOLTAGE – UPPER DINING	450	#12	20	1	20	1			SPARE	15
4	PENDANT LIGHTING – INCANDESCENT – DINING	900	#12	20	1	20	1			SPARE	16
5	ROPE LIGHTING – LED – PATIO BAR	100	#12	20	1	20	1	#12	316	TRACK LIGHTING – ELEC LOW VOLTAGE – REAR BAR AREA	17
6	ROPE LIGHTING – LED – PDR BAR	100	#12	20	1	20	1			SPARE	18
7	PENDANT LIGHTING – INCANDESCENT – TOILET CORRIDOR	240	#12	20	1	20	1	#12	360	PENDANT LIGHTING – INCANDESCENT – PDR/ LOUNGE	19
8	DOWN LIGHTING – ELEC LOW VOLTAGE – DINNIG	1800	#12	20	1	20	1	#12	211	TRACK LIGHTING – ELEC LOW VOLTAGE – PDR/ LOUNGE	20
9	DOWN LIGHTING – ELEC LOW VOLTAGE – BAR AREA	369	#12	20	1	20	1	#12	480	PENDANT LIGHTING – INCANDESCENT – BAR	21
10	EXTERIOR SCONCES – HALOGEN – PATIO FREEZER WALL	50	#12	20	1	20	1	#12	100	ROPE LIGHTING – LED – PDR BAR AREA COVE	22
11	DOWN LIGHTING – ELEC LOW VOLTAGE – BAR AREA	1350	#12	20	1	20	1			SPARE	23
12	SPARE		#12	20	1	20	1	#12	900	DOWN LIGHTING – ELEC LOW VOLTAGE – BAR AREA ALCOVE	24

PANELBOARD NOTES:

1. THIS PANEL SHALL BE LUTRON "GRAFIK" SYSTEMS TYPE "LCP128" SPEC GRADE SERIES, MODEL #LCP24-1204-ML-20 WITH 20A BREAKERS (OR APPROVED EQUAL).
2. THIS PANEL SHALL BE FURNISHED WITH DUAL TAP LUGS.
3. THE LOAD SHOWN ON THIS PANEL INCLUDES THE LOAD FROM PANEL "DPL2-L"

GENERATOR DIMMING PANEL SCHEDULE "GDP-L"

VOLTS: 208/120V PHASE: 3 LOCATION: ELECTRICAL ROOM SHORT CIRCUIT RATING: 10 kAIC
AMPS: 175A MLO WIRE: 4 MOUNTING: SURFACE TOTAL CONNECTED LOAD: 6.1 kVA

CIR. NO.	DESCRIPTION	LOAD VOLT AMP	WIRE SIZE	CIRCUIT BKR.		CIRCUIT BKR.		WIRE SIZE	LOAD VOLT AMP	DESCRIPTION	CIR. NO.
				AMPS	POLES	AMPS	POLES				
1	TRACK LIGHTING – ELEC LOW VOLTAGE – UPPER DINING	221	#12	20	1	20	1	#12	105	DOWN LIGHTING – ELEC LOW VOLTAGE – BAR AREA ALCOVE	9
2	TRACK LIGHTING – ELEC LOW VOLTAGE – DINING	1032	#12	20	1	20	1	#12	421	DOWN LIGHTING – ELEC LOW VOLTAGE – DINING	10
3	TRACK LIGHTING – ELEC LOW VOLTAGE – BAR AREA	663	#12	20	1	20	1	#12	900	DOWN LIGHTING – ELEC LOW VOLTAGE – PATIO BAR	11
4	TRACK LIGHTING – ELEC LOW VOLTAGE – LOBBY	111	#12	20	1	20	1	#12	50	SCONCE LIGHTING – HALOGEN – PATIO BAR	12
5	TRACK LIGHTING – ELEC LOW VOLTAGE – BAR AREA	316	#12	20	1	20	1			SPARE	13
6	DOWN LIGHTING – ELEC LOW VOLTAGE – LOBBY	474	#12	20	1	20	1			SPARE	14
7	MONOPOINT LIGHTING – ELEC LOW VOLTAGE – BAR	526	#12	20	1	20	1			SPARE	15
8	DOWN LIGHTING – ELEC LOW VOLTAGE – PDR/ LOUNGE	1326	#12	20	1	20	1			SPARE	16

PANELBOARD NOTES:

1. THIS PANEL SHALL BE LUTRON "GRAFIK" SYSTEMS TYPE "LCP128" SPEC GRADE SERIES, MODEL #LCP16-1204-ML-20 WITH 20A BREAKERS (OR APPROVED EQUAL).

circuiting calculations

Each circuit was recalculated based on the new lighting load. For a voltage of 120 on 20A circuits, recommended engineering practice designates 1.54 KVA per circuit. All three of the lobby circuits adhere to these guidelines.

Emergency Dimming Panel GDP-L			
Circuit #	Type	Quantity	KVA
1	C3	16	.80
Total kVA			.80
2	C3	15	.75
Total kVA			.75
3	F1	24	.84
Total kVA			.84
5	F1	24	.84
Total kVA			.84

Normal Dimming Panel NDP-L			
Circuit #	Type	Quantity	KVA
1	B1	1	1.2
Total kVA			1.2
2	C3	8	.4
Total kVA			.4
3	D1	11	.39
Total kVA			.39
4	D1	11	.39
Total kVA			.39
8	D1	16	.58
Total kVA			.58
9	J3	50’	.27
Total kVA			.27
11	J4	198’	.89
Total kVA			.89
21	J4	198’	.89
Total kVA			.89
24	J4	199’	.90
Total kVA			.90

The redesigned panelboard schedule for Panels NDP-L and GDP-L are provided below with their corresponding panelboard sizing worksheets. Modified circuits are indicated with a green box.

PANELBOARD SCHEDULE

VOLTAGE: 208Y/120V,3PH,4W SIZE/TYPE BUS: 80A SIZE/TYPE MAIN: 80A/3P C/B	PANEL TAG: NDP-L PANEL LOCATION: RESTAURANT ELEC ROOM PANEL MOUNTING: SURFACE	MIN. C/B AIC: 10K OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
HAL PENDANT	BAR	1200	20A/1P	1	*			2	20A/1P	333	BAR	HAL DWNLT
FLUOR COVE	REST PER	371	20A/1P	3		*		4	20A/1P	333	REST PER	FLUOR COVE
LED ROPE LTG	PATIO	950	20A/1P	5			*	6	20A/1P	950	PATIO	LED ROPE LTG
INCAN PENDANT	RESTROOM	240	20A/1P	7	*			8	20A/1P	551	REST PER	FLUOR COVE
LED COVE	BAR	257	20A/1P	9		*		10	20A/1P	500	PATIO	HAL SCONCES
LED ACCENT COVE	REST CEILING	846	20A/1P	11			*	12	20A/1P	618	-	SPARE
SIGNAGE	EXTERIOR	1140	20A/1P	13	*			14	20A/1P	1140	EXTERIOR	SIGNAGE
SPARE	-	618	20A/1P	15		*		16	20A/1P	618	-	SPARE
TRACK LIGHTING	REAR BAR	1500	20A/1P	17			*	18	20A/1P	618	-	SPARE
INCAN PENDANT	PDR/LOUNGE	360	20A/1P	19	*			20	20A/1P	1500	PDR/LOUNGE	LV TRACK LTG
LED ACCENT COVE	REST CEILING	846	20A/1P	21		*		22	20A/1P	95	PDR/LOUNGE	LED ROPE LTG
SPARE	-	618	20A/1P	23			*	24	20A/1P	855	REST CEILING	LED ACCENT COVE
SPACE		0	20A/1P	25	*			26	20A/1P	0	-	SPACE
SPACE	-	0	20A/1P	27		*		28	20A/1P	0	-	SPACE
SPACE	-	0	20A/1P	29			*	30	20A/1P	0	-	SPACE

CONNECTED LOAD (KW) - A Ph.	6.53	TOTAL DESIGN LOAD (KW)	21.45
CONNECTED LOAD (KW) - B Ph.	3.67	POWER FACTOR	0.97
CONNECTED LOAD (KW) - C Ph.	6.95	TOTAL DESIGN LOAD (AMPS)	62

PANELBOARD SIZING WORKSHEET

Panel Tag-------------------------->	NDP-L	Panel Location:	RESTAURANT ELEC ROOM
Nominal Phase to Neutral Voltage------->	120	Phase:	3
Nominal Phase to Phase Voltage-------->	208	Wires:	4

Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks
1	A	HAL PENDANT	1	BAR	1.2	KVA	1.00	1200	1200	
2	A	HAL DWNLT	1	BAR	0.4	KVA	1.00	400	400	
3	B	FLUOR COVE	1	REST PER	0.39	KVA	0.95	371	390	
4	B	FLUOR COVE	1	REST PER	0.39	KVA	0.95	371	390	
5	C	LED ROPE LTG	1	PATIO	1	KVA	0.95	950	1000	
6	C	LED ROPE LTG	1	PATIO	1	KVA	0.95	950	1000	
7	A	INCAN PENDANT	1	RESTROOM	0.24	KVA	1.00	240	240	
8	A	FLUOR COVE	1	REST PER	0.58	KVA	0.95	551	580	
9	B	LED COVE	1	BAR	0.27	KVA	0.95	257	270	
10	B	HAL SCONCES	1	PATIO	0.5	KVA	1.00	500	500	
11	C	LED ACCENT COVE	1	REST CEILING	0.89	KVA	0.95	846	890	
12	C	SPARE	2	-	0.65	KVA	0.95	618	650	
13	A	SIGNAGE	1	EXTERIOR	1.2	KVA	0.95	1140	1200	
14	A	SIGNAGE	1	EXTERIOR	1.2	KVA	0.95	1140	1200	

15	B	SPARE	2	-	0.65	KVA	0.95	618	650		
16	B	SPARE	2	-	0.65	KVA	0.95	618	650		
17	C	TRACK LIGHTING	1	REAR BAR	1.5	KVA	1.00	1500	1500		
18	C	SPARE	2	-	0.65	KVA	0.95	618	650		
19	A	INCAN PENDANT	1	PDR/LOUNGE	0.36	KVA	1.00	360	360		
20	A	LV TRACK LTG	1	PDR/LOUNGE	1.5	KVA	1.00	1500	1500		
21	B	LED ACCENT COVE	1	REST CEILING	0.89	KVA	0.95	846	890		
22	B	LED ROPE LTG	1	PDR/LOUNGE	0.1	KVA	0.95	95	100		
23	C	SPARE	2	-	0.65	KVA	0.95	618	650		
24	C	LED ACCENT COVE	1	REST CEILING	0.9	KVA	0.95	855	900		
25	A	SPACE	3		0	W	1.00	0	0		
26	A	SPACE	3		0	W	1.00	0	0		
27	B	SPACE	3		0	W	1.00	0	0		
28	B	SPACE	3		0	W	1.00	0	0		
29	C	SPACE	3		0	W	1.00	0	0		
30	C	SPACE	3		0	W	1.00	0	0		
PANEL TOTAL								17.2	17.8	Amps=	49.3
PHASE LOADING								kW	kVA	%	Amps
PHASE TOTAL			A					6.5	6.7	38%	18.6
PHASE TOTAL			B					3.7	3.8	22%	10.7
PHASE TOTAL			C					7.0	7.2	41%	20.1
LOAD CATEGORIES				Connected			Demand				Ver. 1.04
				kW	kVA	DF	kW	kVA	PF		
1	LIGHTING			14.1	14.5		14.1	14.5	0.97		
2	SPARE			3.1	3.3		3.1	3.3	0.95		
3	SPACE			0.0	0.0		0.0	0.0			
Total Demand Loads							17.2	17.8			
Spare Capacity				25%			4.3	4.4			
Total Design Loads							21.4	22.2	0.97	Amps=	61.7

PANELBOARD SCHEDULE

VOLTAGE: 208Y/120V,3PH,4W
SIZE/TYPE BUS: 60A
SIZE/TYPE MAIN: 60A/3P C/B

PANEL TAG: GDP-L
PANEL LOCATION: RESTAURANT ELEC ROOM
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 10K
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
HAL DWNLT	REST	800	20A/1P	1	*			2	20A/1P	333	REST	HAL DWNLT
HAL CABLE	REST PER	840	20A/1P	3		*		4	20A/1P	333	LOBBY	LV TRACK
HAL CABLE	REST PER	840	20A/1P	5			*	6	20A/1P	480	LOBBY	LV DWNLTS
SPARE	-	618	20A/1P	7	*			8	20A/1P	1300	PDR/LOUNGE	LV DWNLTS
SPARE	-	618	20A/1P	9		*		10	20A/1P	618	-	SPARE
LV DWNLTS	REST CEILING	650	20A/1P	11			*	12	20A/1P	500	-	HAL SCONCE
SPARE	EXTERIOR	618	20A/1P	13	*			14	20A/1P	618	EXTERIOR	SPARE
SPARE	-	618	20A/1P	15		*		16	20A/1P	618	-	SPARE

CONNECTED LOAD (KW) - A Ph.	4.75	TOTAL DESIGN LOAD (KW)	13.30
CONNECTED LOAD (KW) - B Ph.	3.42	POWER FACTOR	0.98
CONNECTED LOAD (KW) - C Ph.	2.47	TOTAL DESIGN LOAD (AMPS)	38

PANELBOARD SIZING WORKSHEET

Panel Tag------------------------->	GDP-L	Panel Location:	RESTAURANT ELEC ROOM
Nominal Phase to Neutral Voltage------->	120	Phase:	3
Nominal Phase to Phase Voltage-------->	208	Wires:	4

Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks
1	A	HAL DWNLT	1	REST	0.8	KVA	1.00	800	800	
2	A	HAL DWNLT	1	REST	0.8	KVA	1.00	800	800	
3	B	HAL CABLE	1	REST PER	0.84	KVA	1.00	840	840	
4	B	LV TRACK	1	LOBBY	0.11	KVA	1.00	110	110	
5	C	HAL CABLE	1	REST PER	0.84	KVA	1.00	840	840	
6	C	LV DWNLTS	1	LOBBY	0.48	KVA	1.00	480	480	
7	A	SPARE	1	-	0.65	KVA	0.95	618	650	
8	A	LV DWNLTS	1	PDR/LOUNGE	1.3	KVA	1.00	1300	1300	
9	B	SPARE	2	-	0.65	KVA	0.95	618	650	
10	B	SPARE	2	-	0.65	KVA	0.95	618	650	
11	C	LV DWNLTS	1	BAR	0.65	KVA	1.00	650	650	
12	C	HAL SCONCE	1	PATIO	0.5	KVA	1.00	500	500	
13	A	SPARE	2	-	0.65	KVA	0.95	618	650	
14	A	SPARE	2	-	0.65	KVA	0.95	618	650	
15	B	SPARE	2	-	0.65	KVA	0.95	618	650	
16	B	SPARE	2	-	0.65	KVA	0.95	618	650	
PANEL TOTAL								10.6	10.9	Amps= 30.2

PHASE LOADING		kW	kVA	%	Amps
PHASE TOTAL	A	4.8	4.9	45%	13.5
PHASE TOTAL	B	3.4	3.6	33%	9.9
PHASE TOTAL	C	2.5	2.5	23%	6.9

LOAD CATEGORIES			Connected			Demand				Ver. 1.04
			kW	kVA	DF	kW	kVA	PF		
1	LIGHTING		6.9	7.0		6.9	7.0	1.00		
2	SPARE		3.7	3.9		3.7	3.9	0.95		
3	SPACE		0.0	0.0		0.0	0.0			
Total Demand Loads						10.6	10.9			
Spare Capacity			25%			2.7	2.7			
Total Design Loads						13.3	13.6	0.98	Amps=	37.7

feeder sizing

NDP-L	
Voltage	208Y/120
Design Load (KW)	21.4
Power Factor	0.97
Calculated Design Load (Amps)	61.7
Feeder Protection Size (Amps)	80
Sets	1
Wire Sizes	
Phase	4
Neutral	4
Ground	8
Conduit Size	1 1/4"

GDP-L	
Voltage	208Y/120
Design Load (KW)	13.3
Power Factor	0.98
Calculated Design Load (Amps)	37.7
Feeder Protection Size (Amps)	60
Sets	1
Wire Sizes	
Phase	6
Neutral	6
Ground	10
Conduit Size	1"

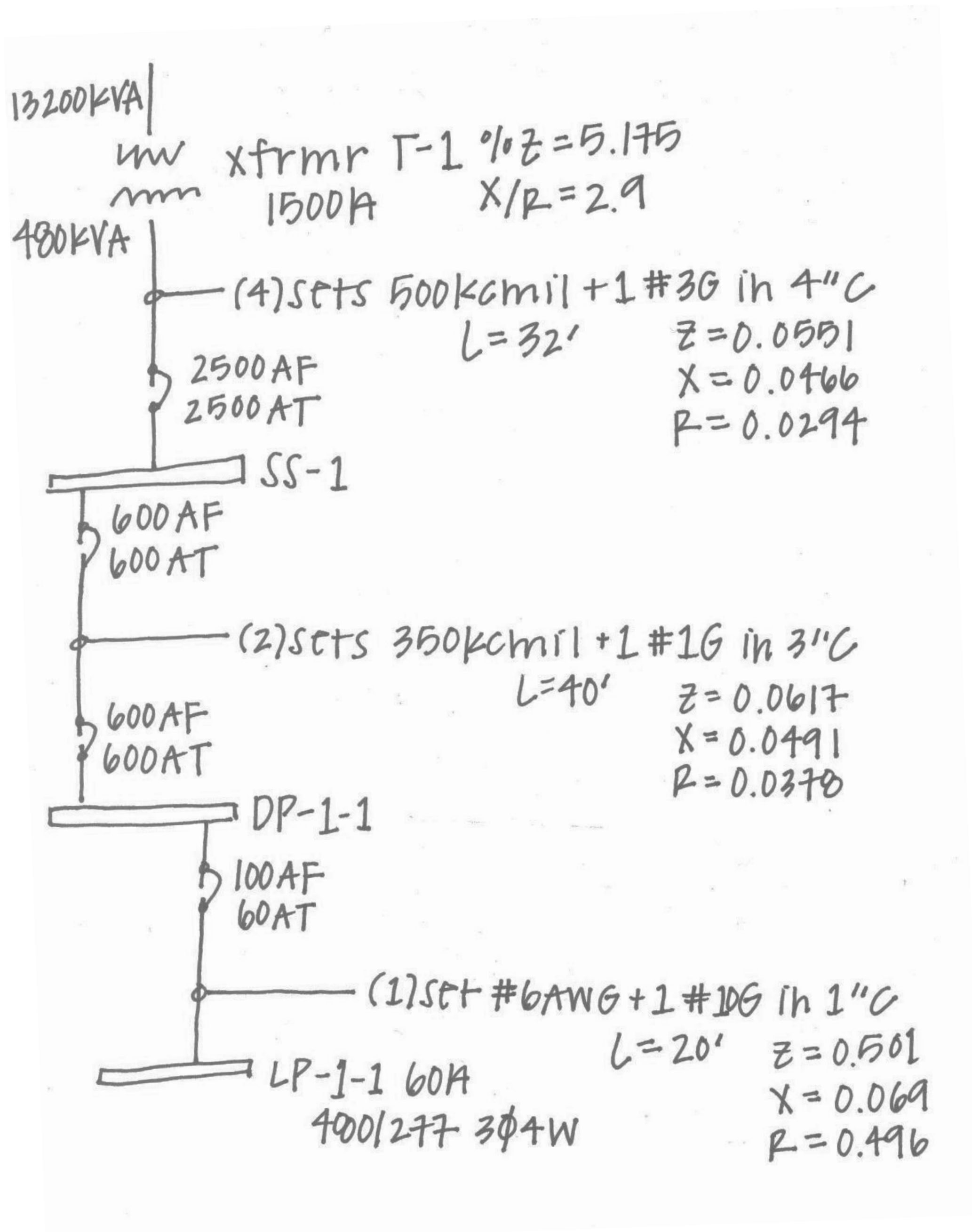
voltage drop calculations

VOLTAGE DROP – NDP-L	
Voltage (V)	208
Ampacity (I)	85
Power Factor (See Note 1)	.95
Wire Size (14,12,10 ... 1/0, 2/0 ... 250,350)	4
# of conductors per phase	1
Type Conductor (A=Aluminum C=Copper)	C
Type Conduit (P=PVC; A=Aluminum S=Steel)	S
Length of Run (ft)	20
Voltage Drop	***0.92***
% Drop	***0.44***

VOLTAGE DROP – GDP-L	
Voltage (V)	208
Ampacity (I)	65
Power Factor (See Note 1)	.95
Wire Size (14,12,10 ... 1/0, 2/0 ... 250,350)	6
# of conductors per phase	1
Type Conductor (A=Aluminum C=Copper)	C
Type Conduit (P=PVC; A=Aluminum S=Steel)	A
Length of Run (ft)	20
Voltage Drop	***1.09***
% Drop	***0.53***

protective device coordination study and short circuit analysis

A protective device coordination study was conducted along a single path of the electrical distribution system, extending from the utility entrance through the main switchboard to distribution panel DP-1-1, and down to panel LP-1-1 (see Figure below). For the 2500A, two 600A, and 60A circuit breakers, the trip curves were superimposed to determine whether the devices were correctly coordinated. Calculation of the short circuit current at each step along the distribution path and determined standard AIC rating are shown in the tables on the following pages.

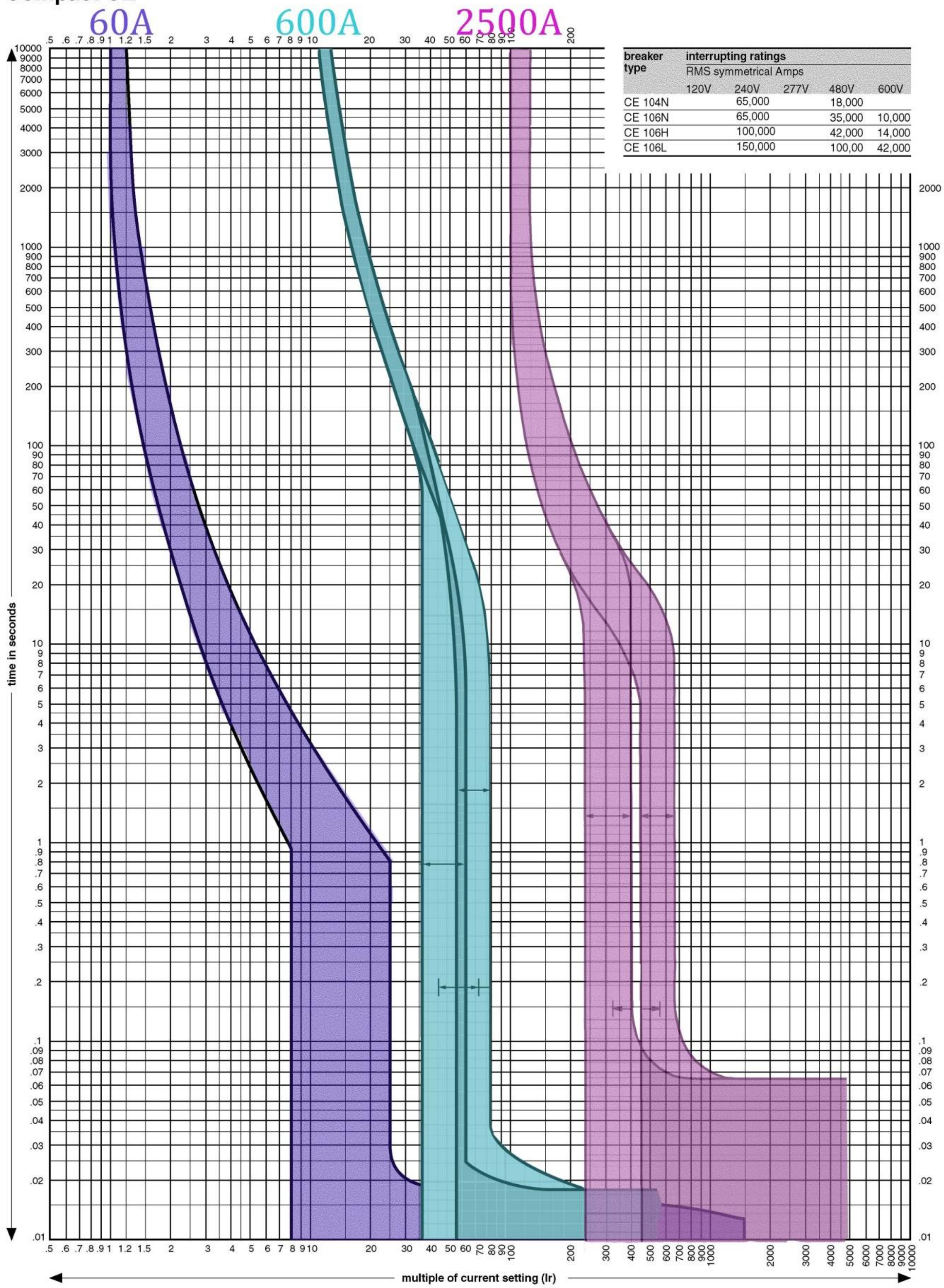


Fault Current Analysis (Per Unit Method)							
Utility Transformer Base kVA			13,200	ΣX	ΣR	ΣZ	I_{sc} (A)
Available Utility Fault (kVA)			100,000				
System kV			0.48				
Utility Transformer Primary							
		X(p.u.) = KVAbase / Utility S.C. KVA =	0.132				4,373
		R(p.u.) =	0				
Utility Transformer Secondary							
%Z =	5.175	X(p.u.) = %X * kVAbase / 100 * kVA_{xfrmr} =	0.326	0.426	0.112	0.463	27,038
Avg. X/R =	2.9	R(p.u.) = %R * kVAbase / 100 * kVA_{xfrmr} =	0.112				
%X =	4.89						
%R =	1.68						
kVA_{xfrmr} =	1,500						
Unit Substation SS-1							
Wire =	500	X = (L/1,000) * XL * (1/sets) =	0.0162	0.442	0.123	0.464	13,234
Length =	32'	R = (L/1,000) * RL * (1/sets) =	0.0102				
Sets =	4						
X =	0.0466						
R =	0.0294						
Main Distribution Panel DP-1-1							
Wire =	350	X = (L/1,000) * XL * (1/sets) =	0.0426	0.458	0.133	0.483	8,431
Length =	40'	R = (L/1,000) * RL * (1/sets) =	0.0328				
Sets =	2						
X =	0.0491						
R =	0.0378						
Branch Circuit Lighting Panel LP-1-1							
Wire =	6	X = (L/1,000) * XL * (1/sets) =	0.0594	0.518	0.563	0.918	5,130
Length =	20'	R = (L/1,000) * RL * (1/sets) =	0.5178				
Sets =	1						
X =	0.0685						
R =	0.496						

Fault Current Analysis Summary		
Switchgear	**Available Fault (A)**	**Standard Breaker Rating (A)**
Utility Transformer Secondary	27,038	35,000
Substation SS-1	13,234	18,000
Distribution Panel DP-1-1	8,431	14,000
Lighting Panel LP-1-1	5,130	14,000

molded case circuit breakers
Compact CE

40-60 Amp
3 pole



breaker type	interrupting ratings RMS symmetrical Amps				
	120V	240V	277V	480V	600V
CE 104N		65,000		18,000	
CE 106N		65,000		35,000	10,000
CE 106H		100,000		42,000	14,000
CE 106L		150,000		100,00	42,000

MERLIN GERIN oct. 91

conclusion

According to the over-current protection analysis, the breakers along the selected path are coordinated correctly. For an instantaneous fault there is some overlap, however they are offset enough that they should still trip in consecutive order. If there is a spike high enough to instantaneously trip all devices along this distribution, all of the equipment will be taken out regardless. Two 600A breakers of the same size between two switchgear elements could cause some shortage overlap, but no matter which one trips first, the equipment upstream will be protected.

depth one: kinetic energy harnessing system

Kinetic energy is being constantly generated. Most circumstances make it uneconomical to harness due to inconsistent generation or difficult collection. At a fitness center, people are there specifically to create kinetic energy, providing the perfect opportunity to capture a large amount of kinetic energy. The proposed system will harness human energy and convert it into usable electricity to power an LED component of the lighting system. Additional energy will be transferred directly to the utility grid via a utility interactive and the AC main panel.

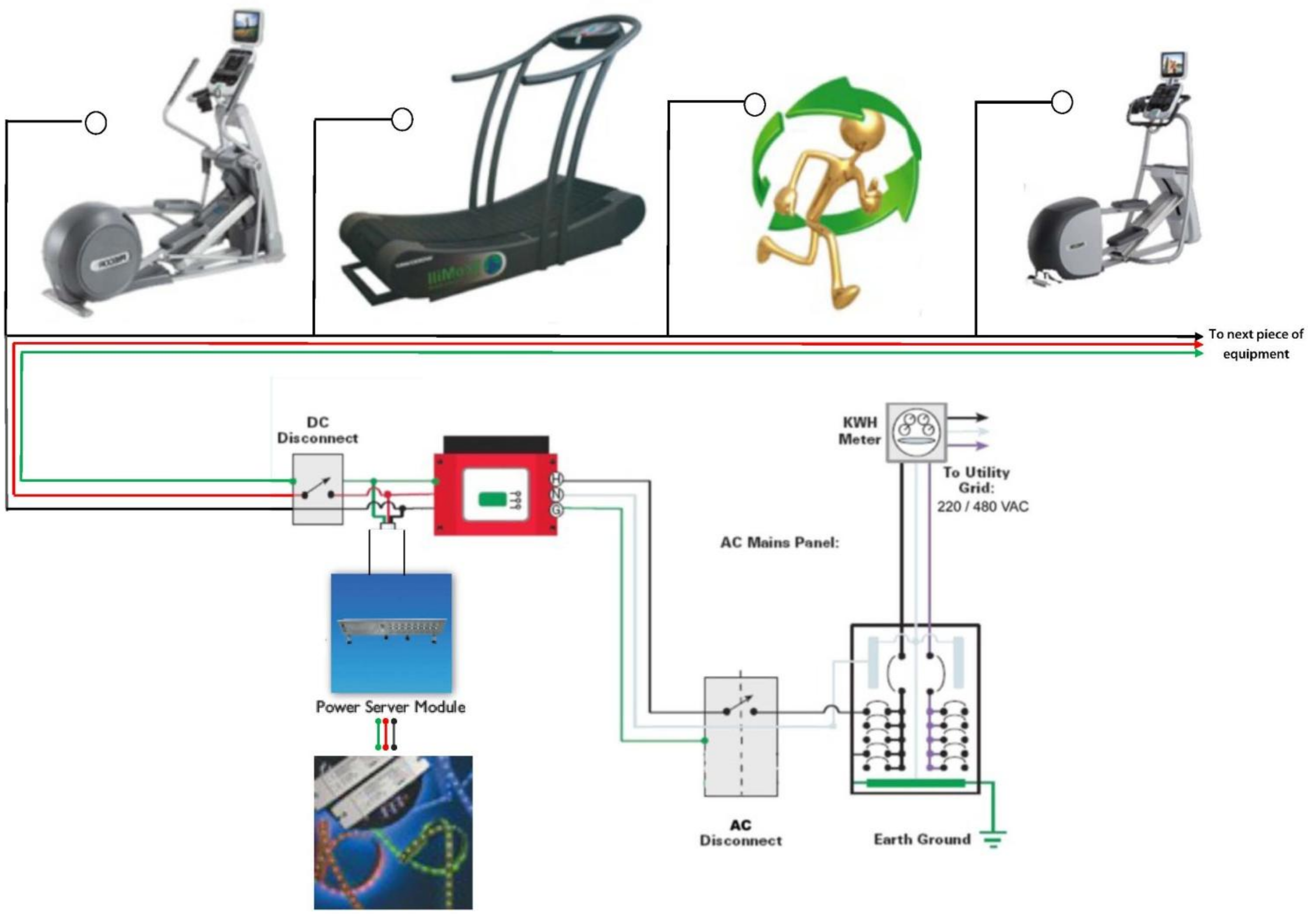
design concept

Sasaki Associates took care to expose the core energy of the building. The facility is fueled by the energy of the occupants as they move within the space just as the body is fueled by core energy during a workout. The minimalist design of the architecture with its structurally exposed concrete, straight lines, clean materials, and strong angles allow the energy and active users to become the feature of the space.

A bright, uniform lighting layout will create a spacious, energizing environment for the occupants within the fitness center. To further reinforce the energy of the building, a blue uplight LED component will be added to the linear fixtures throughout the space so that the energy being exerted is actually visible both to those creating it and to those viewing the fitness center from the exterior. The fluorescent component is controlled by photocell, but the glowing energy created by the exercisers will be visible even during the day when the remainder of the lighting is turned off in the space.

system overview

ReRev™ is a patent-pending system that converts human energy into a usable form of renewable energy. It substitutes the typical fan that disperses excess heat from cardio equipment into the space with a small generator and CPU that converts the power to utility grade electricity. Each outfit feeds through a central processing unit which then feeds through the inverter tapped directly into the AC mains panel. The processing units are prepared to handle up to twenty-five machines without overload, so there will be separate processor on each floor of the fitness center. ReRev is currently designed to equip Precor elliptical machines and Ecomill self-powered treadmills with a converter to harness, regulate, and disperse the power in a practical electric form that will be used to power the LEDs. The sample wiring diagram on the following page shows a configuration in which DC power will be tied directly to the LEDs before carrying the remaining power to the grid. A Nextek Power Server Module can accept 24-24.5VDC at a maximum of 65A and provides modulated consistent quality power to the LED lighting load.



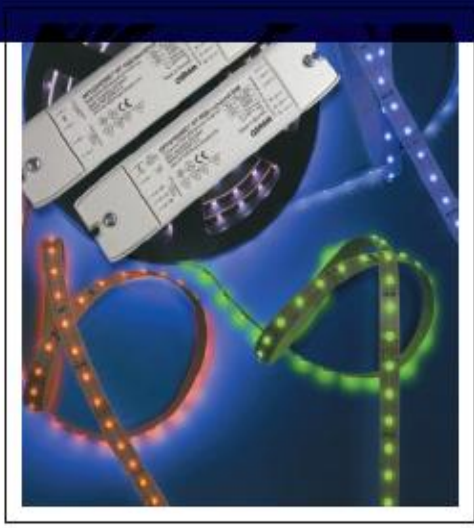
The average 30 minute elliptical workout produces 50 watt-hours of energy, while the average treadmill workout produces up to 100 watt-hours. The blue LEDs will only be lit while the energy is being produced, and so all excess energy will be utilized elsewhere throughout the power system.

Sylvania LINEARlight FLEX Top Colormix, a flexible colormixing LED module, will be fixed directly to the linear Lightolier fixtures. Full cutsheets for both the lighting tape and linear fixture are found in Appendix A.

www.sylvania.com

LINEARlight FLEX® Top Colormix

Flexible Colormixing LED Module



Key Features & Benefits

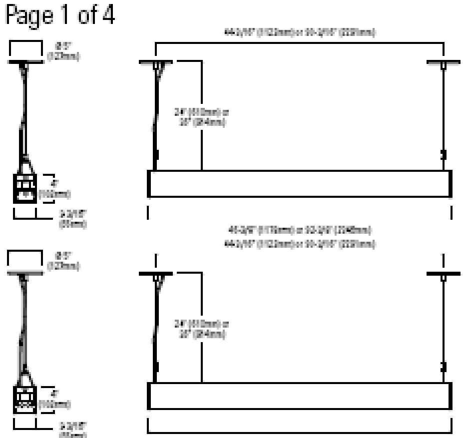
- Flexible circuit board with self-adhesive backing allows for easy installation in complex contours
- Low profile module enables mounting in compact spaces
- Each Multi LED contains an individually powered red, green and blue chip; this unique method of colormixing achieves excellent color consistency and uniformity
- 13 foot module decreases complexity of wiring and programming simplifying installation for long linear runs
- Modules can be field cut to 7.9 inches (20mm) to achieve a customized fit
- LEDs are closely spaced to minimize hot spots in shallow installations
- Dimmable by pulse width modulation, a method that maintains consistent lumen output and color

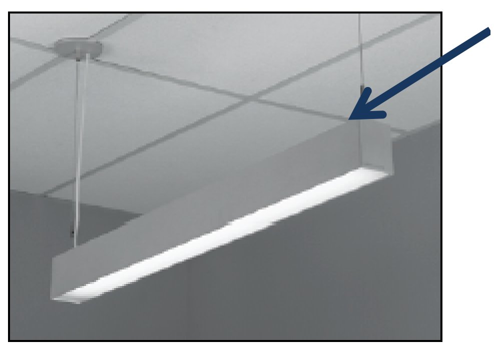
LIGHTOLIER

Spectral H-Profile Direct/Indirect Lens

Page 1 of 4

1 lamp T5 UP, 1 or 2 lamp T5 DOWN per 4' section





Flex light adheres here

Ordering information

Family	Luminaire Length	Pendant Finish	Optics	Wiring	Lamp Qty in a cross section	Lamp	Voltage	Ballast	Options
SL			K						
SL: Spectral H-Profile	4: 4'	W: Textured White finish	K: Flat Frosted Acrylic Lens Down / Indirect Up	S: Double Circuit Ready[1]	2	2: 28WT5	U: UNV, 120-277V	PG: Electronic Program Start T5/T5HO	E: T5/T5HO Emergency Lighting System (Canada) (n/a in 347V)
	8: 8'	A: Ano textured metallic paint finish		N: Double Circuit Network Ready (DALI or Dimming)	3	5: 54WT5HO	1: 120V	DA: IGEN DALI Adressable T5/T5HO (120V or 277V only)	D[1]: Double Switching
				I: Individual Feed			2: 277V	NW: IGEN EZ Sensor Integral Daylight Sensor Control with 1-10VDC ballast (120V or 277V only)	EM: T5/T5HO Emergency Lighting System (USA)
				G: Group Feed			3: 347V		

[1] Double Circuit Ready: all 2-lamp luminaires are shipped with single switching (one ballast). All 3-lamp luminaires are shipped with double switching (two ballasts).

The maximum luminaire length is 16’, so at 4w/ft the maximum LED power a machine would need to produce during a workout is 32 watt-hours (enough to illuminate the LEDs for the duration of the 30 minute workout) plus ten additional hours to power the machine itself.

If a treadmill workout were used at maximum capacity to produce 150 watt-hours, a workout could produce up to 112 watt-hours of power for usage elsewhere throughout the building!

conclusion

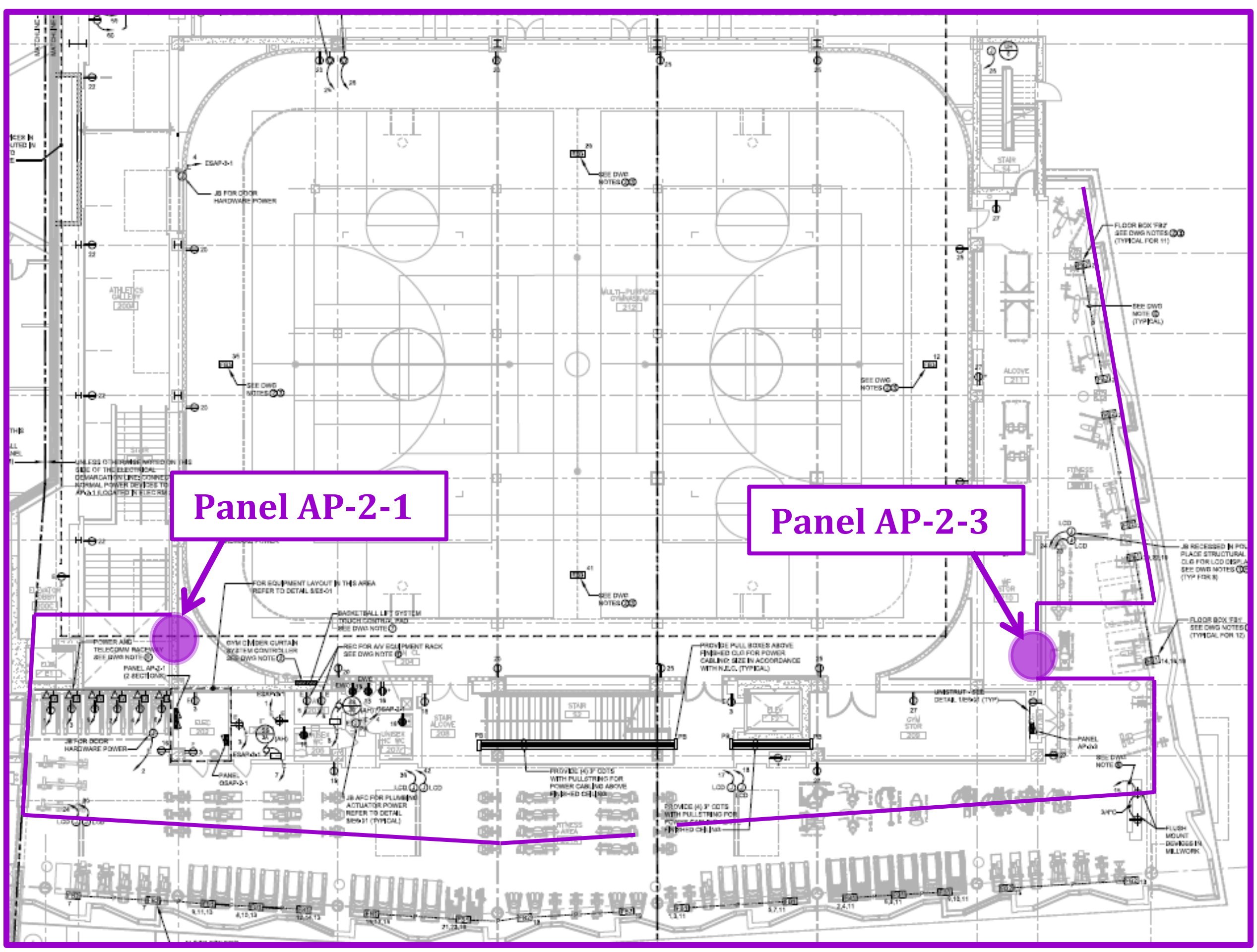
44 machines on the second floor and 20 machines on the floor will be installed using ReRev technology to power the colored component of the lighting fixtures. Remaining unutilized power will return energy to the power grid. Not only will this save Drexel money and provide an interesting and exciting visible component of energy production within this space, it will also give back to the students knowing that they are not only getting in shape, but helping the environment in a tangible way.

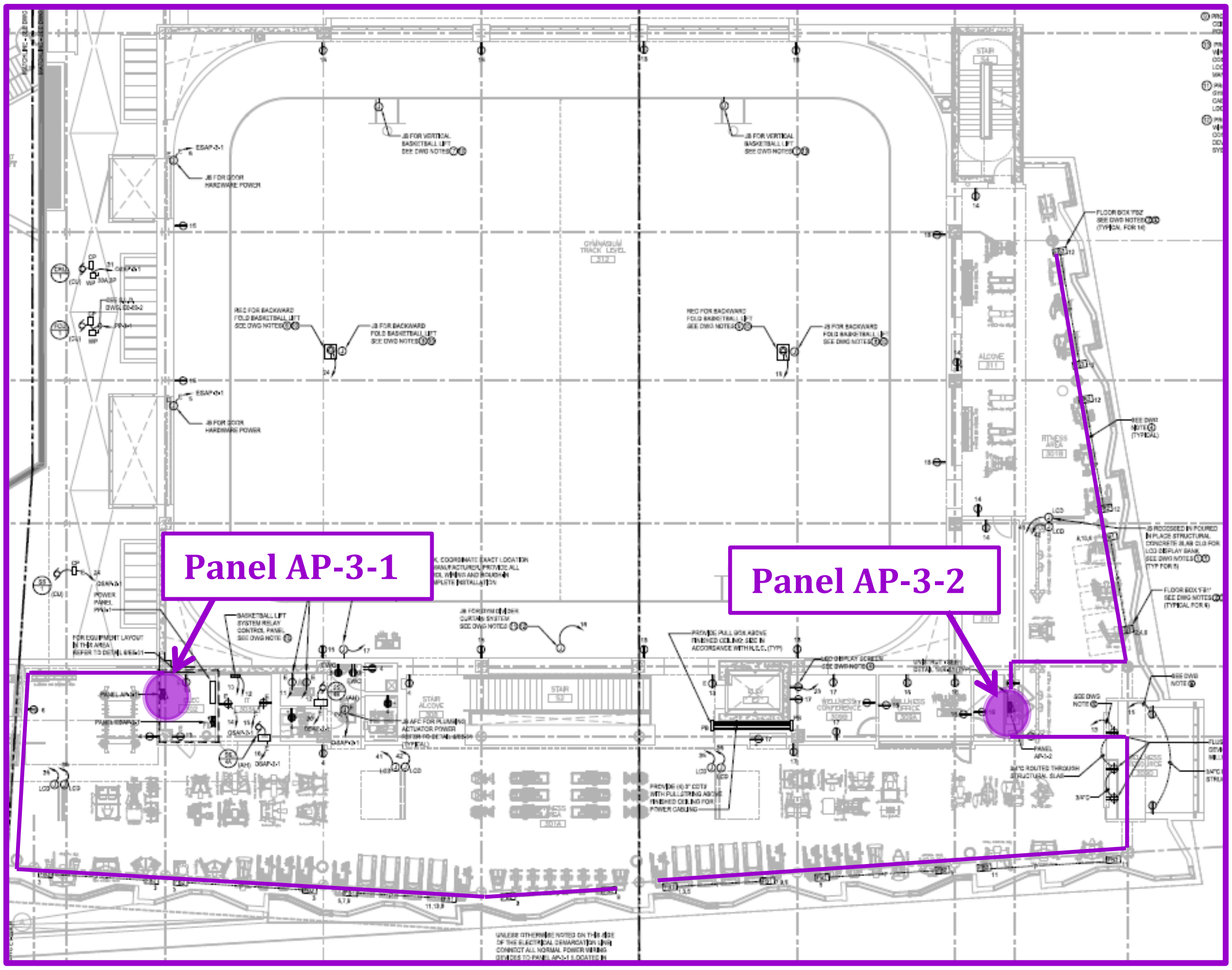
depth two: branch circuit cabling comparison

The existing branch circuiting distribution system in the DRC's fitness center utilizes PVC conduit with combination power and telecommunications boxes located within the floor slab. In order to provide flexibility in the fitness equipment layout, an economic analysis was performed comparing an alternative solution of exposed unventilated metal cable tray on the floors below with poke throughs in place of the floor boxes for the two cardio equipment circuits on the second and third floors. All costs are based on the RS Means Building Construction Cost Data 2011. The following pages show a detailed comparison of PVC conduit and unventilated metal cable tray.

design concept

Two panels on each floor handle all of the treadmill and cardio equipment loads: the figures below denote the locations of these panels and the respective conduit they feed. Additional equipment that is fed by wall-mounted receptacles is not considered in this analysis. Existing Wiremold floor boxes are cost compared with Wiremold recessed poke-thru devices for use with cable tray.





Panel AP-2-1	
Distance	160’
Elbow joints	3
Floor boxes	9
Cardio circuits served	13
Panel AP-2-3	
Distance	210’
Elbow joints	3
Floor boxes	13
Cardio circuits served	17

Panel AP-3-1	
Distance	160’
Elbow joints	3
Floor boxes	8
Cardio circuits served	10
Panel AP-3-2	
Distance	210’
Elbow joints	3
Floor boxes	12
Cardio circuits served	10

Cost Analysis #1 : Existing Branch Circuiting in PVC Conduit

LP-2-1										
Circuit	# of sets	Wire size – Phase	Wire Size – Neutral	Wire Size-Ground	Distance	Phase Cost/100'	Neutral Cost/100'	Ground Cost/100'	Conduit Cost/LF	Total Cost
7	1	12AWG	12AWG	10AWG	80	$48.45	$48.45	$59.50	-	$ 125.12
8	1	12AWG	12AWG	10AWG	97	$48.45	$48.45	$59.50	-	$ 151.71
9	1	12AWG	12AWG	10AWG	90	$48.45	$48.45	$59.50	-	$ 140.76
10	1	12AWG	12AWG	10AWG	97	$48.45	$48.45	$59.50	-	$ 151.71
11	1	12AWG	12AWG	10AWG	90	$48.45	$48.45	$59.50	-	$ 140.76
12	1	12AWG	12AWG	10AWG	105	$48.45	$48.45	$59.50	-	$ 164.22
13	2	12AWG	12AWG	10AWG	105	$48.45	$48.45	$59.50	-	$ 164.22
14	3	12AWG	12AWG	10AWG	105	$48.45	$48.45	$59.50	-	$ 164.22
15	4	12AWG	12AWG	10AWG	116	$48.45	$48.45	$59.50	-	$ 181.42
17	5	12AWG	12AWG	10AWG	116	$48.45	$48.45	$59.50	-	$ 181.42
19	6	12AWG	12AWG	10AWG	159	$48.45	$48.45	$59.50	-	$ 248.68
21	7	12AWG	12AWG	10AWG	132	$48.45	$48.45	$59.50	-	$ 206.45
23	8	12AWG	12AWG	10AWG	132	$48.45	$48.45	$59.50	-	$ 206.45
PVC Conduit in Concrete Slab: 13 sets of .5"					159	-	-	-	$2.21	$4,568.07

AP-2-3										
Circuit	# of sets	Wire size – Phase	Wire Size – Neutral	Wire Size-Ground	Distance	Phase Cost/100'	Neutral Cost/100'	Ground Cost/100'	Conduit Cost/LF	Total Cost
1	1	12AWG	12AWG	10AWG	119	$48.45	$48.45	$59.50	-	$ 186.12
2	1	12AWG	12AWG	10AWG	93	$48.45	$48.45	$59.50	-	$ 145.45
3	1	12AWG	12AWG	10AWG	119	$48.45	$48.45	$59.50	-	$ 186.12
4	1	12AWG	12AWG	10AWG	93	$48.45	$48.45	$59.50	-	$ 145.45
5	1	12AWG	12AWG	10AWG	102	$48.45	$48.45	$59.50	-	$ 159.53
6	1	12AWG	12AWG	10AWG	84	$48.45	$48.45	$59.50	-	$ 131.38
7	1	12AWG	12AWG	10AWG	102	$48.45	$48.45	$59.50	-	$ 159.53
8	1	12AWG	12AWG	10AWG	84	$48.45	$48.45	$59.50	-	$ 131.38
9	1	12AWG	12AWG	10AWG	77	$48.45	$48.45	$59.50	-	$ 120.43
10	1	12AWG	12AWG	10AWG	77	$48.45	$48.45	$59.50	-	$ 120.43
11	1	12AWG	12AWG	10AWG	119	$48.45	$48.45	$59.50	-	$ 186.12
13	1	12AWG	12AWG	10AWG	68	$48.45	$48.45	$59.50	-	$ 106.35
14	1	12AWG	12AWG	10AWG	32	$48.45	$48.45	$59.50	-	$ 50.05
16	1	12AWG	12AWG	10AWG	32	$48.45	$48.45	$59.50	-	$ 50.05
19	1	12AWG	12AWG	10AWG	50	$48.45	$48.45	$59.50	-	$ 78.20
20	1	12AWG	12AWG	10AWG	50	$48.45	$48.45	$59.50	-	$ 78.20
21	1	12AWG	12AWG	10AWG	102	$48.45	$48.45	$59.50	-	$ 159.53
22	1	12AWG	12AWG	10AWG	50	$48.45	$48.45	$59.50	-	$ 78.20
PVC Conduit in Concrete Slab: 18 sets of .5"					221	-	-	-	$2.21	$8,791.38

AP-3-1										
Circuit	# of sets	Wire size – Phase	Wire Size – Neutral	Wire Size-Ground	Distance	Phase Cost/100'	Neutral Cost/100'	Ground Cost/100'	Conduit Cost/LF	Total Cost
3	1	12AWG	12AWG	10AWG	107	$48.45	$48.45	$59.50	-	$ 167.35
5	1	12AWG	12AWG	10AWG	113	$48.45	$48.45	$59.50	-	$ 176.73
7	1	12AWG	12AWG	10AWG	113	$48.45	$48.45	$59.50	-	$ 176.73
9	1	12AWG	12AWG	10AWG	158	$48.45	$48.45	$59.50	-	$ 247.11
11	1	12AWG	12AWG	10AWG	130	$48.45	$48.45	$59.50	-	$ 203.32
13	1	12AWG	12AWG	10AWG	130	$48.45	$48.45	$59.50	-	$ 203.32
PVC Conduit in Concrete Slab: 6 sets of .5"					158	-	-	-	$2.21	$2,095.08

AP-3-2										
Circuit	# of sets	Wire size – Phase	Wire Size – Neutral	Wire Size-Ground	Distance	Phase Cost/100'	Neutral Cost/100'	Ground Cost/100'	Conduit Cost/LF	Total Cost
1	1	12AWG	12AWG	10AWG	121	$48.45	$48.45	$59.50	-	$ 189.24
2	1	12AWG	12AWG	10AWG	37	$48.45	$48.45	$59.50	-	$ 57.87
3	1	12AWG	12AWG	10AWG	121	$48.45	$48.45	$59.50	-	$ 189.24
4	1	12AWG	12AWG	10AWG	37	$48.45	$48.45	$59.50	-	$ 57.87
5	1	12AWG	12AWG	10AWG	102	$48.45	$48.45	$59.50	-	$ 159.53
6	1	12AWG	12AWG	10AWG	46	$48.45	$48.45	$59.50	-	$ 71.94
7	2	12AWG	12AWG	10AWG	105	$48.45	$48.45	$59.50	-	$ 164.22
8	3	12AWG	12AWG	10AWG	46	$48.45	$48.45	$59.50	-	$ 71.94
9	4	12AWG	12AWG	10AWG	105	$48.45	$48.45	$59.50	-	$ 164.22
10	5	12AWG	12AWG	10AWG	46	$48.45	$48.45	$59.50	-	$ 71.94
11	6	12AWG	12AWG	10AWG	70	$48.45	$48.45	$59.50	-	$ 109.48
12	7	12AWG	12AWG	10AWG	98	$48.45	$48.45	$59.50	-	$ 153.27
PVC Conduit in Concrete Slab: 12 sets of .5"					219	-	-	-	$2.21	$5,807.88

Total Cost: $21,262.41

Cost Analysis #2 : Closed bottom 6" aluminum cable tray

LP-2-1										
Circuit	# of sets	Wire size – Phase	Wire Size – Neutral	Wire Size-Ground	Distance	Phase Cost/100'	Neutral Cost/100'	Ground Cost/100'	Conduit Cost/LF	Total Cost
7	1	12AWG	12AWG	10AWG	80	$48.45	$48.45	$59.50	-	$ 125.12
8	1	12AWG	12AWG	10AWG	97	$48.45	$48.45	$59.50	-	$ 151.71
9	1	12AWG	12AWG	10AWG	90	$48.45	$48.45	$59.50	-	$ 140.76
10	1	12AWG	12AWG	10AWG	97	$48.45	$48.45	$59.50	-	$ 151.71
11	1	12AWG	12AWG	10AWG	90	$48.45	$48.45	$59.50	-	$ 140.76
12	1	12AWG	12AWG	10AWG	105	$48.45	$48.45	$59.50	-	$ 164.22
13	2	12AWG	12AWG	10AWG	105	$48.45	$48.45	$59.50	-	$ 164.22
14	3	12AWG	12AWG	10AWG	105	$48.45	$48.45	$59.50	-	$ 164.22
15	4	12AWG	12AWG	10AWG	116	$48.45	$48.45	$59.50	-	$ 181.42
17	5	12AWG	12AWG	10AWG	116	$48.45	$48.45	$59.50	-	$ 181.42
19	6	12AWG	12AWG	10AWG	159	$48.45	$48.45	$59.50	-	$ 248.68
21	7	12AWG	12AWG	10AWG	132	$48.45	$48.45	$59.50	-	$ 206.45
23	8	12AWG	12AWG	10AWG	132	$48.45	$48.45	$59.50	-	$ 206.45
Galvanized Steel Closed-Bottom Cable Tray: 6"					159	-	-	-	$ 19.15	$3,044.85

AP-2-3										
Circuit	# of sets	Wire size – Phase	Wire Size – Neutral	Wire Size-Ground	Distance	Phase Cost/100'	Neutral Cost/100'	Ground Cost/100'	Cable Tray Cost/LF	Total Cost
1	1	12AWG	12AWG	10AWG	119	$48.45	$48.45	$59.50	-	$ 186.12
2	1	12AWG	12AWG	10AWG	93	$48.45	$48.45	$59.50	-	$ 145.45
3	1	12AWG	12AWG	10AWG	119	$48.45	$48.45	$59.50	-	$ 186.12
4	1	12AWG	12AWG	10AWG	93	$48.45	$48.45	$59.50	-	$ 145.45
5	1	12AWG	12AWG	10AWG	102	$48.45	$48.45	$59.50	-	$ 159.53
6	1	12AWG	12AWG	10AWG	84	$48.45	$48.45	$59.50	-	$ 131.38
7	1	12AWG	12AWG	10AWG	102	$48.45	$48.45	$59.50	-	$ 159.53
8	1	12AWG	12AWG	10AWG	84	$48.45	$48.45	$59.50	-	$ 131.38
9	1	12AWG	12AWG	10AWG	77	$48.45	$48.45	$59.50	-	$ 120.43
10	1	12AWG	12AWG	10AWG	77	$48.45	$48.45	$59.50	-	$ 120.43
11	1	12AWG	12AWG	10AWG	119	$48.45	$48.45	$59.50	-	$ 186.12
13	1	12AWG	12AWG	10AWG	68	$48.45	$48.45	$59.50	-	$ 106.35
14	1	12AWG	12AWG	10AWG	32	$48.45	$48.45	$59.50	-	$ 50.05
16	1	12AWG	12AWG	10AWG	32	$48.45	$48.45	$59.50	-	$ 50.05
19	1	12AWG	12AWG	10AWG	50	$48.45	$48.45	$59.50	-	$ 78.20
20	1	12AWG	12AWG	10AWG	50	$48.45	$48.45	$59.50	-	$ 78.20
21	1	12AWG	12AWG	10AWG	102	$48.45	$48.45	$59.50	-	$ 159.53
22	1	12AWG	12AWG	10AWG	50	$48.45	$48.45	$59.50	-	$ 78.20
Galvanized Steel Closed-Bottom Cable Tray: 6"					221	-	-	-	$ 19.15	$ 4,232.15

AP-3-1										
Circuit	# of sets	Wire size – Phase	Wire Size – Neutral	Wire Size-Ground	Distance	Phase Cost/100'	Neutral Cost/100'	Ground Cost/100'	Cable Tray Cost/LF	Total Cost
3	1	12AWG	12AWG	10AWG	107	$48.45	$48.45	$59.50	-	$ 167.35
5	1	12AWG	12AWG	10AWG	113	$48.45	$48.45	$59.50	-	$ 176.73
7	1	12AWG	12AWG	10AWG	113	$48.45	$48.45	$59.50	-	$ 176.73
9	1	12AWG	12AWG	10AWG	158	$48.45	$48.45	$59.50	-	$ 247.11
11	1	12AWG	12AWG	10AWG	130	$48.45	$48.45	$59.50	-	$ 203.32
13	1	12AWG	12AWG	10AWG	130	$48.45	$48.45	$59.50	-	$ 203.32
Galvanized Steel Closed-Bottom Cable Tray: 6"					158	-	-	-	$ 19.15	$ 3,025.70

AP-3-2										
Circuit	# of sets	Wire size – Phase	Wire Size – Neutral	Wire Size-Ground	Distance	Phase Cost/100'	Neutral Cost/100'	Ground Cost/100'	Cable Tray Cost/LF	Total Cost
1	1	12AWG	12AWG	10AWG	121	$48.45	$48.45	$59.50	-	$ 189.24
2	1	12AWG	12AWG	10AWG	37	$48.45	$48.45	$59.50	-	$ 57.87
3	1	12AWG	12AWG	10AWG	121	$48.45	$48.45	$59.50	-	$ 189.24
4	1	12AWG	12AWG	10AWG	37	$48.45	$48.45	$59.50	-	$ 57.87
5	1	12AWG	12AWG	10AWG	102	$48.45	$48.45	$59.50	-	$ 159.53
6	1	12AWG	12AWG	10AWG	46	$48.45	$48.45	$59.50	-	$ 71.94
7	2	12AWG	12AWG	10AWG	105	$48.45	$48.45	$59.50	-	$ 164.22
8	3	12AWG	12AWG	10AWG	46	$48.45	$48.45	$59.50	-	$ 71.94
9	4	12AWG	12AWG	10AWG	105	$48.45	$48.45	$59.50	-	$ 164.22
10	5	12AWG	12AWG	10AWG	46	$48.45	$48.45	$59.50	-	$ 71.94
11	6	12AWG	12AWG	10AWG	70	$48.45	$48.45	$59.50	-	$ 109.48
12	7	12AWG	12AWG	10AWG	98	$48.45	$48.45	$59.50	-	$ 153.27
Galvanized Steel Closed-Bottom Cable Tray: 6"					219	-	-	-	$ 19.15	$ 4,193.85

Total Cost: $14,496.52

conclusion

Not only does specifying cable tray instead of conduit within the slab save money, it is also provides flexibility for the upgrade and/or rearranging of the fitness equipment on both the second and third floors. An architectural concern, six inch cable tray run along the windown will not be noticeable or unattractive, especially when considering the high ceiling heights and newly designed lighting in the lobby.

breadth one (MAE): daylighting

Gymnasiums are an ideal design space for daylight integration into the lighting system. Daylight is primarily introduced into the Drexel gymnasium by the façade glazing on the Northern wall. A redesign of the daylighting in the space created additional energy savings by incorporating skylights to increase uniformity and increase daylight penetration further in the space. The integration of daylighting into my gymnasium is the study that involves coursework specific to the M.A.E. program. Techniques and information learned in AE 565 – "Daylighting", taught by Dr. Richard Mistrick, will be applied to the study and analysis of the daylight in the space. The Daysim computer software is able to perform annual energy studies and calculate energy savings from a dimming system utilizing daylight sensors, taking into account real-time annual sky condition data.

description

The bi-level gymnasium is located on the second and third floors of the Northern face of the Athletic Center addition and can be entered from the fitness area, or for special events from the courtyard. The space serves as the practice facility for the Drexel Dragons basketball team and has an elevated running track around the perimeter of the second level. The northern wall is composed almost entirely of glass providing natural light to the space. The gymnasium measures 103 x 130' and spans a total of 13,420sf.

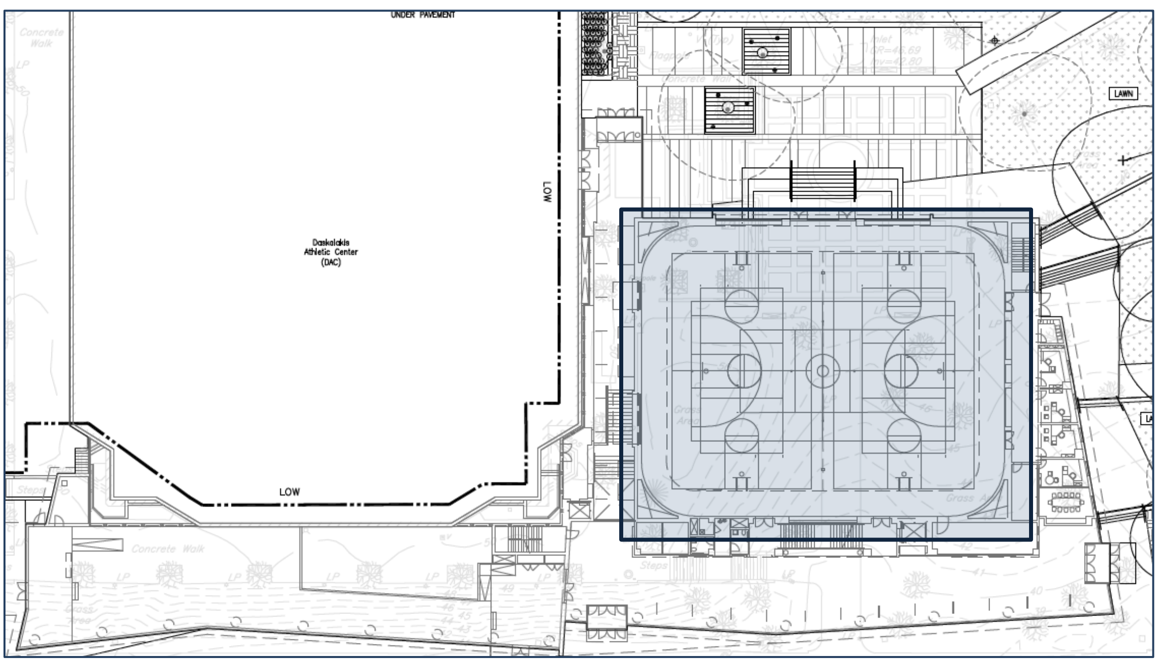


figure d.1 – orientation of gymnasium in building

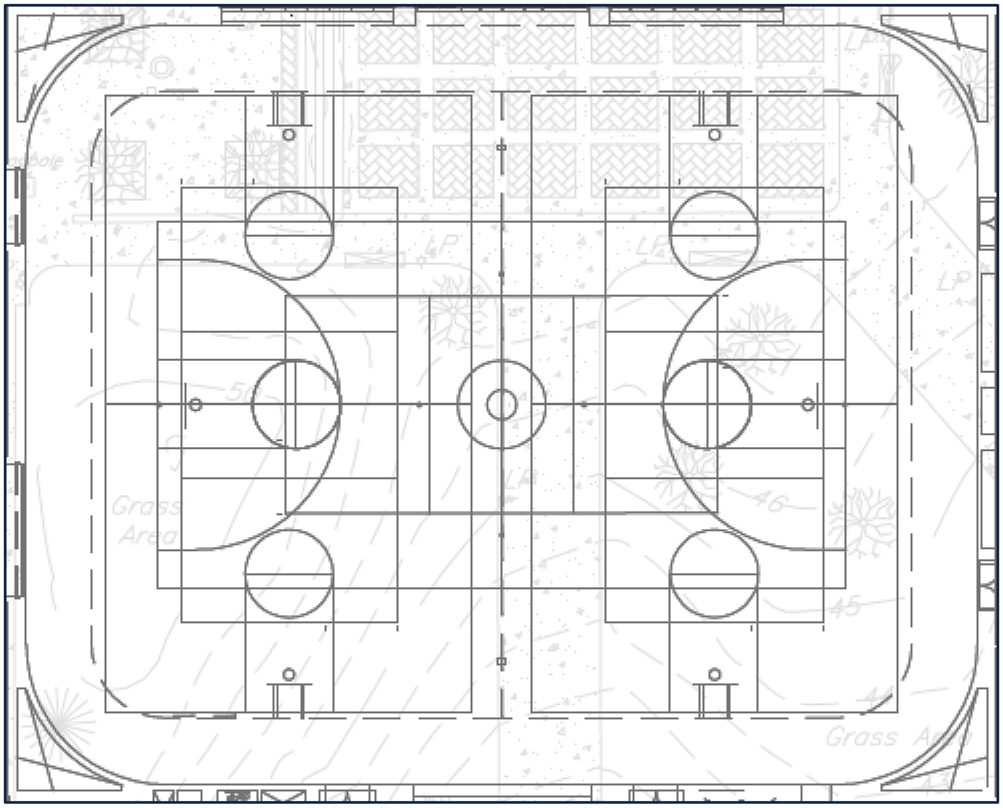


figure d.2 – gymnasium plan

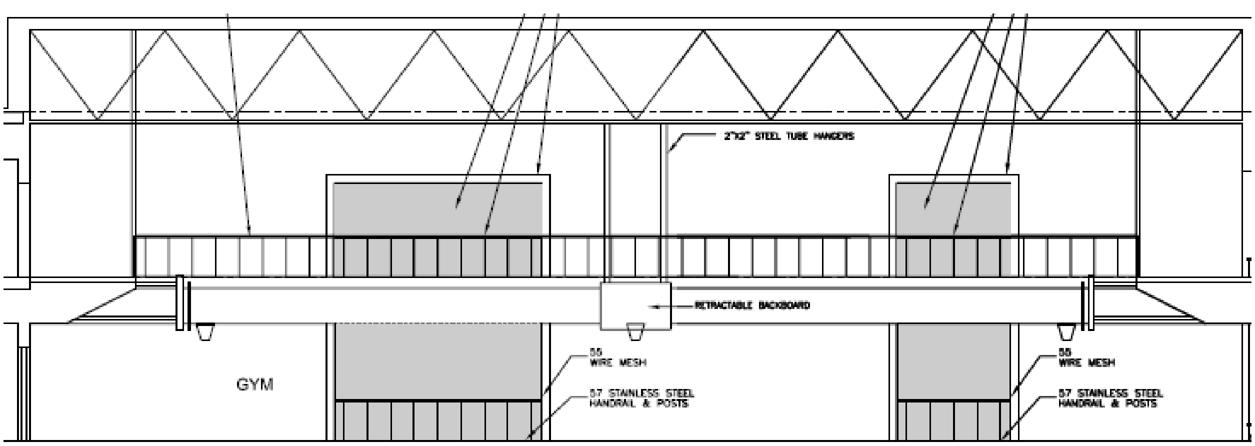


figure d.3 – gymnasium section

Materials and Finishes		
Surface	**Description**	**Reflectance**
floor	Northern Hard Maple wood flooring system	0.24
ceiling	exposed structural steel painted white	0.60
track	12mm Mondo light blue rubber track	0.25
walls above track	GWB painted Sherwin Williams Useful Grey	0.24
walls below track	CMU painted Sherwin Williams Useful Grey	0.27
glazing	Viracon insulating laminated glass VRE 1-54	t = 0.46
skylights	OldCastle Building Envelope insulated N-series	t = 0.57

table d.1 – gymnasium materials and finishes

system overview

desired illuminance levels and design goals

A gymnasium is the perfect place in which to integrate and control the amounts of daylighting within a space. Daylighting can be tricky in a space where uniformity is desired, so a northern facing façade is preferred in order to avoid strong shadows and bright spots in the early and late parts of the day. Dimming of the luminaires using a photocell to monitor the light levels within the space is the most successful way to utilize daylight to control both light levels and energy costs. The desired high illuminance levels in a multi-purpose gymnasium make this a space in which daylight addition and dimming can be produce substantial energy cost savings.

gymnasium- basketball class III, training facility:
horizontal – **50fc**

gymnasium- volleyball class III, training facility:
horizontal – **50fc**

This multi-purpose space should always feel public and open, giving an impression of visual clarity both for the players and anyone who is watching from the track or from one of the fitness centers. A bright, uniform lighting layout is appropriate, with the possibility of some perimeter lighting to accentuate ceiling height and push out the walls. Light finishes should be used to make the space appear brighter and provide a comfortable environment where players can feel energized and focused at practice.

The existing lighting design employs compact fluorescent high-bay fixtures, and provides an even illumination to the gymnasium floor. Electric light levels provided in the gymnasium are above the desired level, making energy savings possible even during non-daylight hours.

Luminaire Schedule									
Type	Description	Manufacturer	Catalog Number	Lamp		V	Power Supply	Input Watts	PF
				No	Type				
C2	10" compact fluorescent down light with recessed housing and impact resistant polycarbonate lens.	Gotham	AF-232TRT-10AR-PCL-277	2	PLT-32 4100 85 MIN CRI	277	GE T5 HE Ballast 99655-GE228MVPPS-A	36	.95
GP1	Compact fluorescent highbay sports lighting pendant fixture with drop lens and wireguard.	Sportlite	LX800-T42-35K-21PRL-21DLCP-277-4SL-3PEN-21XWG-21AL	8	PLT-32 4100 85 MIN CRI	277	Integral universal LED driver	33	.9

table d.2 – gymnasium luminaire schedule

Light Loss Factors				
Lamp Type	LLD	LDD	BF	Total
C6	.86	.90	1.0	.75
PB1	.86	.90	1.0	.75

table d.3 – gymnasium light loss factors

**The above light loss factors were calculated using the new method in the 2010 IESNA handbook. The Room Surface Dirt Depreciation (RSDD) was neglected and the Luminaire Dirt Depreciation (LDD) was calculated using the updated calculation outlined in the book. A lamp maintenance schedule of twelve months was assumed.*

skylight layout and design

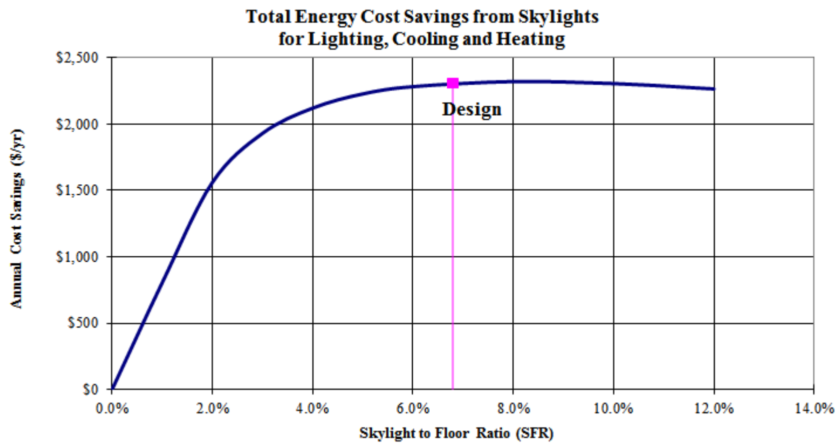
The OldCastle Building Envelope "N"Series Skylight System triple glazed skylight units are ENERGY STAR certified and provide optimal performance with minimal heat gain, and provide opportunities not only to maximize energy savings, but to receive ENERGY STAR rebates.

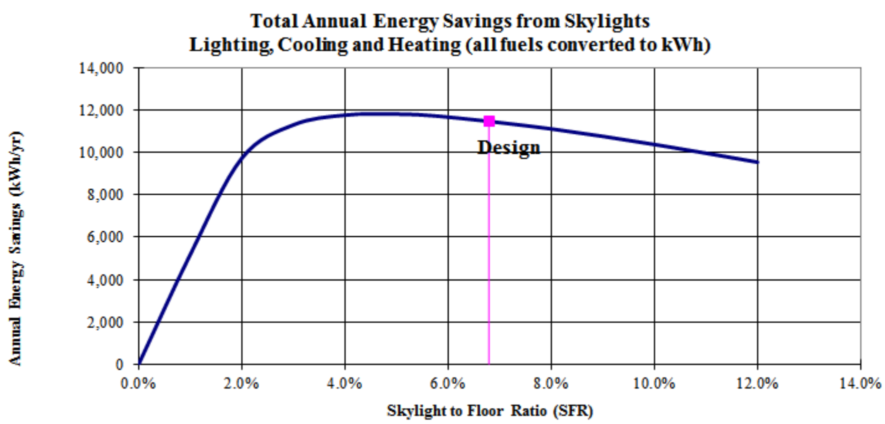
Skylight Data	
Manufacturer	OldCastle Building Envelope
System	"N" Series insulated Skylight System
Total Number	12
Dimensions	8' x 10' x 6"
t	.34
U	.27
SHGC	.20
Skylight/floor ratio	6.8%- ratio dictated by SkyCalc results

table d.4 – skylight data

figure d.4 – gymnasium skylight example

SkyCalc software was used as a guide to select an efficient skylight-to-floor ratio. A skylight size of 8' x 10' was selected based on the analysis of energy and cost savings. A lower ratio would have saved more heating energy but less money overall, and so 6.8% was determined ideal. (*See figures below for description of SkyCalc results).*





The final skylight layout was determined based on truss location and position of the existing lighting system. Although the maximum energy savings would be resultant of a skylight-to-floor ratio of 4%, the maximum energy cost savings is a higher priority to the owner, and so a ratio of proximately seven percent was achieved based on the results of the SkyCalc study.

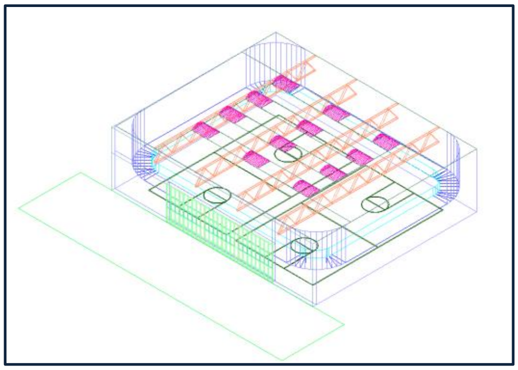


figure d.5 –isometric of skylight design

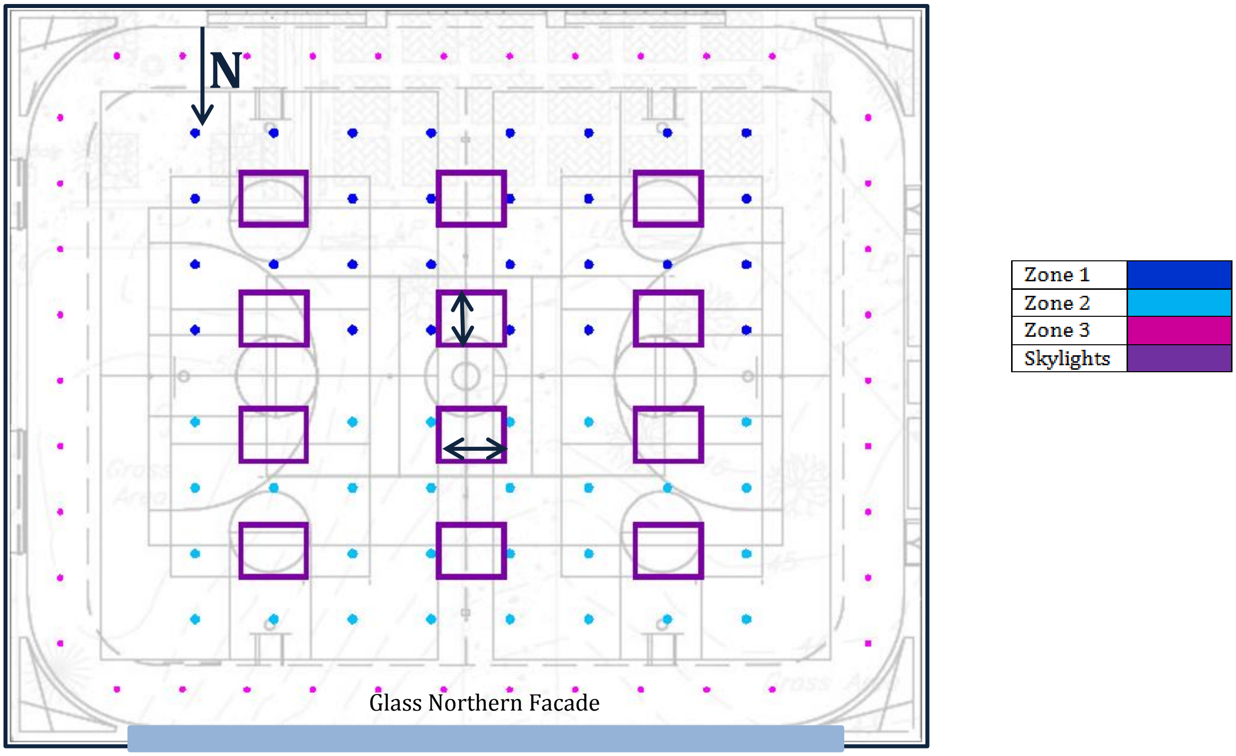
controls

The gymnasium lighting will be controlled using three separate zones. The first zone is the perimeter lighting below the suspended track, which will be always on throughout the day to provide consistent light levels and avoid shadows on the floor, as well as to regulate the luminance levels on the wall surfaces as the daylight condition changes. The high-bay fluorescent lighting is dimmed in two separate zones to maximize energy savings and uniformity, as the northern half of the gymnasium has higher light levels throughout the day due to the fenestration that makes up a majority of the Northern façade.

A Wattstopper daylighting control dimming system is specified for automatic dimming control of the fluorescent luminaires. Each zone has a separate daylight sensor on the ceiling, facing down to optimize energy savings and provide consistent light levels throughout the space.

Gymnasium Control Schedule			
Type	Manufacturer	Product	Description
LMLS-305	Wattstopper	LightSaver Photocell	Closed loop photosensor provides the daylight data necessary for operation.
LMRC-202	Wattstopper	LightSaver Room Dimming Controller	Provides automatic dimming control for fluorescent fixtures. Closed loop control utilizes a single photocell for multi-zone dimming.
LMSW-100	Wattstopper	LightSaver Wall Switches	Allows occupants to temporarily override the daylighting control systems.

table d.5 – gymnasium control schedule



Zoning diagram and skylight layout plan. Please note that in order to provide consistency with Daysim graphics, North is depicted at the bottom of the drawing, instead of the traditional orientation.

performance analysis - DAYSIM

Using DAYSIM to perform an hour by hour year-long analysis, a two-zone dimming analysis was performed to calculate energy savings per zone. To get the most accurate results possible, Zone 1 and 2 were tested separately. Zone 1, the interior zone was tested with Zone 2 turned off to minimize interference because for the majority of the day the northern façade provides enough daylight to the northern half of the gymnasium. Zone 2, the exterior zone near the window was tested with the interior zone turned on, because the dimming level is almost always lower in Zone 1, and the electric light will be affecting the calculations. Zone 3 was left on for all calculations.

occupancy

The Drexel Recreation Center has extensive hours throughout the year- operating from 6am-midnight throughout the school year and from 8am-10pm in the summer. For this analysis, I wanted to see how much savings the daylight would provide for the daylight hours, and so the analysis is only for operated daylight hours of 8am-8pm.

photo sensor placement

The photocells for each zone were placed on the exposed trusses, at a height of 25’, facing down in order to effectively monitor the daylight levels.

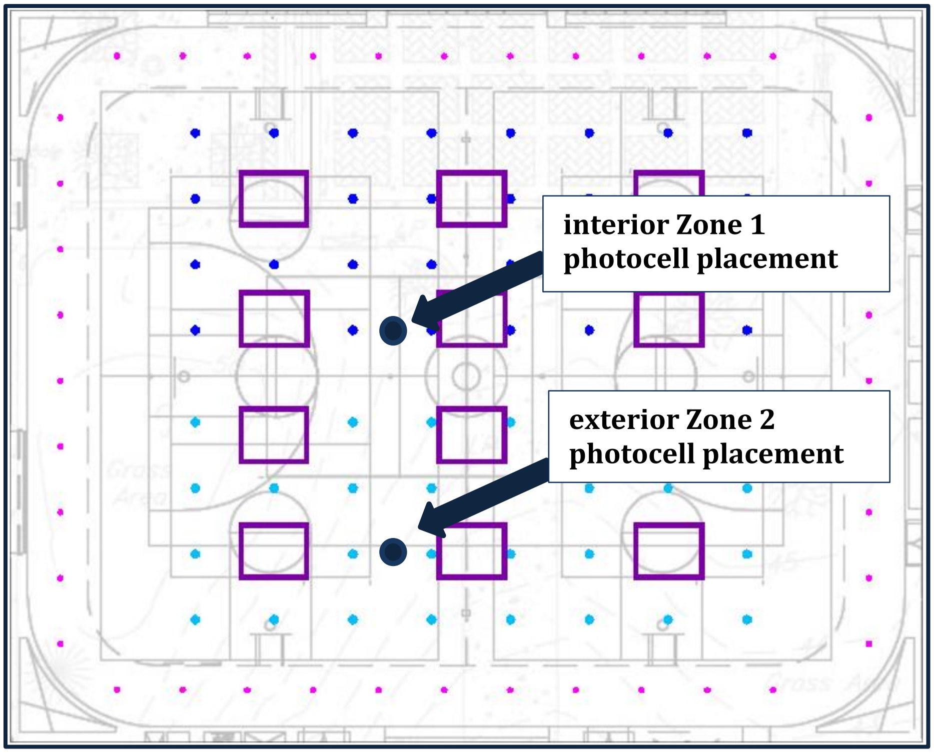


figure d.6– daylight photosensor placement

critical point selection

The critical point is exactly as it sounds: critical to a well-designed daylight dimming system. To locate that perfectly placed critical point, the analysis point was selected where the highest dimming level for that zone of electric light was needed. For the interior zone, Zone 1, the critical point was selected with Zone 2 off, and for the exterior zone, Zone 2, it was selected with Zone 1 on as the dimming levels are typically higher and will contribute to the light that Zone 2 sees throughout the day. See below for the locations of the critical points for zones one and two.

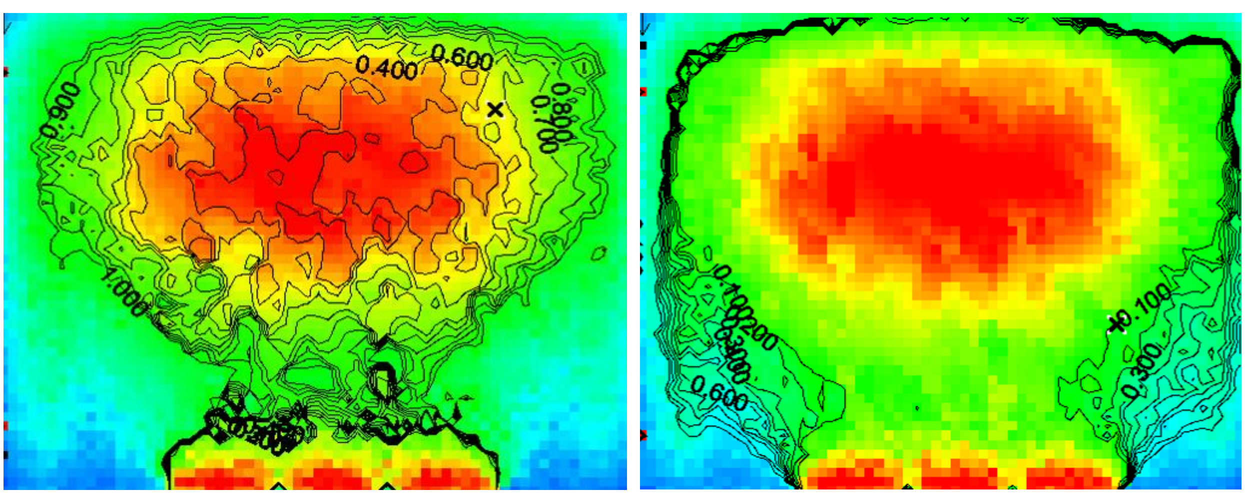


figure d.7– Critical point placement for Zone 1, left and Zone 2, right

control algorithm settings

The photo sensors were calibrated selected using a closed loop proportional algorithm. An overcast Philadelphia sky on January 12 was selected in order to provide the most accurate signals to the sensor. A target value of 500 lux was set, and for additional energy savings the luminaires are set to turn off when they reach the lowest ballast output of 5%.

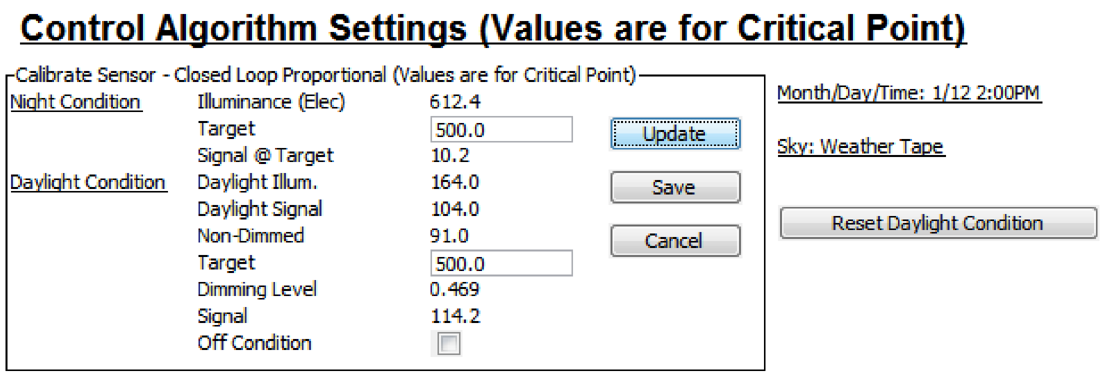


figure d.8- control algorithm settings for Zone 1

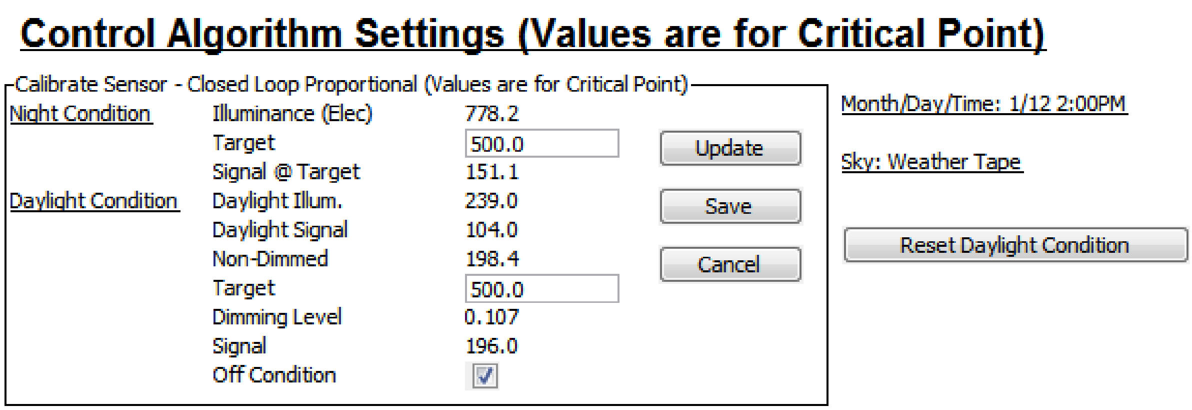


figure d.9- control algorithm settings for Zone 2

results

Hour by hour calculations show you exactly how a space is affected by daylight at each hour of the day. Below are hour by hour results for each zone on the spring/fall equinox, the summer solstice, and winter solstice.

spring/fall equinox hour by hour results

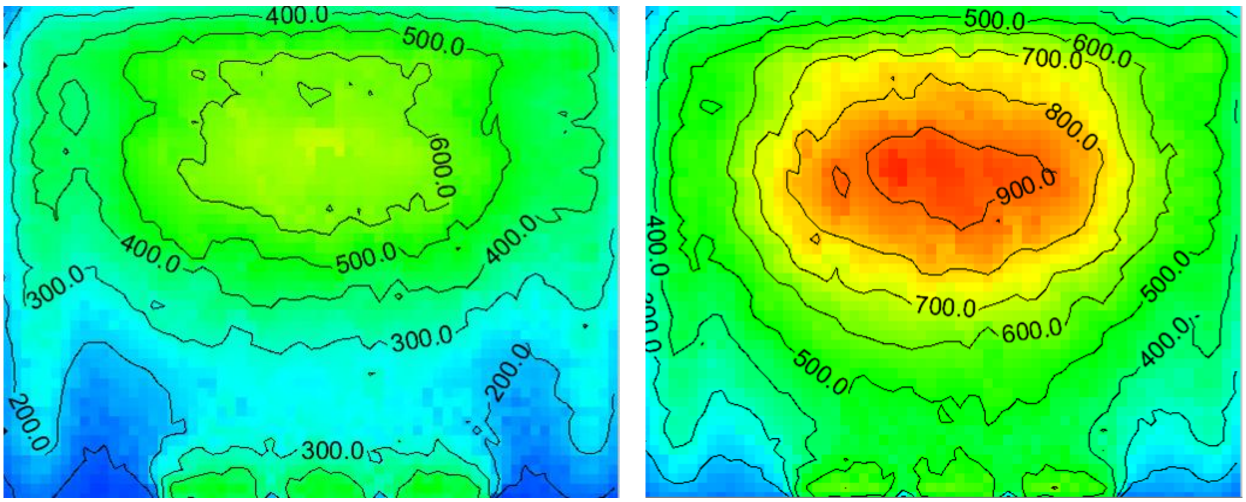


Figure E.1 – 8am Zone 1 dimmed to .787, Zone 2 dimmed to .341

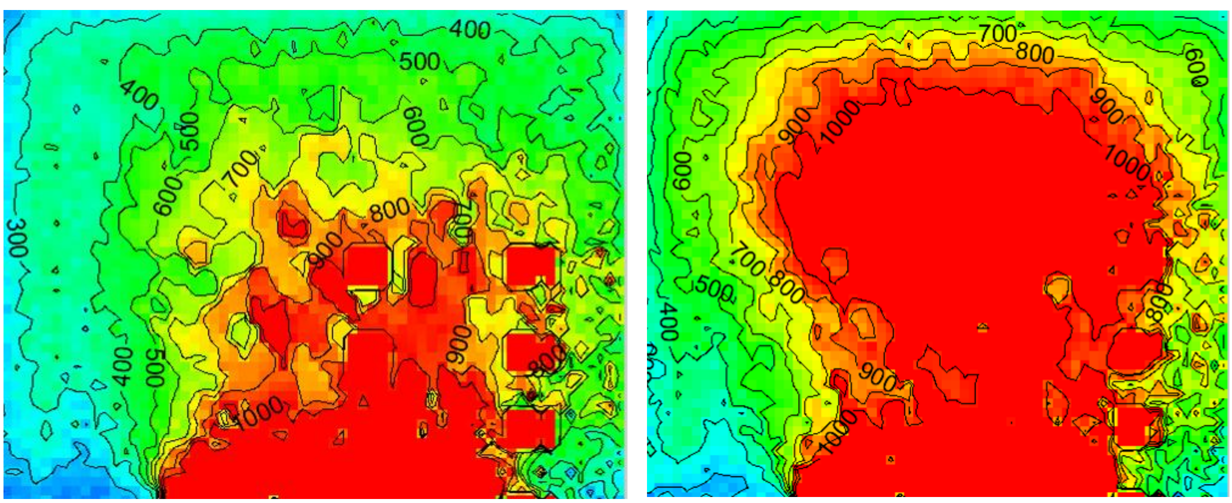


Figure E.2 – 9am Zone 1 dimmed t o.236, Zone 2 off

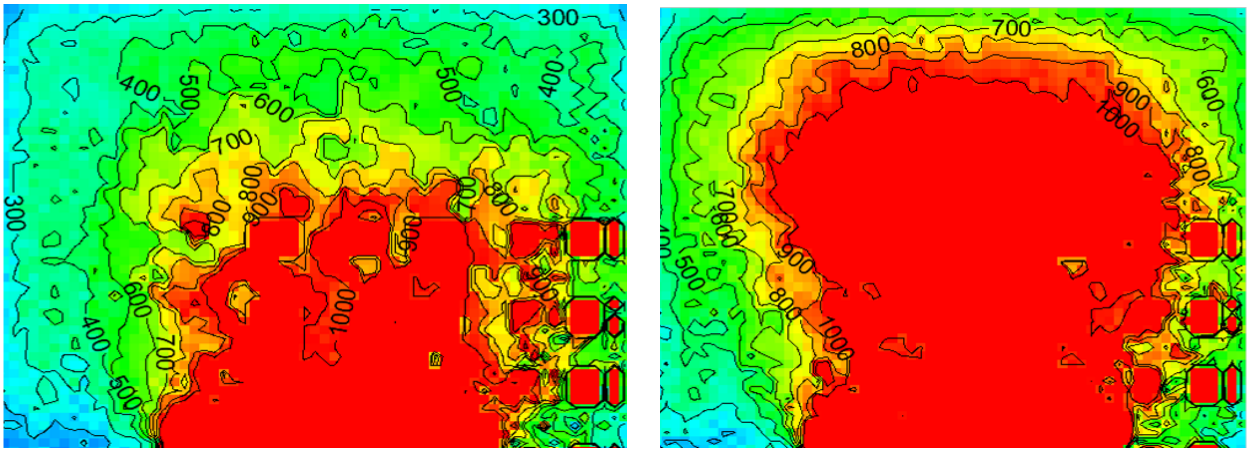


Figure E.3 – 10am Zone 1 dimmed to .173, Zone 2 off

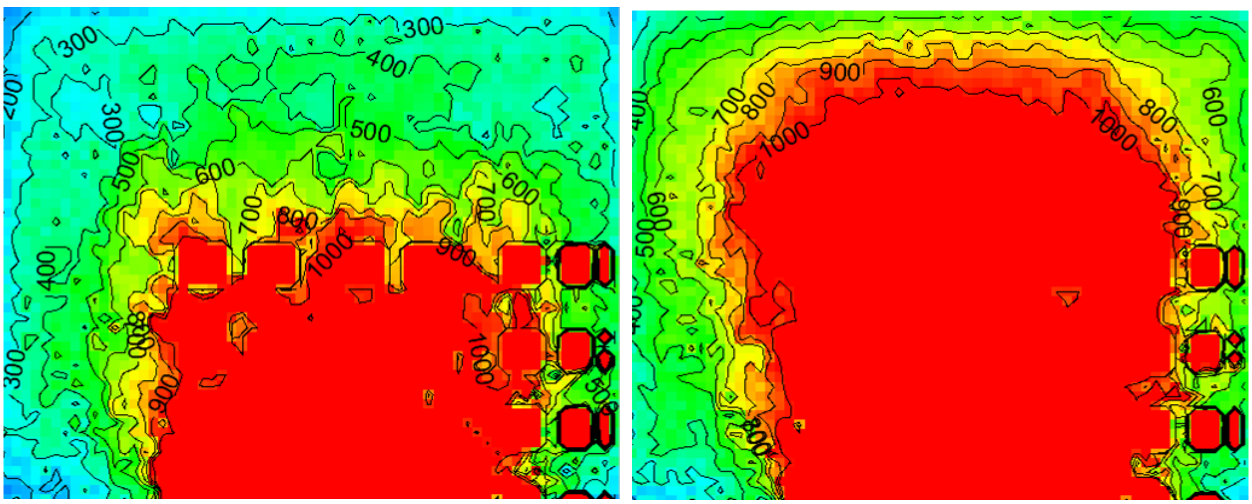


Figure E.4 – 11am Zone 1 off, Zone 2 off

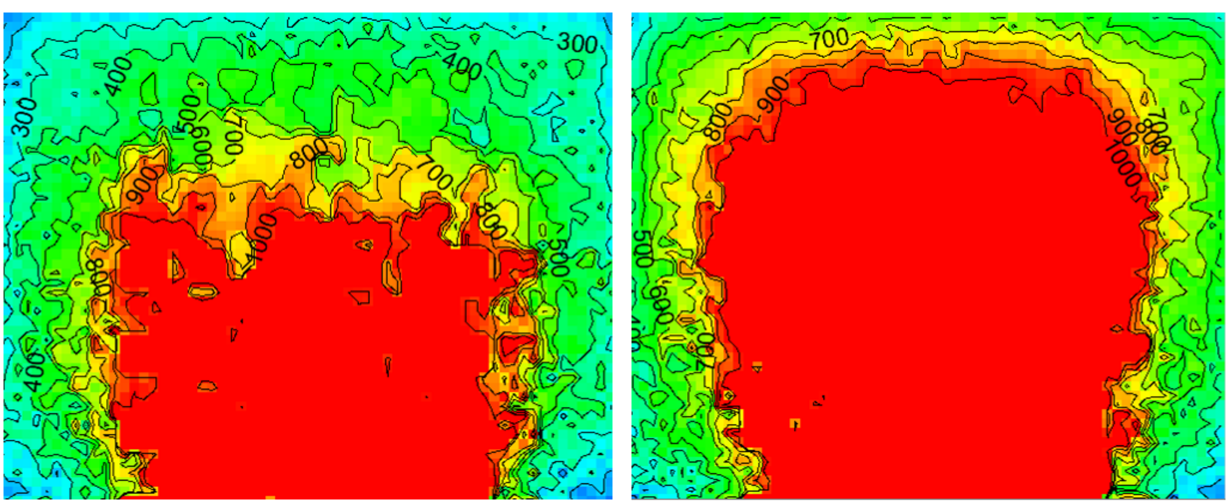


Figure E.5 – 12pm Zone 1 dimmed t o.051 , Zone 2 off

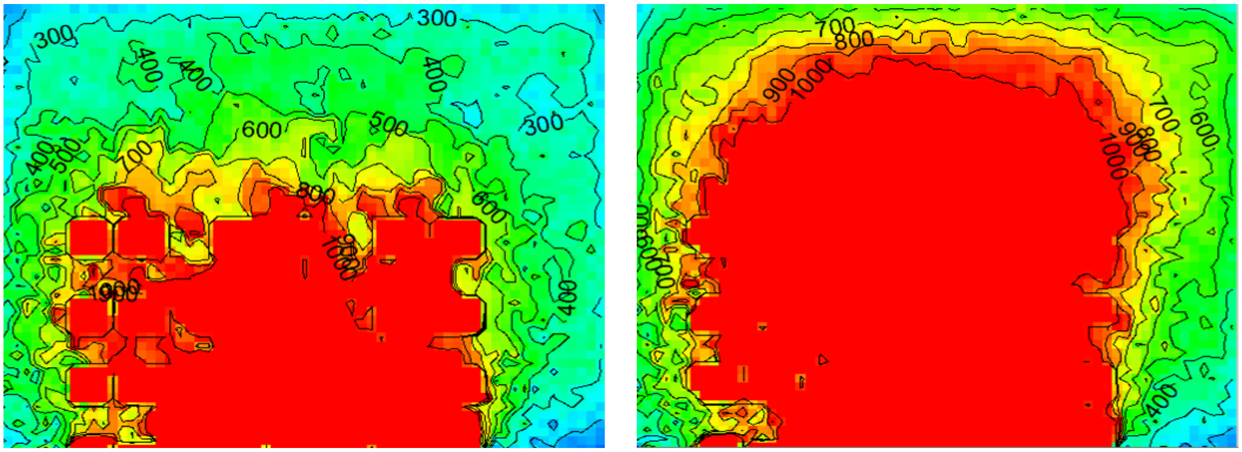


Figure E.6 – 1pm Zone 1 off, Zone 2 off

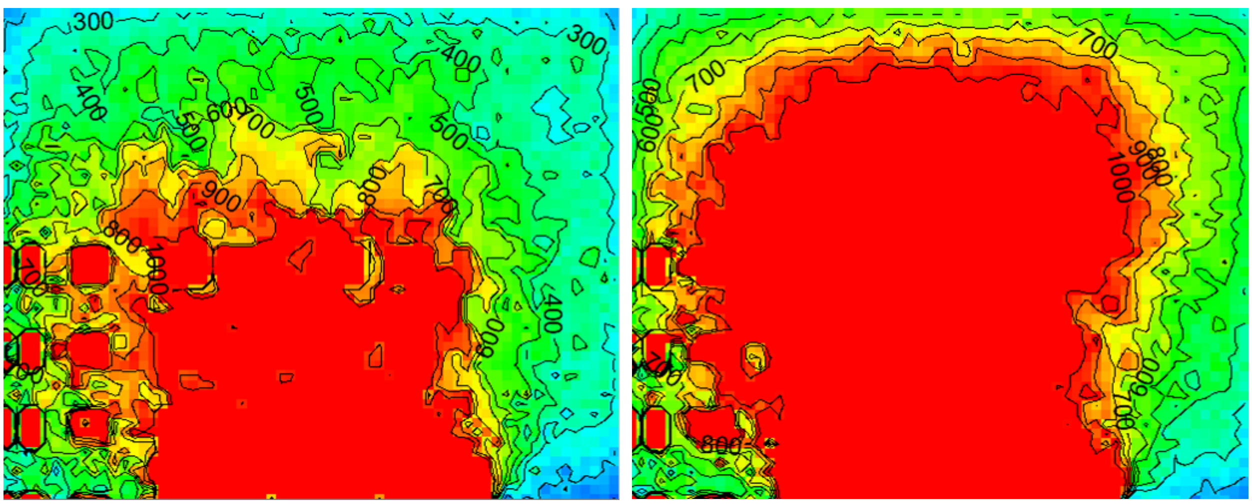


Figure E.7 – 2pm Zone 1 dimmed to .056, Zone 2 off

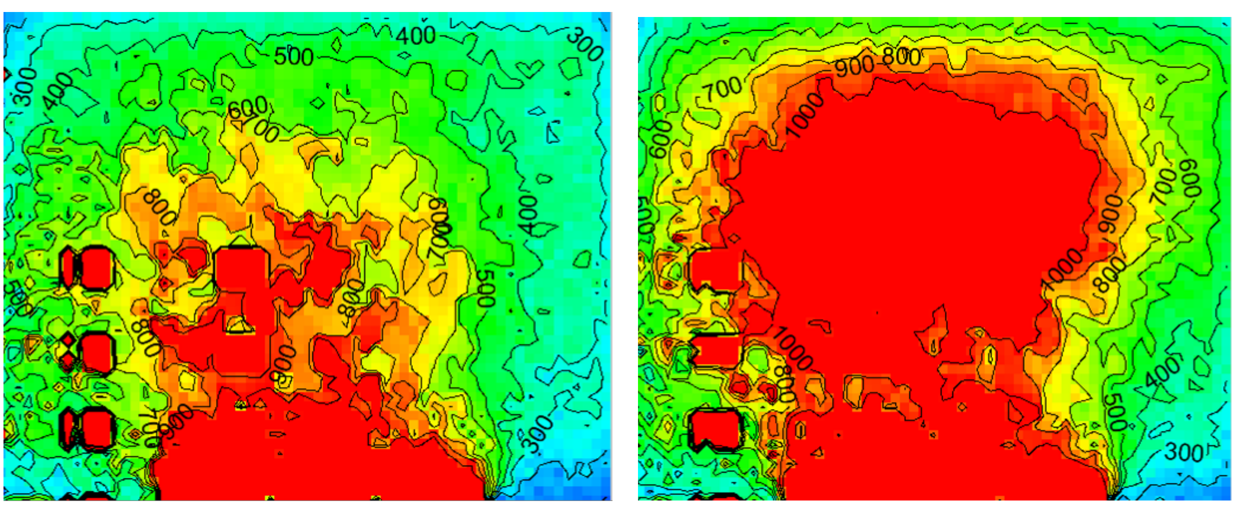


Figure E.8 – 3pm Zone 1 dimmed t o .227, Zone 2 off

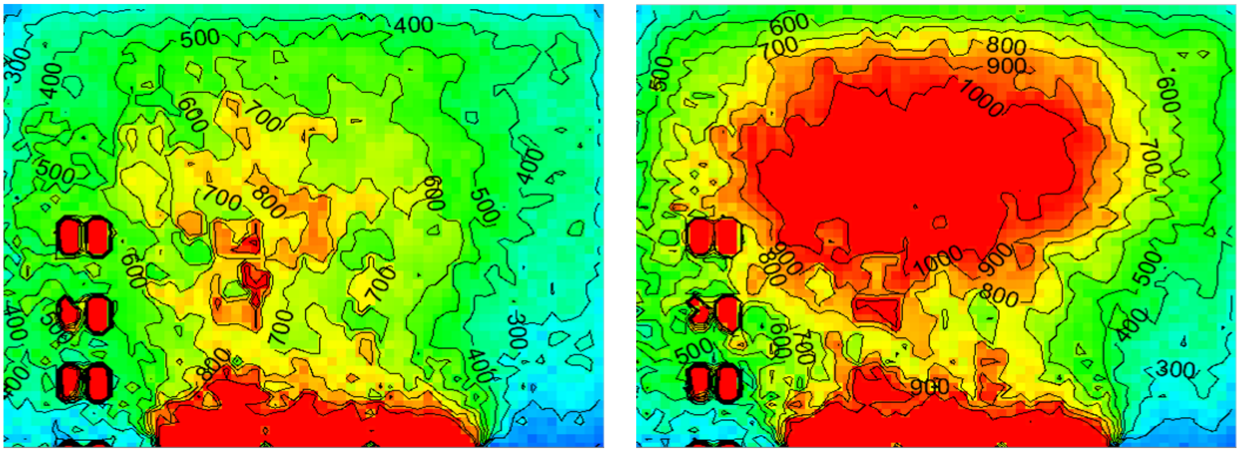


Figure E.9 – 4pm Zone 1dimmed to 0.385, Zone 2 off

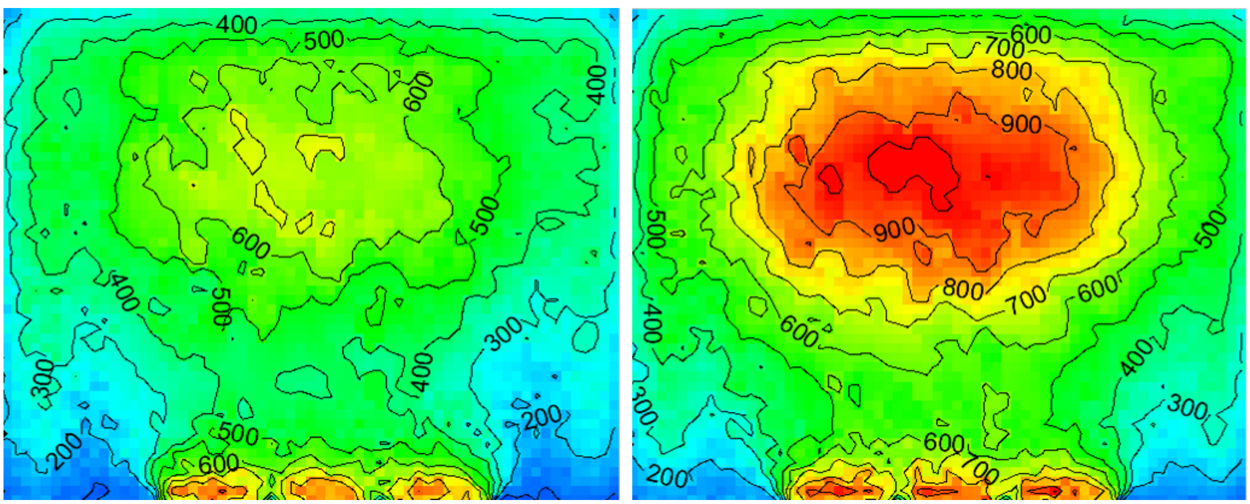


Figure E.10 – 5pm Zone 1 dimmed to .619, Zone 2 dimmed to .167

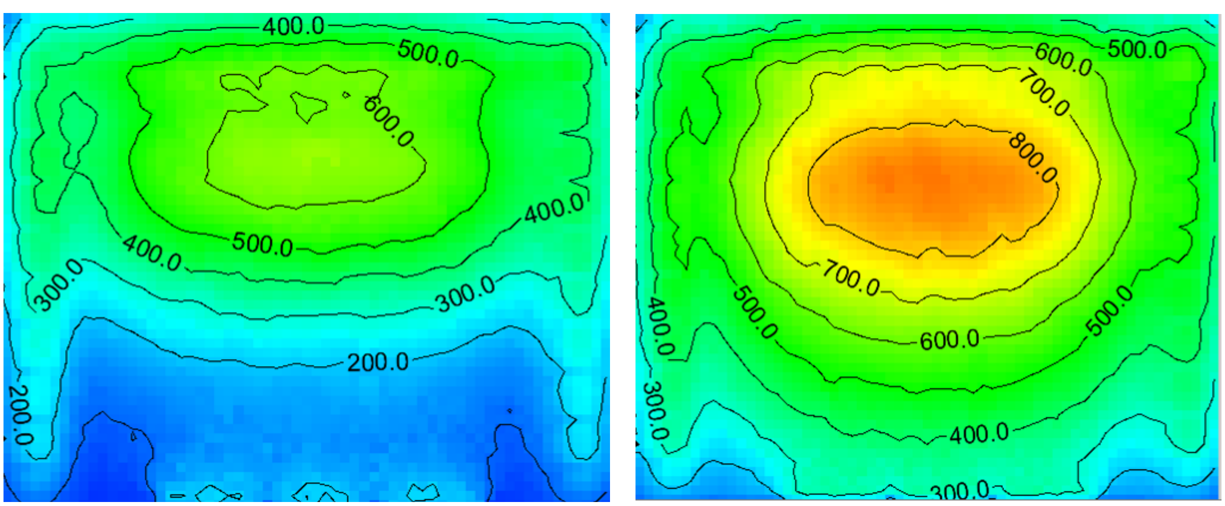


Figure E.11 – 6pm Zone 1 dimmed t o .813 , Zone 2 dimmed to .452

summer solstice hour by hour results

The Northern façade receives high levels of light throughout the summer, and so the exterior zone is able to be switched off for the entirety of the day. For this reason, only the calculations from Zone 1 are shown as they are calculated with Zone 2 switched off.

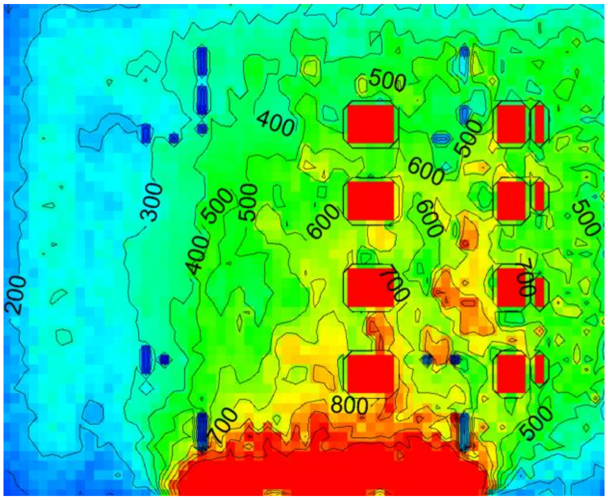


Figure E.12 – 8am Zone 1 off, Zone 2 off

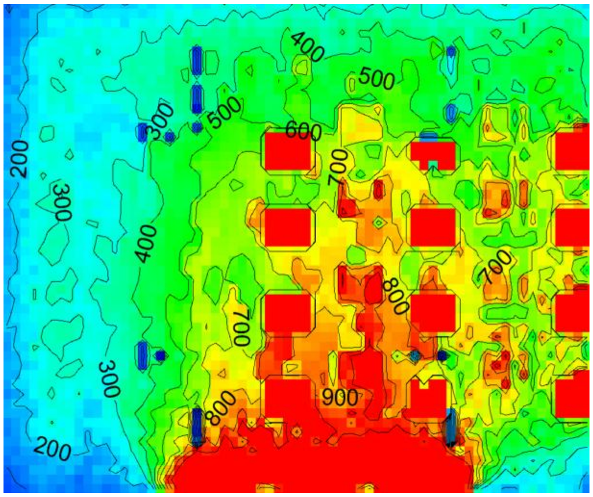


Figure E.13 – 9am Zone 1 dimmed t o .227, Zone 2 off

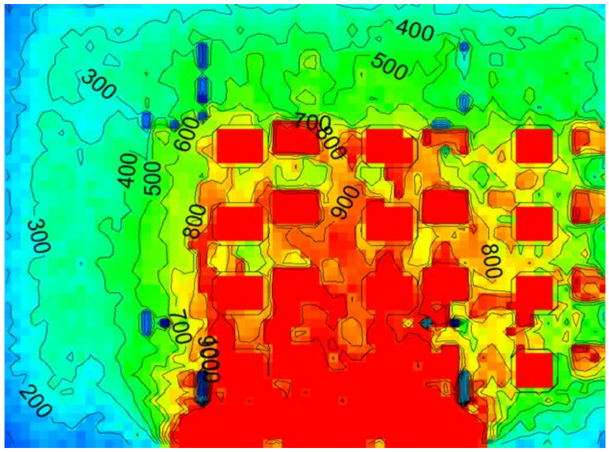


Figure E.14 – 10am Zone 1 off, Zone 2 off

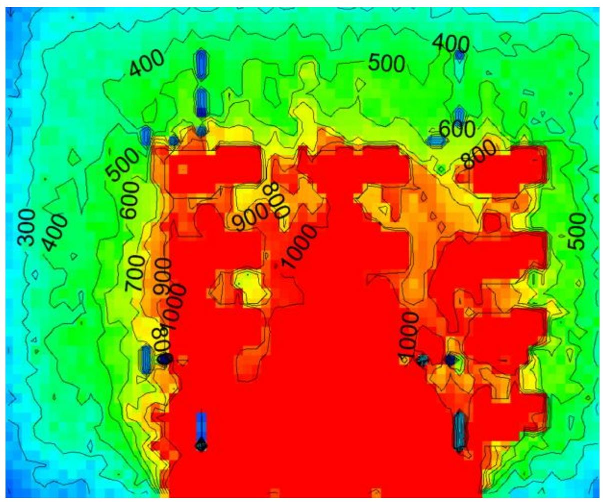


Figure E.13 – 11am Zone 1 off, Zone 2 off

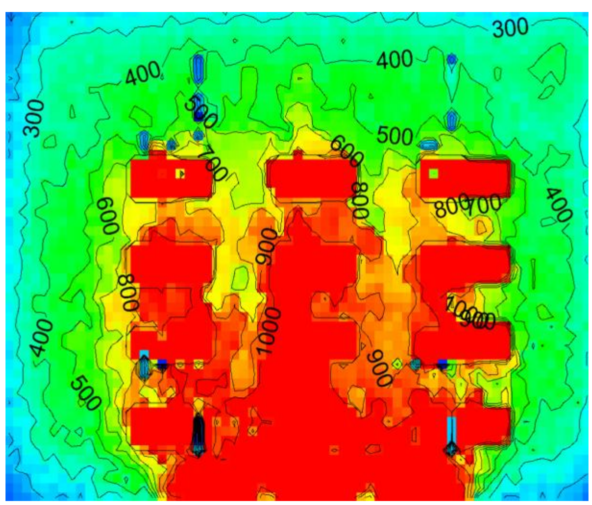


Figure E.14 – 12pm Zone 1 off, Zone 2 off

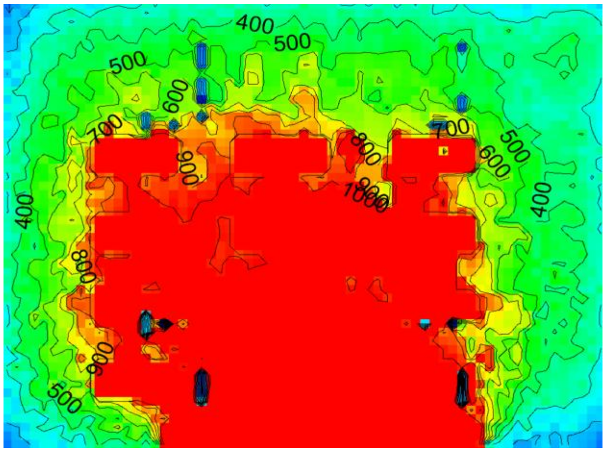


Figure E.15 – 1pm Zone 1 off, Zone 2 off

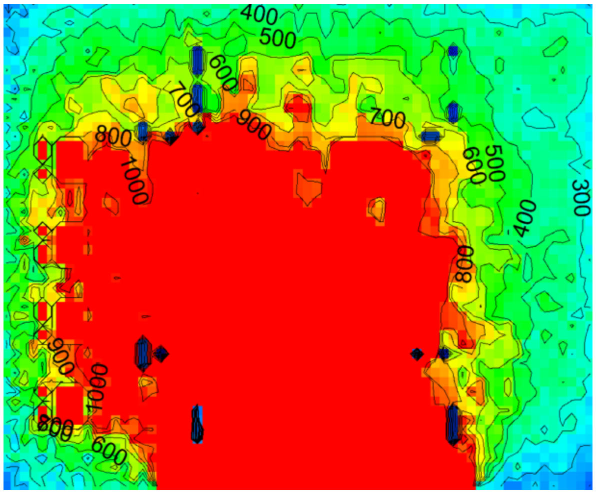


Figure E.16 – 2pm Zone 1 off, Zone 2 off

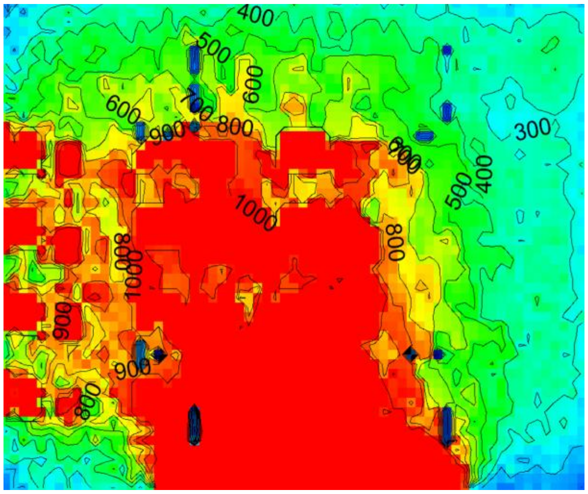


Figure E.17 – 3pm Zone 1 off, Zone 2 off

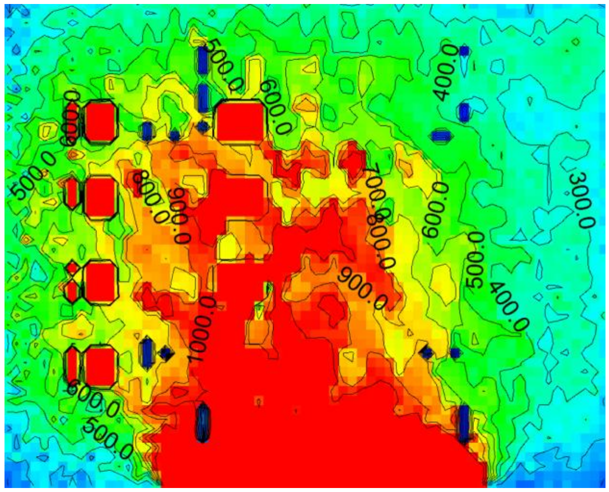


Figure E.18 – 4pm Zone 1 off, Zone 2 off

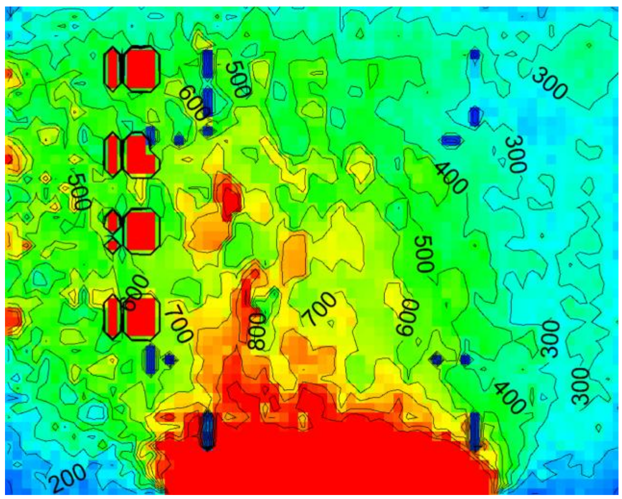


Figure E.19 – 5pm Zone 1 off, Zone 2 off

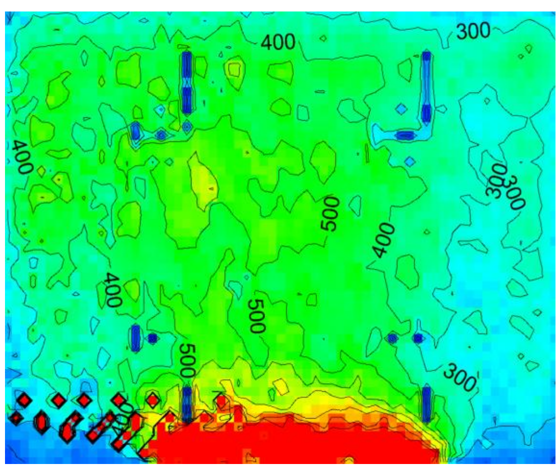


Figure E.20 – 6pm Zone 1 dimmed to .273, Zone 2 off

winter solstice hour by hour results

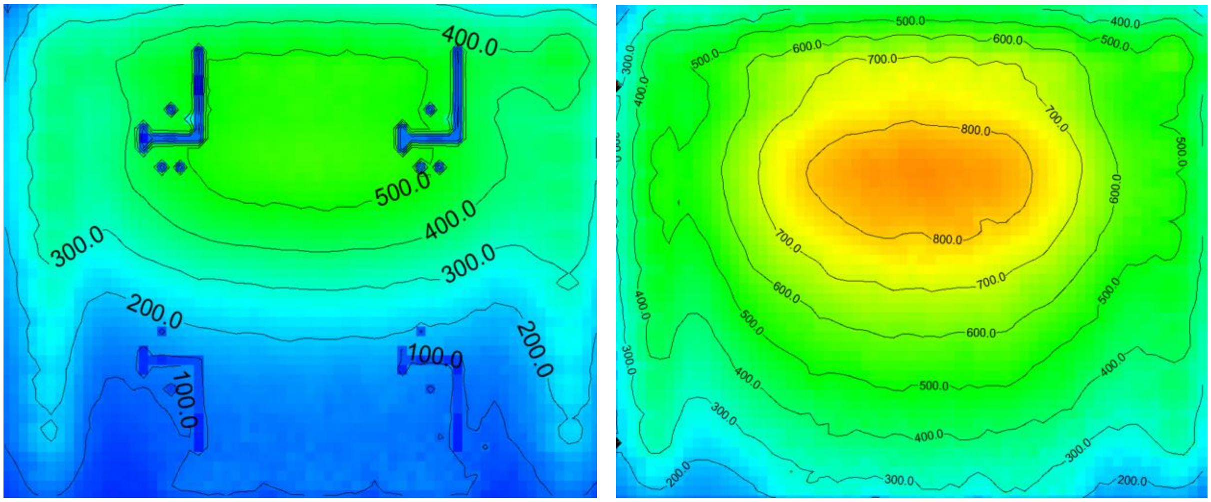


Figure E.21 – 8am Zone 1 dimmed to .754, Zone 2 dimmed to .468

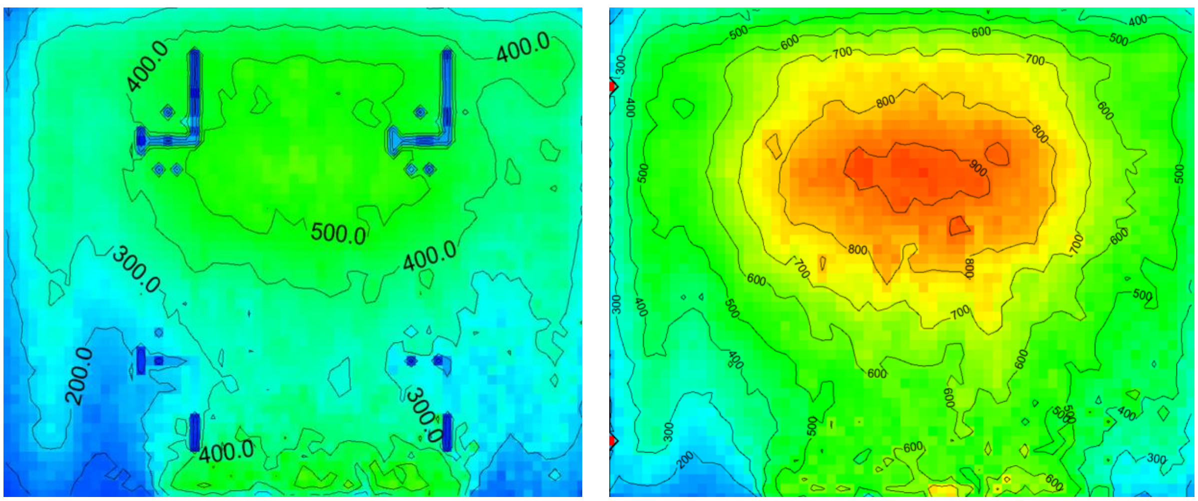


Figure E.22 – 9am Zone 1 dimmed t o .62, Zone 2 dimmed to .274

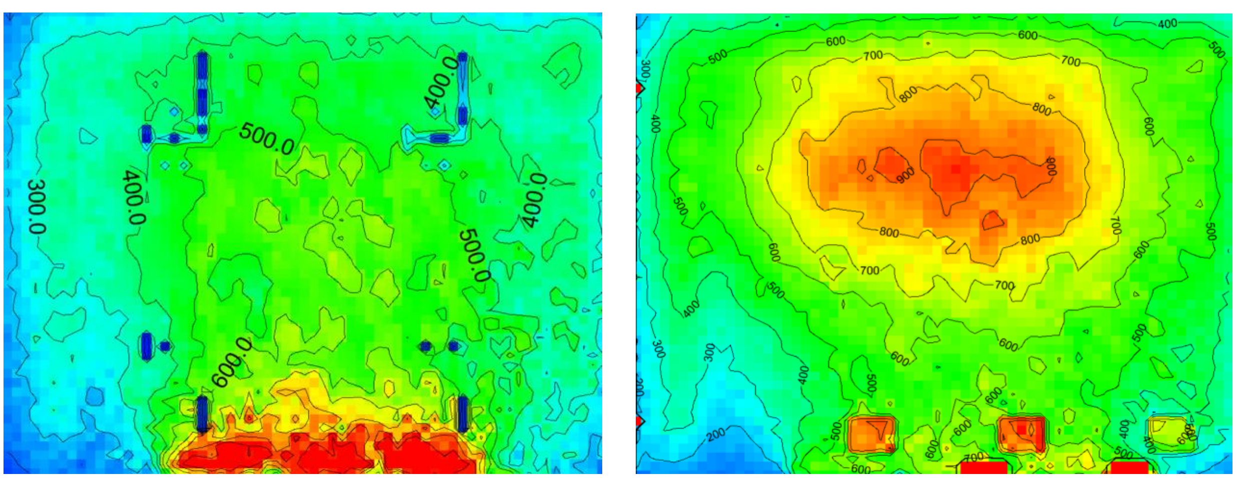


Figure E.23 – 10am Zone 1 dimmed to 0.348, Zone 2 dimmed to .171

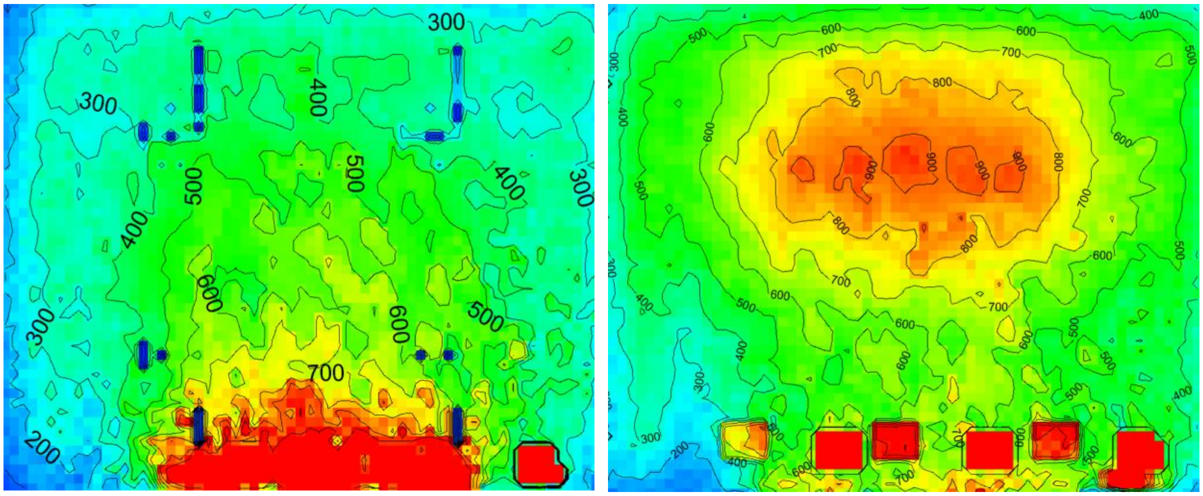


Figure E.24 – 11am Zone 1 dimmed to .2, Zone 2 dimmed to .05

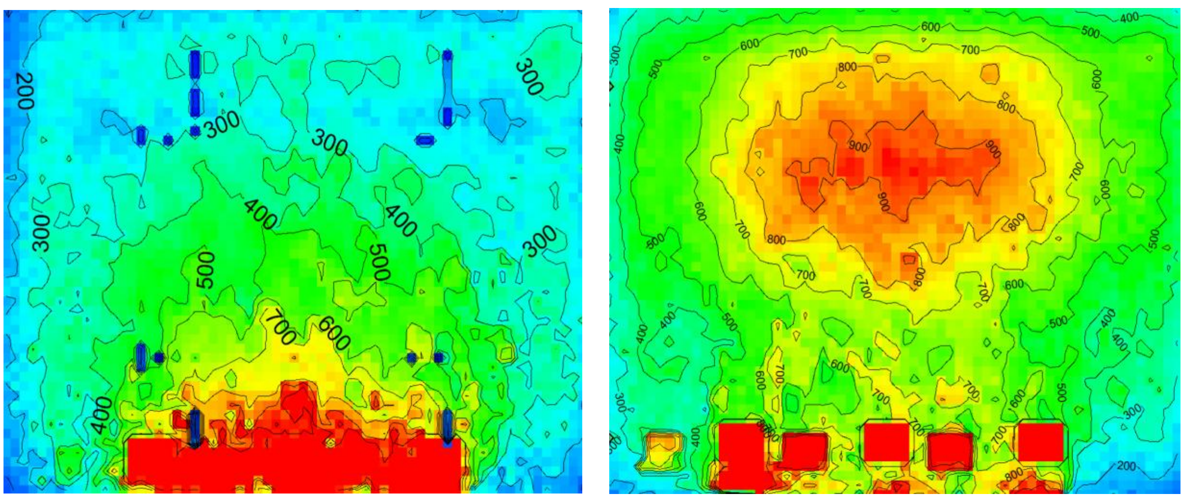


Figure E.25 – 12pm Zone 1 of, Zone 2 off

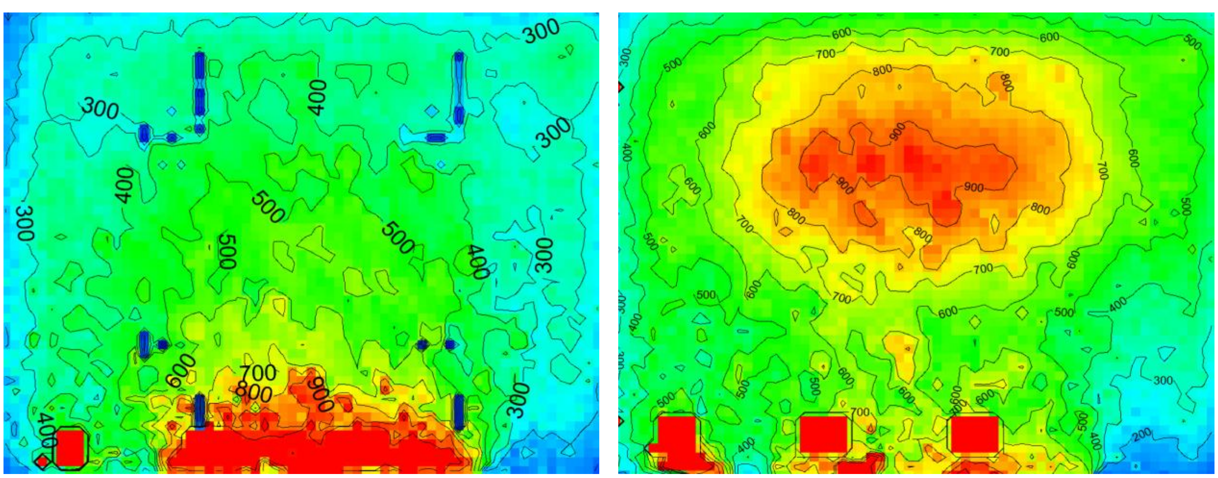


Figure E.26 – 1pm Zone 1 dimmed to 0.212, Zone 2 off

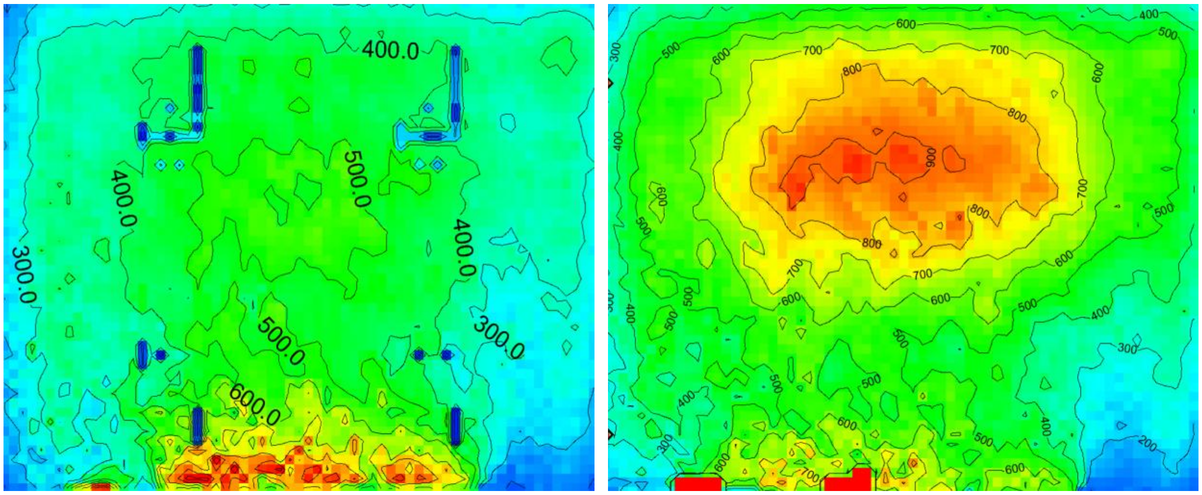


Figure E.27 – 2pm Zone 1 dimmed to .403, Zone 2 off

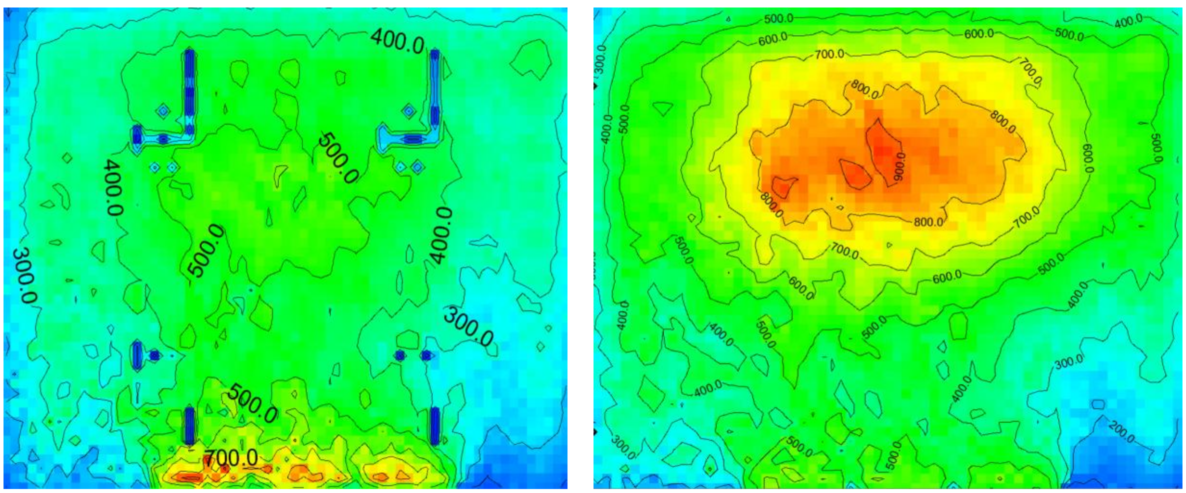


Figure E.28 – 3pm Zone 1 dimmed to .448, Zone 2 off

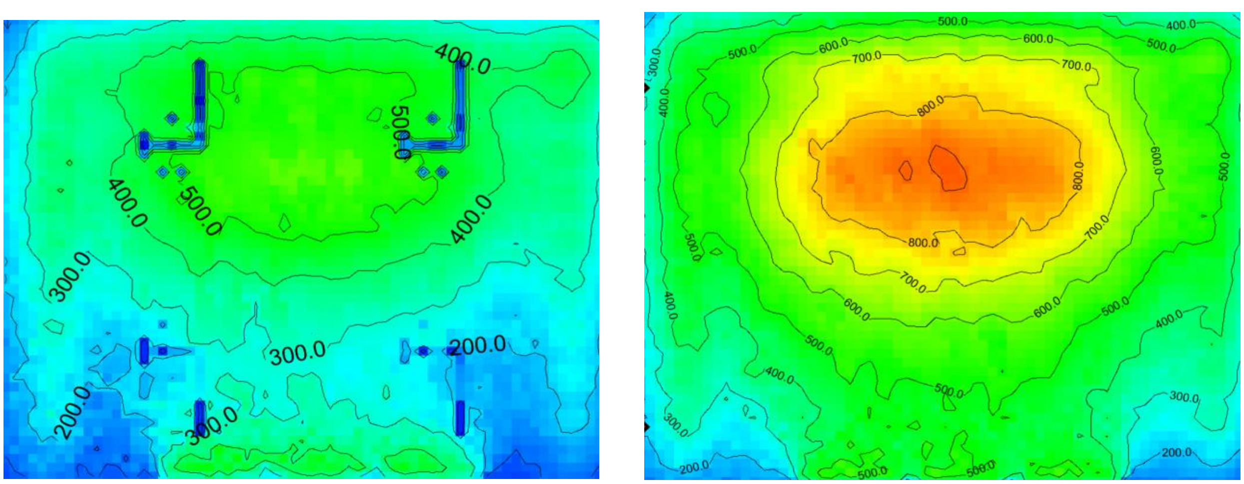


Figure E.29 – 4pm Zone 1 dimmed to 0.636, Zone 2 dimmed to .321

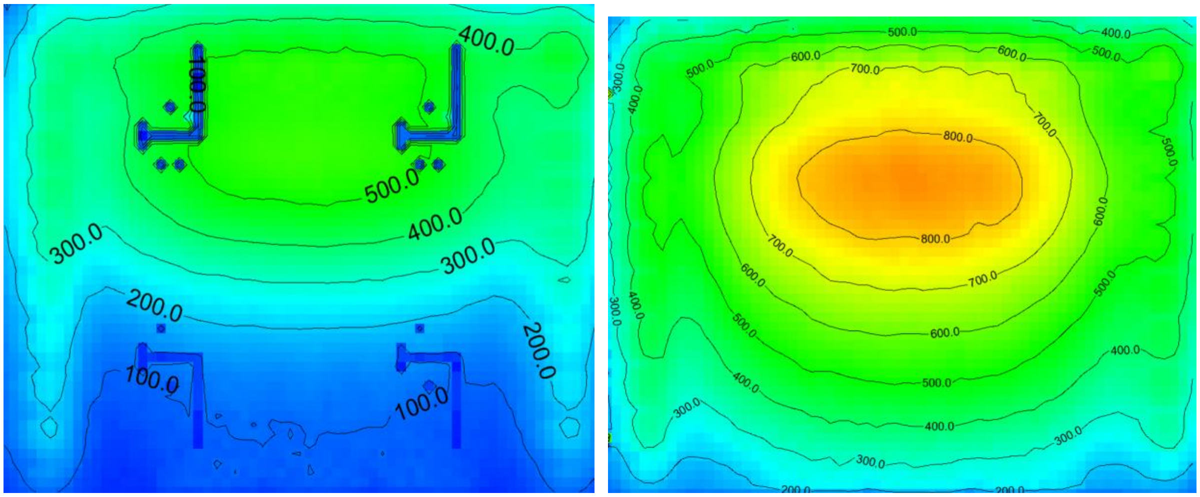


Figure E.28 – 5pm Zone 1 dimmed to .766, Zone 2 dimmed to .488

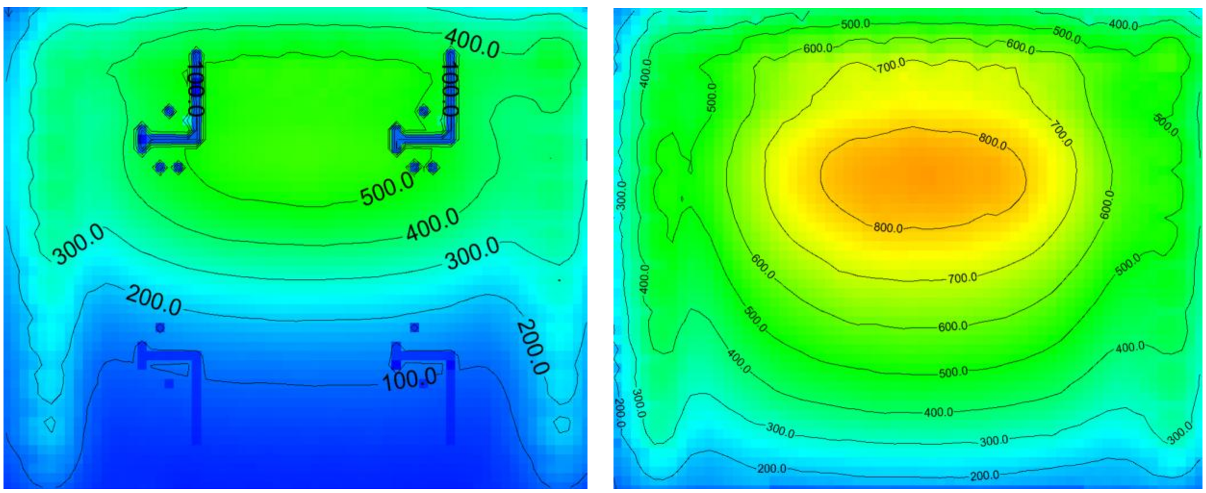
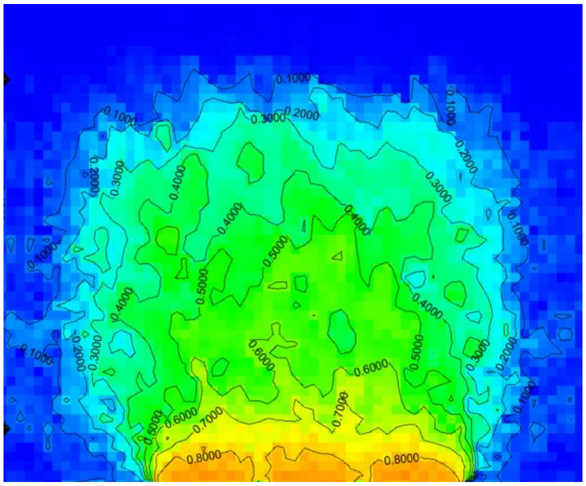


Figure E.29 – 6pm Zone 1 dimmed to .784, Zone 2 dimmed to .52

daylight autonomy

Daylight autonomy and continuous daylight autonomy are useful annual daylight performance metrics that are used to evaluate the performance of daylight in a space. Daylight autonomy shows the fraction of occupied hours that the daylight levels are sufficient in a space to eliminate the need for electric lighting, and is an effective metric when considering whether to use a switching system in the design space. Continuous daylight autonomy allows partial credit, so if a point is daylit to half of the desired illuminance level, half an hour credit is given. This metric is particularly useful for estimating the energy savings for a dimming system. The figures below show daylight autonomy and continuous daylight autonomy for 500 lux, or 50fc.



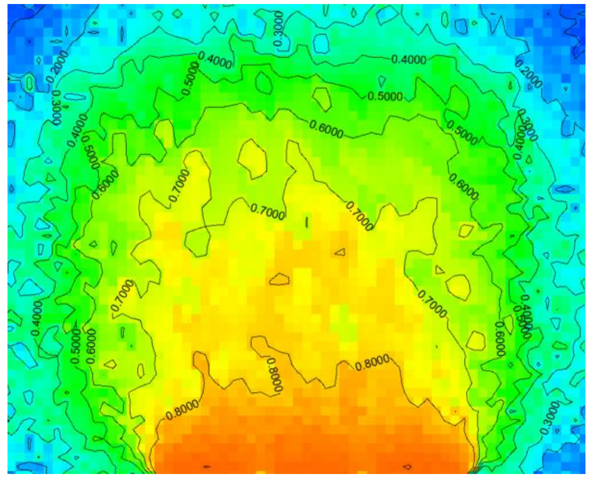


Figure – daylight autonomy and continuous daylight autonomy at 50fc (500lux)

conclusion

Although the light levels appear to be very bright throughout the spring and fall, in order to accurately calculate multi-zone dimming in DAYSIM, both dimmed zones must be calculated separately. This means that for example, in E.11 above, at 6pm, the illuminance levels throughout the gymnasium would be uniform and consistent. When Zone 2 is switched off, the left image of Zone 1 is the accurate portrayal of what is taking place within the space. Although illuminance levels can reach over 100fc during the day, occuppants have a much higher tolerance for daylight than electric light and will improve and brighten the ambient energy level in the gymnasium.

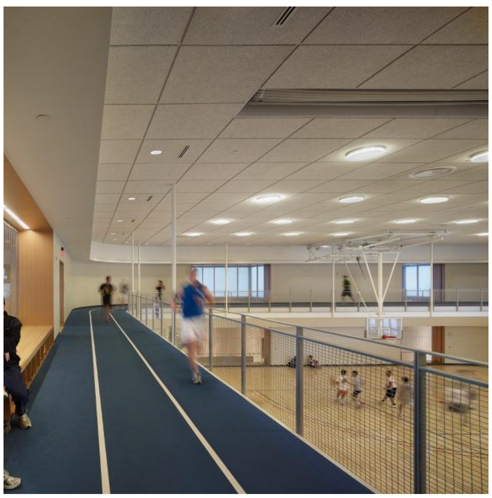
Light levels remain high enough in the gymnasium throughout the summer to almost eliminate the need for electric light during daylight hours. The addition of skylights increases daylight penetration into the space enough to keep Zone 1 almost completely dimmed during the day as well. Although there is some direct sunlight penetration in the summer, this will actually be appreciated by the occupants. Philadelphia is very humid through the summer and this way, they can experience the sunshine and summery environment while exercising and playing sports with their friends in a pleasant way, in the air conditioning.

Not only does adding skylights to the gymnasium increase the aesthetic experience in the space, it also saves over 50% of the energy that would be supplied to the electric lighting system.

breadth two: acoustical

The existing gymnasium ceiling height in the Drexel Recreation Center is 27' with a reflective, high performance acoustical ceiling. Incorporating the new daylight design required the removal of the perforated co-polymer panels, which altered the acoustic performance of the space. The ceiling height is increased from 27' to 35' with the removal of the dropped panels, exposing the structural steel ceiling composed of trusses and metal decking. The following calculations determined whether the acoustical performance resulted in desirable reverberation times and echo levels and investigated the need for sound absorbing or reflecting materials.

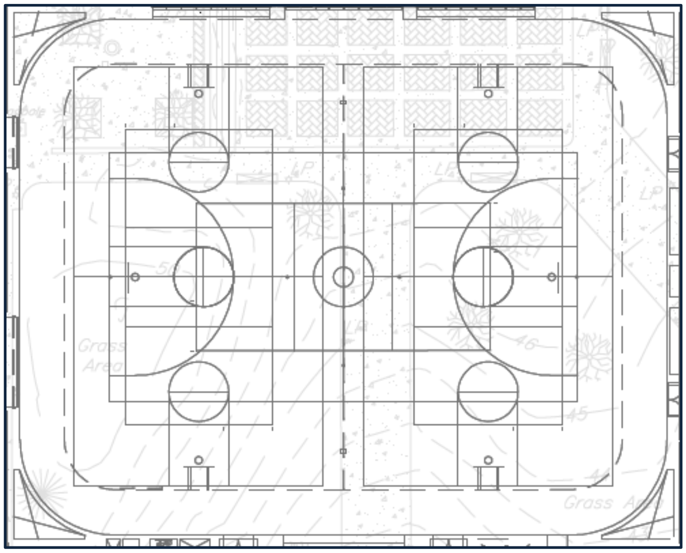
space description

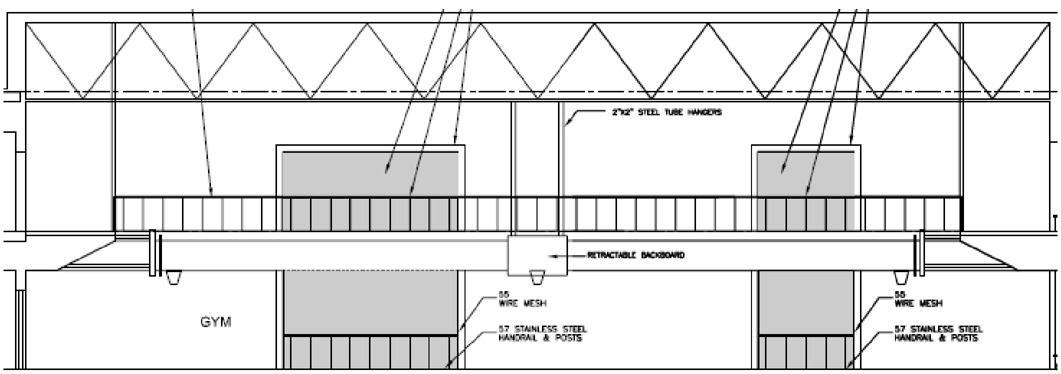


The bi-level gymnasium is located on the second and third floors of the Northern face of the Athletic Center addition and can be entered from the fitness area or for special events from the courtyard. The space serves as the practice facility for the Drexel Dragons basketball team and has an elevated running track around the perimeter of the second level. A divider is enclosed within the dropped ceiling to section off the gymnasium for classes and different sports teams practice times. The northern wall is composed almost entirely of glass providing natural light to the space.

dimensions

The gymnasium measures 103 x 130' and spans a total of 13,420sf.





acoustic criteria

Reverberation time is the most common method of measuring the acoustic performance in an environment. The size of the space and the amount of reflective and absorptive materials determine the length of time it takes for sound to be absorbed in a space. The preferred value of reverberation time at mid-frequency (the average of reverberation time at 500 and 1,000Hz) is under 2 seconds. Because the Drexel gymnasium is used for a variety of sports practices and functions, a slightly lower reverberation time of 1.8 is the acoustic performance goal of this study.

calculation methods

Using the Sabine method, the absorptive co-efficients of materials applied across the space were compiled by unit surface area in order to obtain the reverberation time for common frequencies.
The formula following formula was then used to calculate the reverberation time for each frequency.

$$T = 0.05 * \frac{v}{\alpha}$$

where T= reverberation time required for sound to
decay 60db after time has stopped (seconds)
v = room volume (cf)
a = total sf of room absorption (sabins)

These values and results are shown in the table below.

Gymnasium Reverberation Analysis														
Surface	Description	Area (sf)	Sα - sabins by Frequency (Hz)											
			125Hz		250Hz		500Hz		1,000Hz		2,000Hz		4,000Hz	
east and west walls	high performance painted gypsum wall board	466	0.55	256.3	0.14	65.2	0.08	37.3	0.04	18.6	0.12	55.9	0.11	51.3
north and south walls	high performance painted gypsum wall board	769	0.55	423.0	0.14	107.7	0.08	61.5	0.04	30.8	0.55	423.0	0.55	423.0
north wall	Viracon insulated laminated glazing	710	0.35	248.5	0.25	177.5	0.18	127.8	0.12	85.2	0.07	49.7	0.09	63.9
elevated track level	12 mm rubber track surface	3,200	0.02	64.0	0.02	64.0	0.03	96.0	0.03	96.0	0.03	96.0	0.02	64.0
gymnasium flooring	bio channel wood flooring system	13,390	0.02	0.0	0.14	1,874.6	0.08	1,071.2	0.04	535.6	0.55	7,364.5	0.55	7,364.5
ceiling beneath track	painted gypsum wall board	3,200	0.55	1,760.0	0.14	448.0	0.08	256.0	0.04	128.0	0.55	1,760.0	0.55	1,760.0
gymnasium ceiling	exposed structural steel painted white	12,430	0.73	9,073.9	0.69	8,576.7	0.99	12,305.7	0.89	11,062.7	0.52	6,463.6	0.31	3,853.3
skylights	OldCastle Builing Envelope insulated skylights	1,152	0.35	403.2	0.25	288.0	0.18	207.4	0.12	138.2	0.07	80.6	0.04	46.1
air	values per 1000cf	469	0.09	42.2	0.2	93.8	0.49	229.8	1.2	562.8	2.9	1,360.1	7.4	3,470.6
people	values per 1/10 person	250	0.25	62.5	0.35	87.5	0.42	105.0	0.46	115.0	0.5	125.0	0.5	125.0
Total Sα				12,333.6		11,783.0		14,497.7		12,772.9		17,778.4		17,221.6
Reverberation Time				1.90		1.99		1.62		1.83		1.32		1.36

conclusion

All reverberation times are below the recommended level of 2 seconds. The additional criteria of 1.8 seconds based on the average of 500 and 1,000Hz is also met with a value of 1.71 seconds. The removal of the dropped tile ceiling to incorporate daylight into the space will successfully increase energy savings and the aesthetics and environment in the gymnasium without sacrificing acoustic performance.

breadth three: structural

The modification of the ceiling for daylight integration adjusted the structural loading on the steel truss system supporting the roof. The loading distribution due to design modifications, including the rearranging of the mechanical equipment was be recalculated using STAAD, and the resulting stresses on the truss were analyzed to ensure that the existing truss was sufficiently designed to support the distributed weight.

breadth scope

The existing mechanical equipment layout needed to be adjusted as the rooftop air handling units and their mounting pads were distributed across the center of the space, hindering a uniform skylight layout.

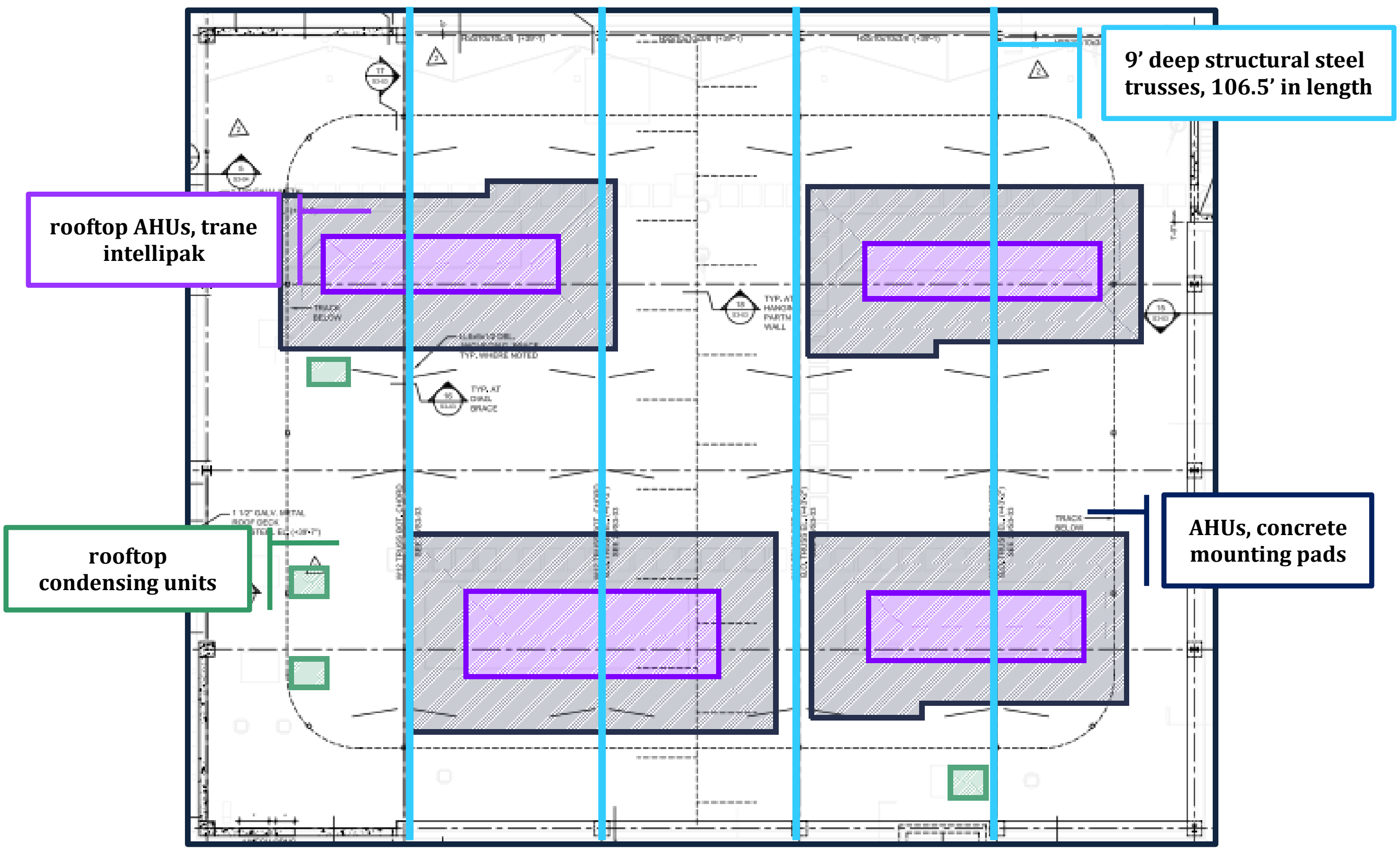


figure s.1- Existing rooftop mechanical layout

The rooftop air handling units and their supporting concrete mounting pads were manipulated in order to accommodate the centralized skylight layout allowing maximum uniform daylight in the space. This required the displacement of the rooftop condensing units to make room along the perimeters for the AHUs and their mounting pads.

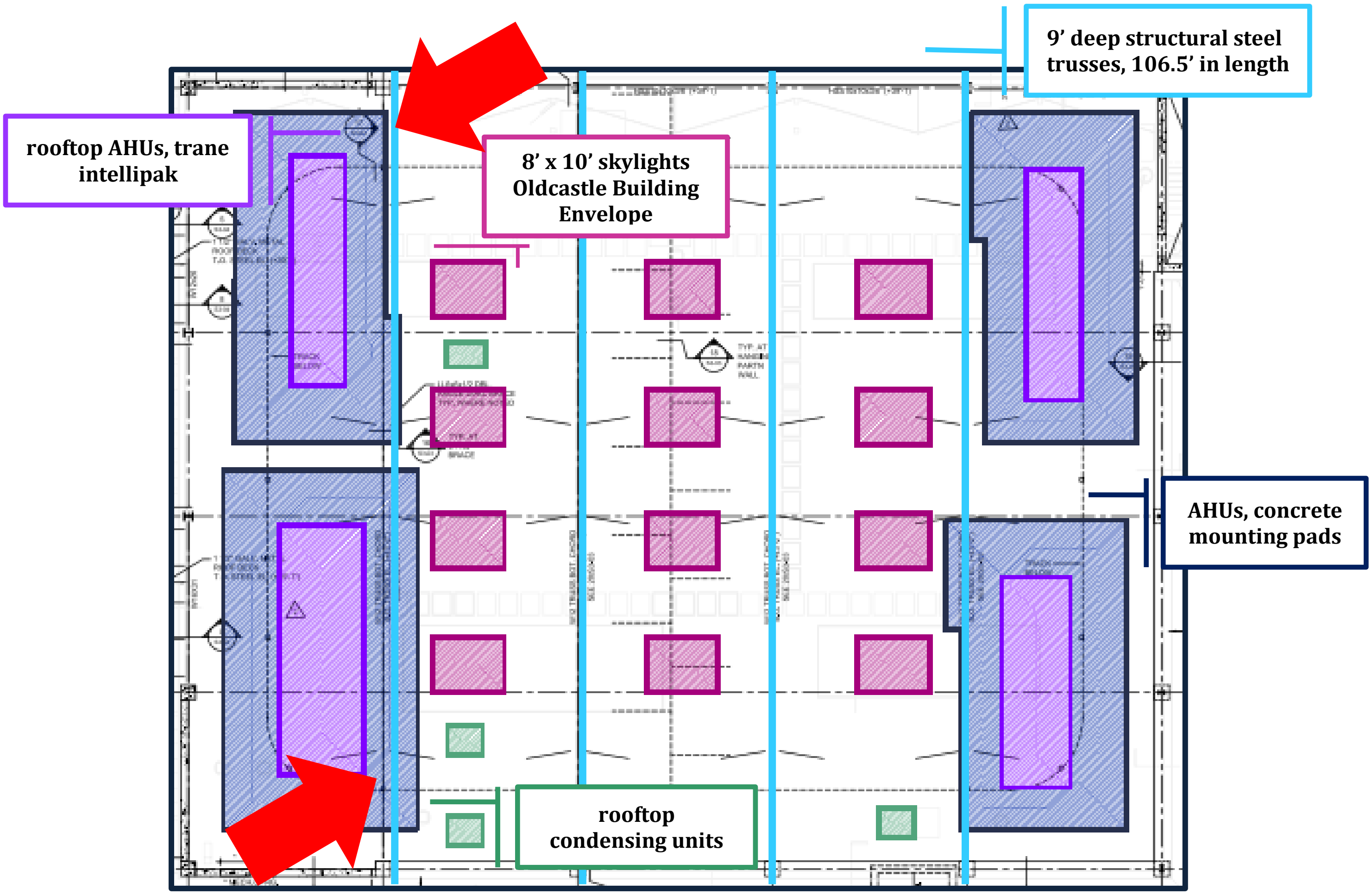


figure s.2 -Updated Roof Mechanical Equipment Plan

All four trusses shown above are identical, with a 26.5' spacing. The truss highlighted above with two red arrows is the most heavily loaded after the mechanical equipment shifts, and so was the one selected for analysis.

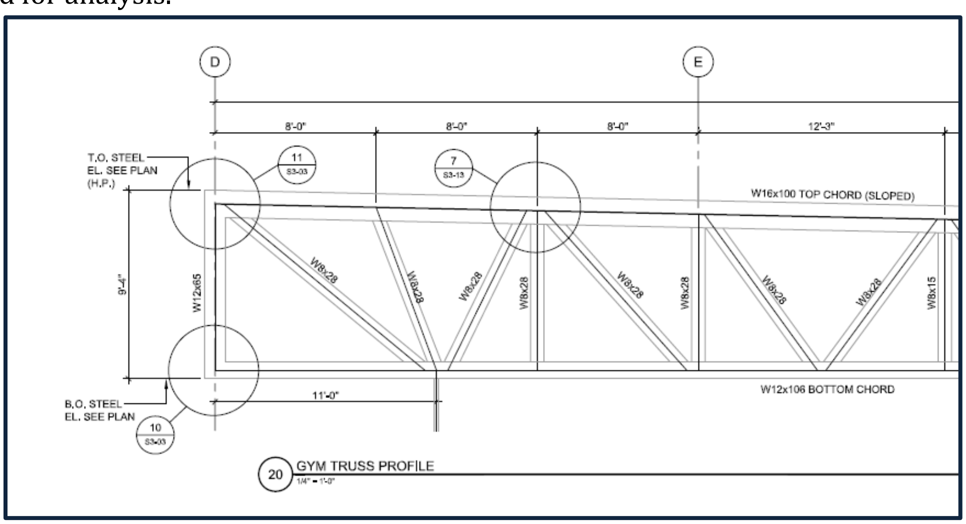


figure s.1 - Structural Profile of Existing Trusses

loading calculation

A combination of loads provided by the structural engineer, assumptions from ASCE 7-05 and IBC 2006, and actual calculations based on the weight of actual Trane mechanical equipment from cut sheets were used to determine the loading on the selected truss. Outlined below is a breakdown by load type.

snow load- criteria

snow exposure factor, C_e	1
roof exposure	partially
exposure category	B
snow thermal factor, C_t	1
snow importance factor, I_s	1.1
ground snow load, P_g	30

$Pf= 0.7C_eC_tI_sP_g = 23.1$

For general design, a snow load of 25psf was selected.

live load

A superimposed live load of 25psf was assumed, taken from ASCE 7-05, table 4-1.

dead load

roof deck: 3" 20-gage galvanized roof deck	5 psf
Oldcastle Building Envelope insulated skylights	12 psf
ceiling/mechanical	13 psf
AHU concrete mounting pads	145csf
AHUs, Trane Intellipak 55-75 tons	44,550lbs
condensing units, rooftop	138.9lbs

The applied load case was ***(1.6) live/snow + (1.2) dead*** which resulted in the following loadings when considering the tributary area of 26.5'

Unified loading of (1.6)*622.5plf + (1.2)*477plf across the entire beam, with the dead load increasing to (1.2)*622.5 at skylight locations.
Point loads of 138.9lbs and 557 lbs at 30' and 98.5' respectively.
Distributed loads of 232plf for the concrete mounting pads and 3,205plf for the two AHUs.

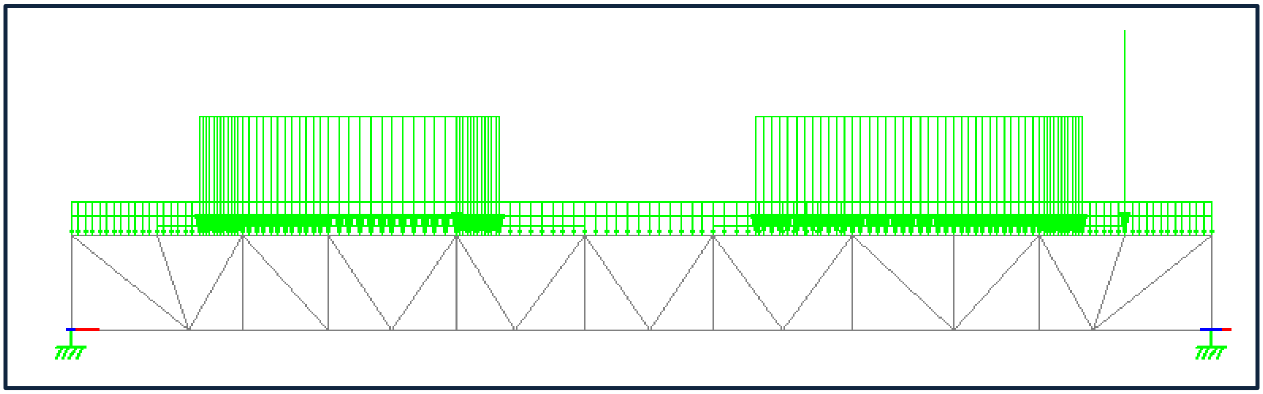


figure s.2 - Diagram of load application in STAAD

truss analysis

supports

Support one was modeled as a pinned connection, fixed but released for moments in z, and support two was modeled as a roller, fixed but released for moments in z and forces in x.

members

top chord: *W14x120*
bottom chord: *W12x106*
end supports: *W12x65*
truss members: *W8x28 and W8x15, as designed.*

spot checks

top chord- compression member

available strength in axial compression (Fy=50ksi)	807kips
maximum axial compression from load	587kips

bottom chord- tensile member

available shear strength in tension (Fy=50ksi)	236kips
maximum shear forces in y from load	48kips

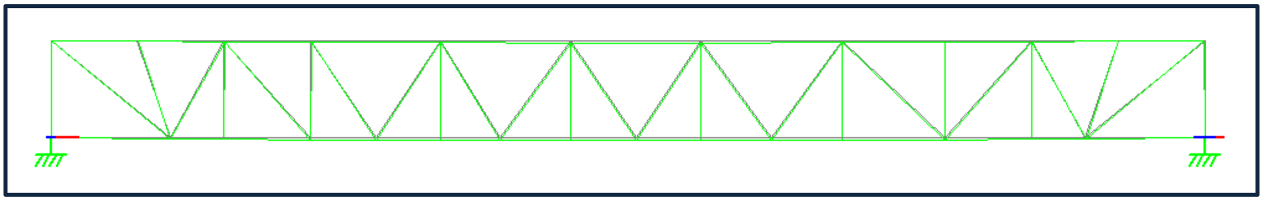


Figure s.3-Displacement diagrom from resulting loads

max stress checks

beam 18: W8x28

available shear strength (Fy=50ksi)	68.9kips
maximum shear forces in y from load	.41kips
available moment	102kip-ft
maximum moment from load case	41.2kip-ft

beam 25: W8x28

available shear strength (Fy=50ksi)	68.9kips
maximum shear forces in y from load	13.1kips
available moment	102kip-ft
maximum moment from load case	61.1kip-ft

beam 13: W8x15

available shear strength (Fy=50ksi)	59.6kips
maximum shear forces in y from load	4.3kips
available moment	51kip-ft
maximum moment from load case	27.9kip-ft

beam 29: W8x28

available shear strength (Fy=50ksi)	68.9kips
maximum shear forces in y from load	21.5kips
available moment	102kip-ft
maximum moment from load case	78kip-ft

conclusion

Based on the above calculations and analysis, the truss does not need to be redesigned for the addition of skylights. Even with the new layout of the system, the existing truss is sized substantially to support the mechanical loading on the roof with skylights both in tensile and compressive stresses.

summary and conclusions

The purpose of the AE senior thesis is not only to perform design and analysis in lighting and electrical studies, but to further comprehend the integration of all building systems and their effects on the total energy consumption, cost savings, system efficiency, and aesthetics and other effects on a project. The result of extensive research, design development, and analysis, this thesis presents a set of new concepts and ideas that enhance the sustainability, aesthetics, and performance of the Drexel Recreation Center.

The exterior space was transformed into a courtyard full of visual interest and safety. The fitness center utilizes the core energy of the building by interacting with the energy created by the user and exposing the source of the power generation to the exterior. The lobby provides a highly energy efficient lighting solution while directly complementing the lines of the architecture. The restaurant creates an enticing new venue in University City, continuing the design concepts of the fitness center while differentiating itself as a separate space entirely.

To incorporate the new lighting designs, the electrical system was also redesigned at the branch circuit level, with a short circuit and protective device coordination study to guarantee the safety of the overcurrent protection through the distribution center. An alternative to cast-in-place distribution to the fitness equipment branch circuits, an option of cable tray was presented as a cost-effective and feasible solution providing future flexibility.

Introducing skylights into the gymnasium enhanced the ambient energy within the space and provided over 50% electricity cost savings throughout the year. A structural and acoustical analysis of this solution concluded that the addition of skylights is in fact a feasible and beneficial addition to the delighting in the space.

The structural design of the Recreation Center presented the primary lighting challenges in that no fixtures could be recessed into the architecture in the fitness center or lobby, but this resulted in lighting designs that fully fulfilled the goal of exposing the energy of the building by exposing the lighting and providing innovative, aesthetically pleasing solutions to a complex design problem.

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software

3DStudioMAX, Adobe Photoshop CS5, AGI32, Autodesk AutoCAD 2011, DAYSIM 2.1, STAAD.Prov8i

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