Designing a Power Distribution System for the ARCE 257 Revit Structural Model

By Reid Wilhelm

Senior Project

ELECTRICAL ENGINEERING DEPARTMENT

California Polytechnic State University

San Luis Obispo

2016

Table of Contents

List of Tables and Figures

Tables Page

Figures Page

Acknowledgements

Mom, Dad, and Rachel,

From the bottom of my heart, thank you for providing me with the love, support, and encouragement to pursue my college degree. You guys have believed in me since day one and taught me to never give up. Without you guys, I would have never made it. You are the reason for my hard work and perseverance, and I love you all so much.

Doctor Tina Smilkstein,

Thank you so much for being my senior project advisor. I know I was not the best student, but I appreciate your openness and willingness to let me take-on this project.

exp *San Diego Office,*

Thank you for the knowledge and encouragement to embark on this project. Also, thank you for allowing me to use your Revit families and libraries. Without these, I wouldn't have been able to complete this endeavor!

Mr. David Phan,

I am beyond grateful for all of the help and guidance you provided to me on this project. I cannot wait to start working with you and the rest of the crew at **exp***!*

Ms. Hannah Rogers and Mr. Stewart Hooks,

Thank you for being on "standby" with the Revit support, and for giving me the rights to use your ARCE 257 structural model. Your support and positivity is infectious, and I will miss you both immensely!

Abstract

The construction industry needs engineers. Mechanical, electrical, and plumbing engineers, better known as MEPs, comprise a large number of employees who design and assist in the building of commercial structures. In particular, electrical engineers design power distribution systems for these buildings, including the power, lighting, low voltage, and fire protection subsystems.

Here at Cal Poly, architectural engineers enrolled in ARCE 257 create authentic structural plans for a fictitious two-story structure. This senior project transforms these structural plans into an architectural model and creates a power distribution system for the entire building. This is done through a building information modeling (BIM) software called *Revit*.

In this project, the architectural model is used to create floor plans where the separate power and lighting subsystems are drafted. Electric panel schedules define the loads on each circuit used within the subsystems. Finally, a single line diagram will present the overall architecture of the power distribution system by exhibiting the interconnections between the larger pieces of electrical equipment. The final product compiles of all this information onto personalized construction sheets.

Chapter 1

Introduction

Like clean running water and personal vehicles, American's take for granted their ability to access power and electricity. The brains behind this artificial resource are electrical engineers who practice their skills to manipulate power and design distribution systems for all different types of structures. These distribution systems are responsible for sourcing everything electrical in a building, from power receptacles and mechanical motors, to lighting and low-voltage systems.

After completing an internship with **exp**, a global and highly respected MEP contractor, I learned the fundamentals needed to design power distribution systems for commercial buildings. Specifically, I was exposed to the power, lighting, low voltage, and fire protection subsystems. In addition, I learned about the coordination necessary between other engineering disciplines; ensuring a smooth, cheaper, and overall faster construction process.

In this project, I designed a fully functional power and lighting distribution system for a two-story commercial building. The building's model comes from Cal Poly's own ARCE 257 course, where structural plans were produced in the multidisciplinary construction software called *Revit*. The building does not actually exist. Rather, it has been calculated and engineered by ARCE students and theoretically, it could be erected.

Using this structural model, I created the architectural model needed to draft electrical plans in *Revit*. In addition, corresponding electrical schedules were produced for power and lighting. These describe the power consumption and load of each electrical connection. Another software called *AutoCAD* generated the single line diagram (SLD) for the project. The SLD is equivalent to a block diagram used in electronics. Instead of displaying microcontrollers and integrated circuits, the SLD provided a comprehensive architecture of the panelboards, switchboards, and transformers used to create the entire power distribution system.

Chapter 2

Customer Needs Assessment

In consulting engineering, customer needs stem from the owner and architect of the project. These needs are then commutated to the design engineers from the project manager. Considering I started this project by creating an architectural model, my first set of customer needs was determining the necessary rooms in an office building. I generated the following room list: CEO/Management Offices, General Workspace for Employees, Conference Room, Elevator, Stairs, Lobby, Restrooms, Electric Room, and Kitchenette. The need for these rooms were based on my personal experience of working in an office building and asking my peers what kind of rooms would they prefer in the workplace.

The next customer need is safety. The power distribution system should be unnoticed or "camouflaged" to the average worker. This means electrical conduit (or wiring) will not be exposed, and access to panelboards and transformers will be limited to engineers familiar with the system. When used properly, the overall system will pose no physical threat and never harm any individual in contact with it. For example, by installing GFI receptacles near any source of running water, the engineer is mitigating the risk of a hydro-electric shock. As for the electrical lighting system, certain lights will be placed on a "critical branch." In case of emergency, these lights will illuminate a safe path to exit. This "path of egress" with host additional exit signs. Also, all codes and laws enforced by state and federal governments will be met. In particular, the National Electric Code (NEC) will be followed closely.

Due to a lack of the appropriate software, an Arc Flash Study could be completed to isolate any faults within the power distribution system. These studies coordinate which electric circuit breakers will trip in the event of failure.

The final customer need is power efficiency. Proper sizing of electric equipment helps reduce power consumption. In addition, control receptacles and motion sensors can temporarily shut off their sourced power while not in use. Combined, these measures reduce the overall cost of electric bills.

Requirements and Specifications

After determining my customer needs, I constructed the first draft of my SLD. The SLD helped me derive the essential marketing requirements. My engineering specifications involved taking these broad requirements, and constraining them into a specific phrase that any engineer would unambiguously understand. See Table 2.1 for all marketing requirements, corresponding engineering specifications, and respective justifications.

In Table 2.1, most of the requirements apply to the sizing and rating of the electrical equipment on the SLD. Particularly, distinguishing which pieces of equipment are sourced from the 480V or 208V busses, along with the internal design requirements for the panelboards are shown.

TABLE 2.1

POWER DISTRIBUTION SYSTEM REQUIREMENTS AND SPECIFICATIONS

Marketing Requirements	Engineering Specifications	Justification
1	A 13.8kV : 480V, 45kVA-rated utility transformer is supplied by the local electric company and located within 150 feet of the perimeter of the building.	This is a standard utility transformer rating offered by SDG&E. The location of the transformer ensures safety to the employee in the event of failure, while still being close enough in proximity to source power.
1,3	A 3-Phase, 4-Wire Main Switch Board (MSB) is rated at 480/277V and connects to the utility transformer via an electric meter.	This is a standard switch board rating. The electric meter provided by the electric company tracks the total power consumed, so a monthly bill can be sent to the building's tenants.
1	A 3-Phase, 4-Wire Distribution Board (DB1) is rated at 208/120V.	This distribution board offers a lower bus voltage to source various panelboards.
1,2	A 480V : 208V transformer (XFMR) connects the MSB to the DB1.	This stepdown transformer is required to connect the different voltage levels of MSB to DB1.
2	All power panelboards will be rated at 208/120V and will be connected to the DB1.	The lower voltage is required across receptacles, which are loaded on this panelboard. The breakers are sized according to power consumption. Please see Chapter 3.
2	All lighting panelboards will be rated at 480/277V and will be connected to the MSB.	A higher voltage improves the efficiency of the system, as it allows for more lighting fixtures loaded on a single circuit. Please see Chapter 3.
3	Each panelboard will contain a minimum of six spare circuits.	It is good practice to leave approximately 10% of a panelboard unloaded for future installations. In a 42 circuit panelboard, six spares meet this criteria, allowing for two circuits on each phase (A, B, and C).
1	The maximum current flowing on a circuit will not exceed 80% of the circuit breaker's current-rating.	This satisfies the requirements of the NEC.

1, 2,3	The electrical room will be located on the first floor and will not exceed 300 square feet.	The MSB, DB1, XFMR, and all power and lighting panelboards will be located in the electrical room, therefore an ample amount of space is required.
Marketing Requirements 1. Safe 2. Efficient 3. Adaptable		

Table 2.2 provides an estimation of the most important deliverable dates for my senior project. The three Gantt Charts in Figures 4.1-4.3 contain the same dates.

TABLE 2.2
POWER DISTRIBUTION SYSTEM DELIVERABLES

Delivery Date	Deliverable Description
5/9/16	Design Review with Coworker
5/24/16	EE 461 Report V2 (Interim Report)
10/14/16	Final Project Revision with Advisor
11/14/16	Update Specifications and ABET Sr. Project Analysis
11/21/16	EE 462 Report Feedback
12/12/16	EE 462 Final Report Submission

Chapter 3

Architectural Modeling

I acquired the ARCE 257 structural model from my architectural engineering friends. The model solely consisted of columns and beams, as seen in Figure 3.2. My friends helped me convert the structural plans into architectural floor plans by showing me how to create walls, doorways, windows, and room tags. In the industry, the architect normally designs the floor plans and sends them to the MEP. Also, architectural models are consistently updated and forwarded to the MEP, which can result in major design changes. Overall, I learned this job is extremely tedious, as it took me weeks to perfect my design. This gave me a greater appreciation and understanding for the architect and the work they do within the industry. Figures 3.1-3.6 illustrate the before and after pictures of this process.

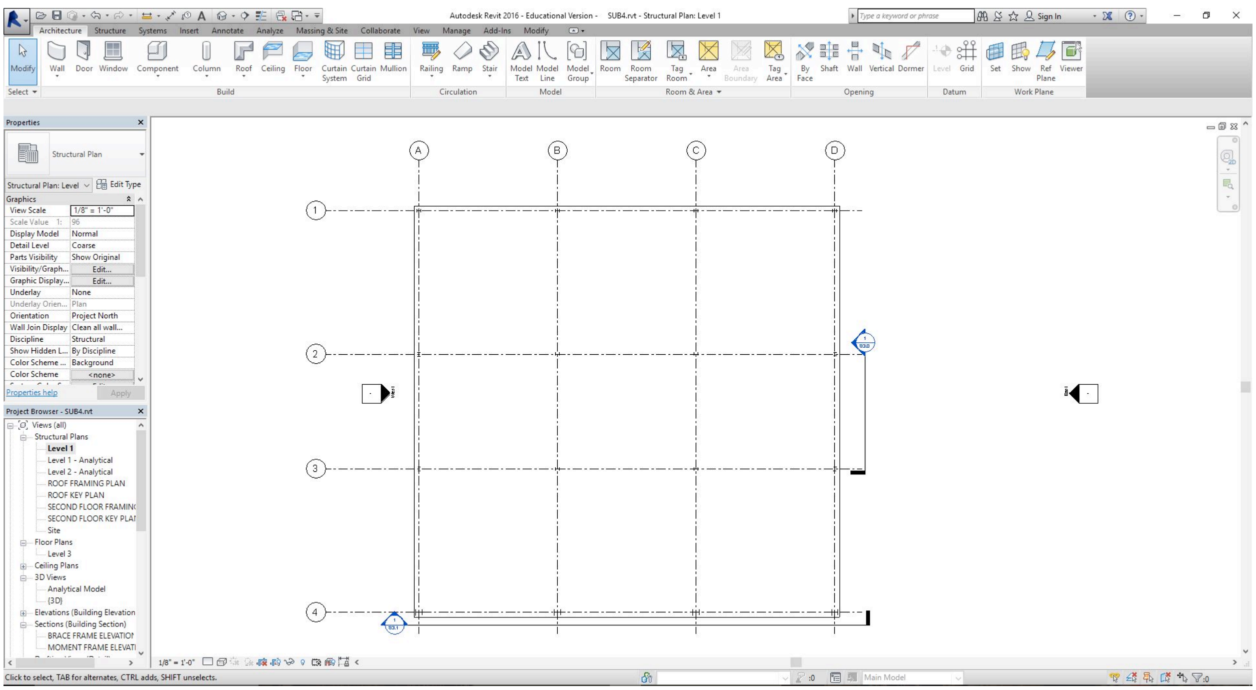


FIGURE 3.1: ORIGINAL ARCE 257 FIRST FLOOR STRUCTURAL PLAN

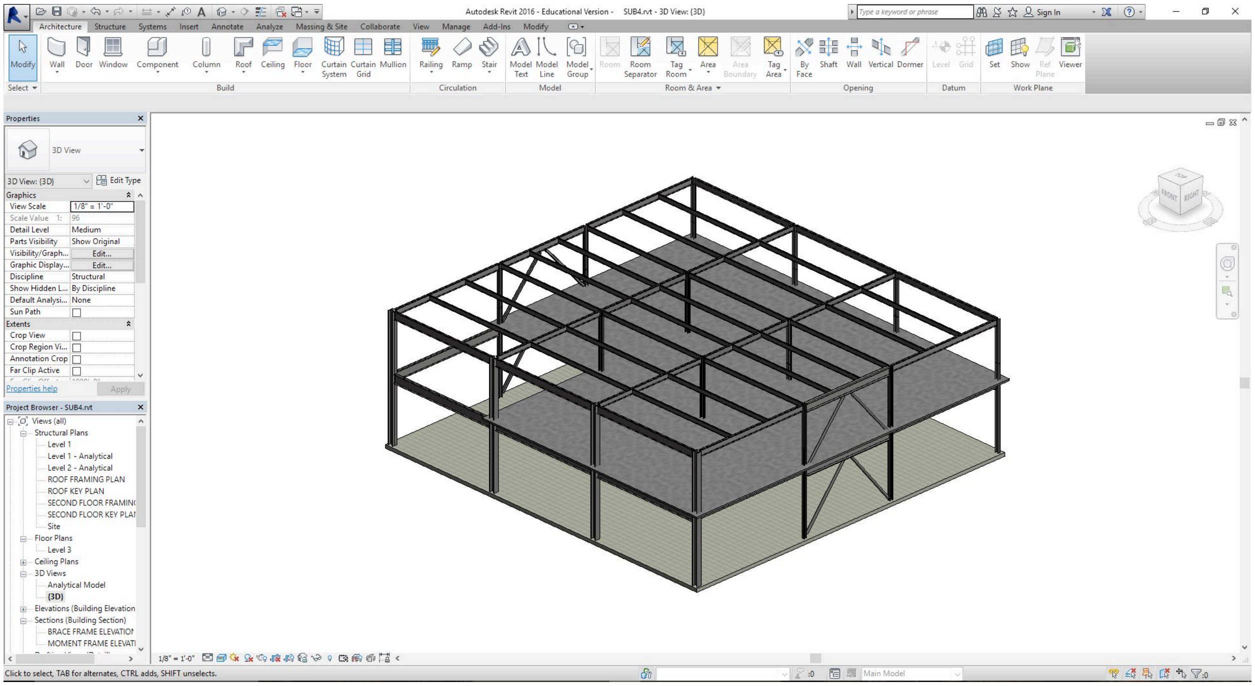


FIGURE 3.2: ORIGINAL ARCE 257 STRUCTURAL 3D MODEL

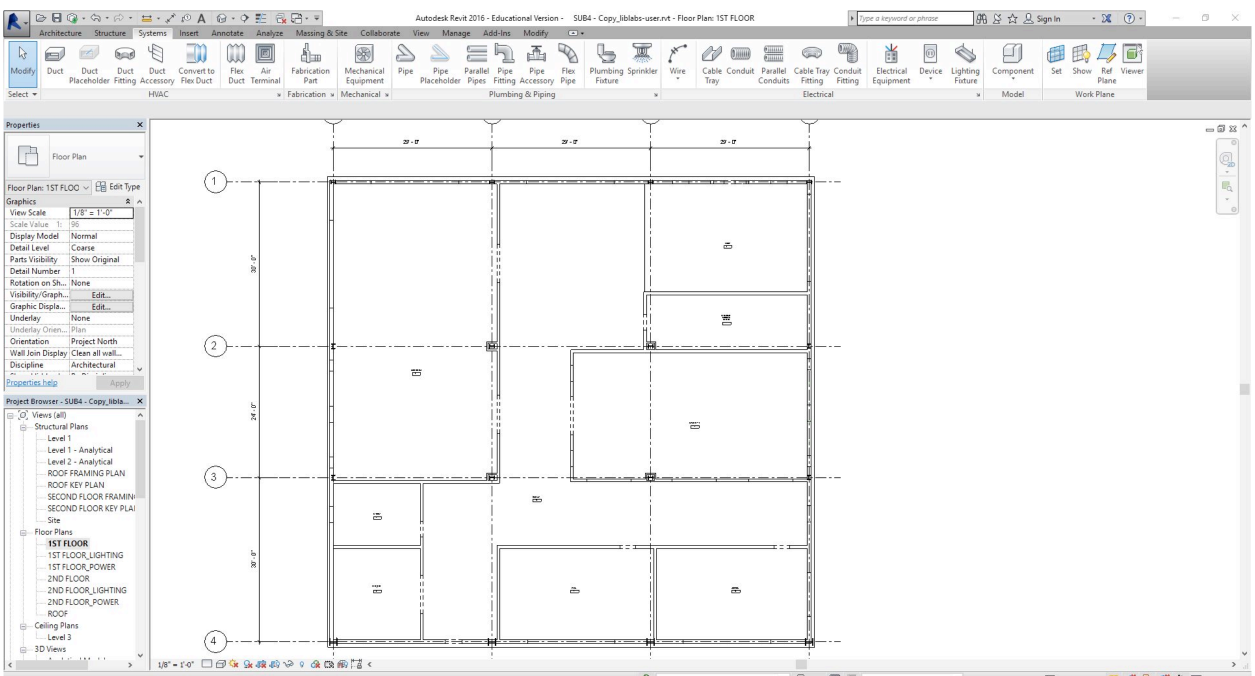


FIGURE 3.3: FIRST FLOOR ARCHITECTURAL FLOOR PLAN

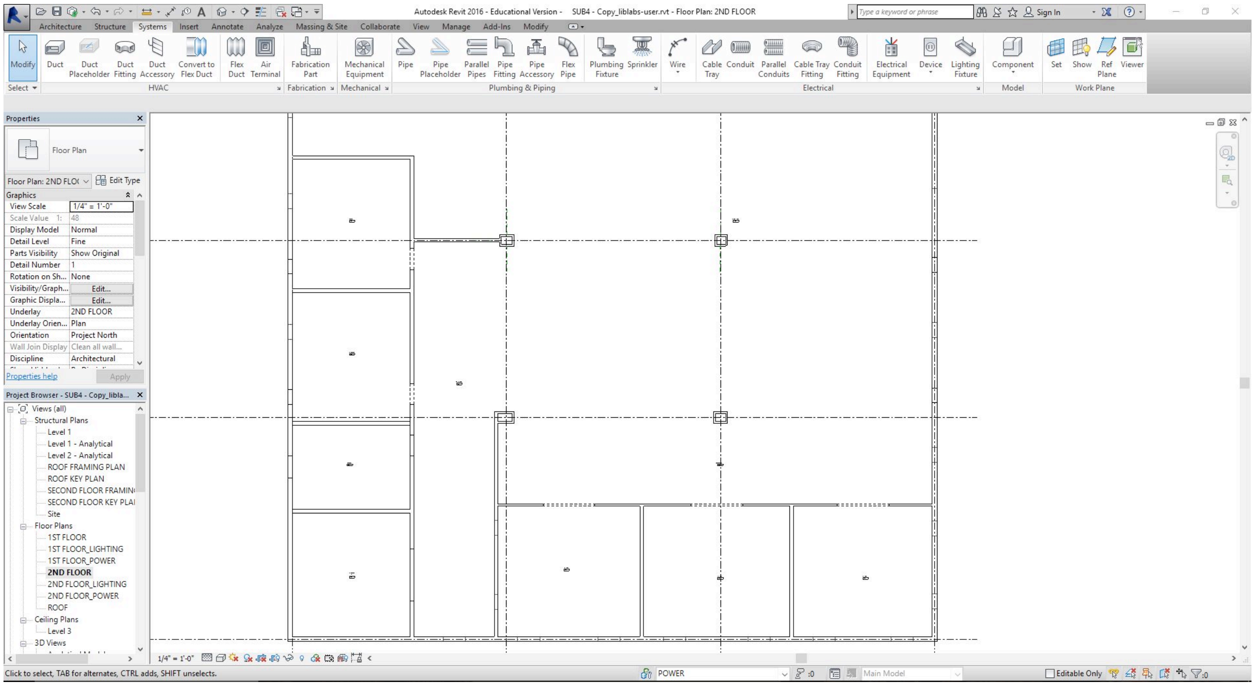


FIGURE 3.4: SECOND FLOOR ARCHITECTURAL FLOOR PLAN

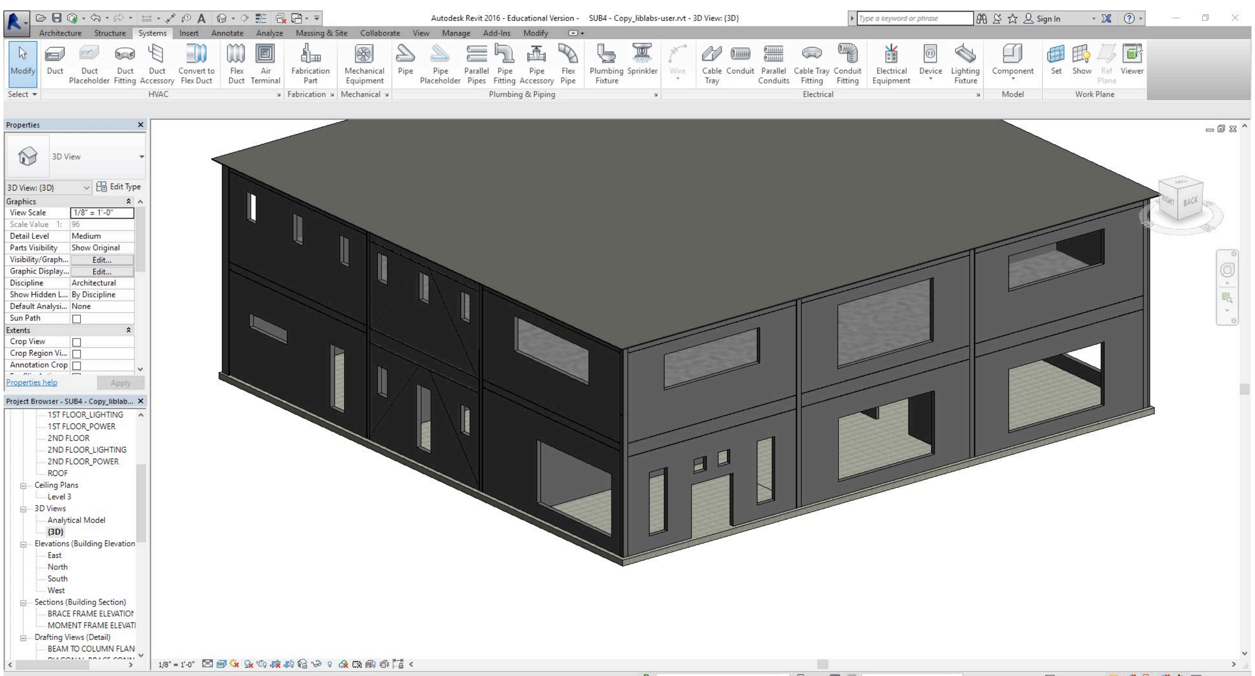


FIGURE 3.5: FRONT ARCHITECTURAL 3D MODEL

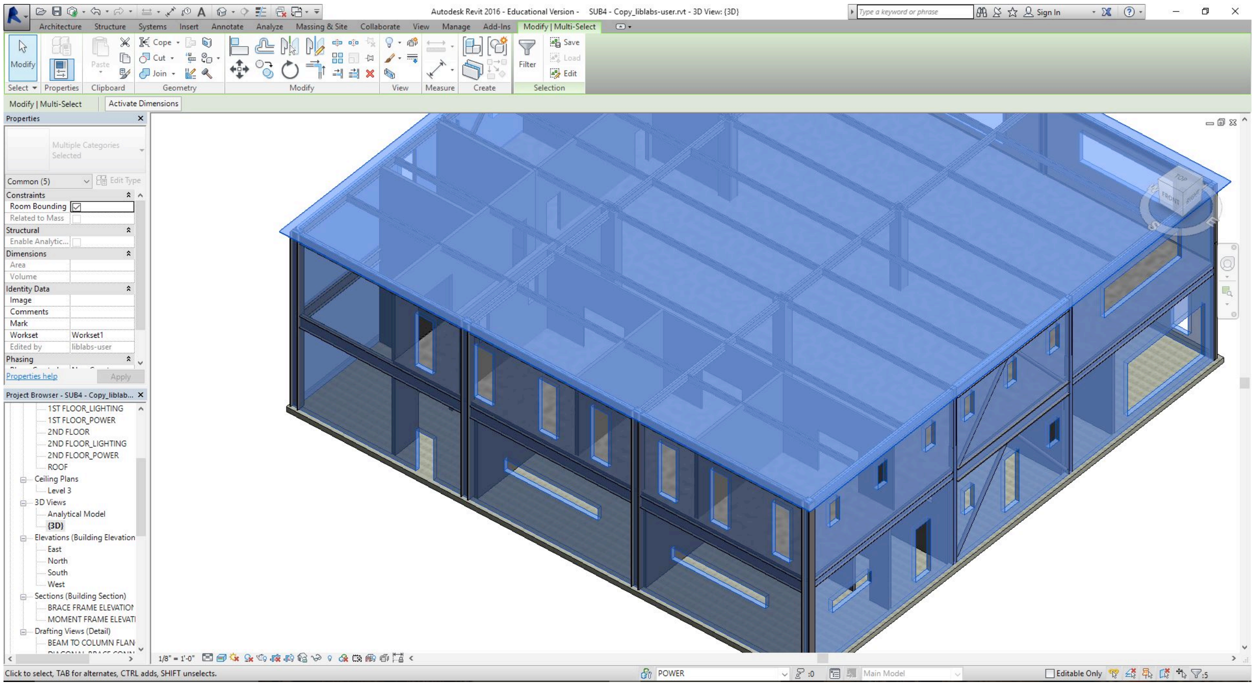


FIGURE 3.6: REAR ARCHITECTURAL 3D MODEL WITH SEE-THROUGH VIEW

As seen in Figures 3.1 and 3.2, the structural plans lacked a roof, floors, walls, windows, doors, and rooms. Figures 3.3 and 3.4 display the rooms I designed including: offices, general workspace, conference room, elevator shafts, staircase, lobby, restrooms, electric room, and kitchenette. Figure 3.5 shows the front of the building in 3D; for reference, the main entrance and lobby are located in the center of the picture, on the first floor. Finally, Figure 3.6 offers a 3D, transparent picture of the back of the building. In particular, the offices and elevator shaft are clearly seen. Please note, more detailed images of the floor plans can be viewed on the final electrical sheets, located in Appendix B.

Electrical Power and Lighting Schedules

Electrical schedules describe the loads connected to each circuit within a panelboard. In addition, they list important specifications exclusive to each panelboard including but not limited to: the rated voltage, total power consumption, total current consumption, and the supplied power source. Please see Figure 3.7 which shows the first floor power panel schedule. Note, a more detailed version of all the panel schedules created for this project can be viewed on the on the final electrical sheets, located in Appendix B.

Branch Panel: PWR1

Location: ELECTRICAL AND DATA CENTE...	**Volts:** 120/208	**A.I.C. Rating:**
Supply From: DB1	**Phases:** 3	**Mains Type:**
Mounting: Surface	**Wires:** 4	**Mains Rating:** 150 A
Enclosure: Type 1		**MCB Rating:**

Notes:

CKT	Circuit Description	Trip	Poles	A		B		C		Poles	Trip	Circuit Description	CKT
1	RECEPTACLE, LOBBY	20 A	1	1080 VA	1080 VA					1	20 A	RECEPT, PROJECTOR JBOX, CONF RM.	2
3	RECEPTACLE, LOBBY AND HALLWAY	20 A	1			1080 VA	1080 VA			1	20 A	RECEPTACLE, HALLWAY	4
5	RECEPTACLE, KICTHEN AND ELEC RM.	20 A	1					1080 VA	1720 VA	1	20 A	RECEPTACLE, EXHAUST FAN, RESTRMS.	6
7	REFRIGE MICROWAVE - KITCHEN	20 A	1	1000 VA	720 VA					1	20 A	RECEPTACLE, HALLWAY	8
9	RECEPTACLE, KITCHEN	20 A	1			1080 VA	540 VA			1	20 A	RECEPTACLE, STAIRS AND ELEVATOR	10
11	RECEPTACLE, CONFERENCE RM	20 A	1					1080 VA	0 VA	1	20 A	SPARE	12
13	SPARE	20 A	1	0 VA	0 VA					1	20 A	SPARE	14
15	SPARE	20 A	1			0 VA	0 VA			1	20 A	SPARE	16
17	SPARE	20 A	1					0 VA	0 VA	1	20 A	SPARE	18
19	SPARE	20 A	1	0 VA	0 VA					1	20 A	SPARE	20
21	SPARE	20 A	1			0 VA	0 VA			1	20 A	SPARE	22
23	SPARE	20 A	1					0 VA	0 VA	1	20 A	SPARE	24
25	SPARE	20 A	1	0 VA	0 VA					1	20 A	SPARE	26
27	SPARE	20 A	1			0 VA	0 VA			1	20 A	SPARE	28
29	SPARE	20 A	1					0 VA	0 VA	1	20 A	SPARE	30
31	SPARE	20 A	1	0 VA	0 VA					1	20 A	SPARE	32
33	SPARE	20 A	1			0 VA	0 VA			1	20 A	SPARE	34
35	SPARE	20 A	1					0 VA	0 VA	1	20 A	SPARE	36
37	SPARE	20 A	1	0 VA	0 VA					1	20 A	SPARE	38
39	SPARE	20 A	1			0 VA	0 VA			1	20 A	SPARE	40
41	SPARE	20 A	1					0 VA	0 VA	1	20 A	SPARE	42
			Total Load:	3880 VA		3780 VA		3880 VA					
			Total Amps:	32 A		32 A		32 A					

Legend:

Load Classification	Connected Load	Demand Factor	Estimated Demand	Panel Totals	
Power	1180 VA	100.00%	1180 VA		
				Total Conn. Load:	11540 VA
				Total Est. Demand:	11360 VA
				Total Conn. Current:	32 A
				Total Est. Demand Current:	32 A

FIGURE 3.7: FIRST FLOOR POWER PANEL SCHEDULE

As seen in Figure 3.7, panelboards typically have a total of 42 circuits, and each circuit is associated with a single phase. Therefore, there are typically 14 circuits on Phase A, 14 on Phase B, and 14 on Phase C. Unlike distribution and switch boards, the circuits on a panelboard are directly connected to their respective loads through a circuit breaker. The rating of the circuit breaker is denoted by the "Trip" and "Poles" column in Figure 3.7.

A load can vary in phase and rating. For example, a duplex receptacle only needs to be loaded on one circuit, or phase, and it has an average power consumption, or load value, of 180VA. Alternatively, a motor would typically occupy three circuits (or phases A, B, and C) and most likely consume power in the 2000-3000VA range.

The breaker sizes for the two previous examples would vary considerably and need to be sized appropriately. According to the NEC, breakers are sized to handle 125% of the load's maximum current [2]. Please see the following example describing this rule:

Assume I have a load of 1800VA on a 208/120V panelboard. This load occupies one circuit.

Because the load "occupies one circuit" or one phase, $120V_{LN}$ is used to calculate maximum current:
S=VI
1800VA = 120V(I)
I=15A

To determine the size of the breaker, the maximum current needs to be multiplied by 125%. According to NEC 705.12(D)(2), "For all bus and feeder ampacity calculations, 125% of the inverter output circuit current shall be used" [4]. Therefore:

15A(1.25) = 18.75A ≅ 19A

*Because a 19A/1-Pole circuit breaker does not exist, the breaker is sized up to the next available size. Thus, a **20A/1-Pole** circuit breaker should be selected.*

There are a few things to note about the previous example. First, the term "pole" is almost equivalent to "phase." The difference is that a 1-pole circuit breaker indicates there is one "hot" wire and one neutral wire. A 2-pole breaker would mean there are two "hot" wires and one neutral wire, and so on. Next, panelboards are usually fitted with 42 of the same sized circuit breakers in an attempt to save money. The 20A/1-Pole breaker is the most commonly used on a 208/120V panelboard, meaning all 42 circuits would be fitted with a 20A/1-Pole breaker.

One problem associated with installing 42 of the same sized breakers is under-sizing and oversizing. If the circuit breaker is under-sized, the load may cause the breaker to consistently trip even though it is sourcing an appropriate amount of current. On the other hand, if oversized, the breaker may not trip if the current is exceeding its rated limit. This can cause the electric wire to burn, creating a dead short and ultimately result in a fire hazard. This is why the engineer must confirm each circuit is properly loaded and that each phase is evenly balanced. To achieve this, multiple loads are often put on the same circuit.

Single Line Diagram

Similar to a block diagram in electronics, single line diagrams (SLDs) present the overall architecture of the power distribution system. Typical pieces of equipment displayed on SLDs include: panelboards, distribution boards, switch boards, transformers, fuses, disconnects, circuit breakers, and motors. In addition, voltage, current, and power ratings are often marked on the SLD.

Figure 3.8 presents the first hand-written draft I made for my power distribution system. I designed the system completely from scratch, meaning there were no constraints or limitations. Some MEP renovation projects require the engineer to design around previously installed equipment, which can be quite challenging. Because this project was new construction, I had the freedom to design an appropriate and simple system.

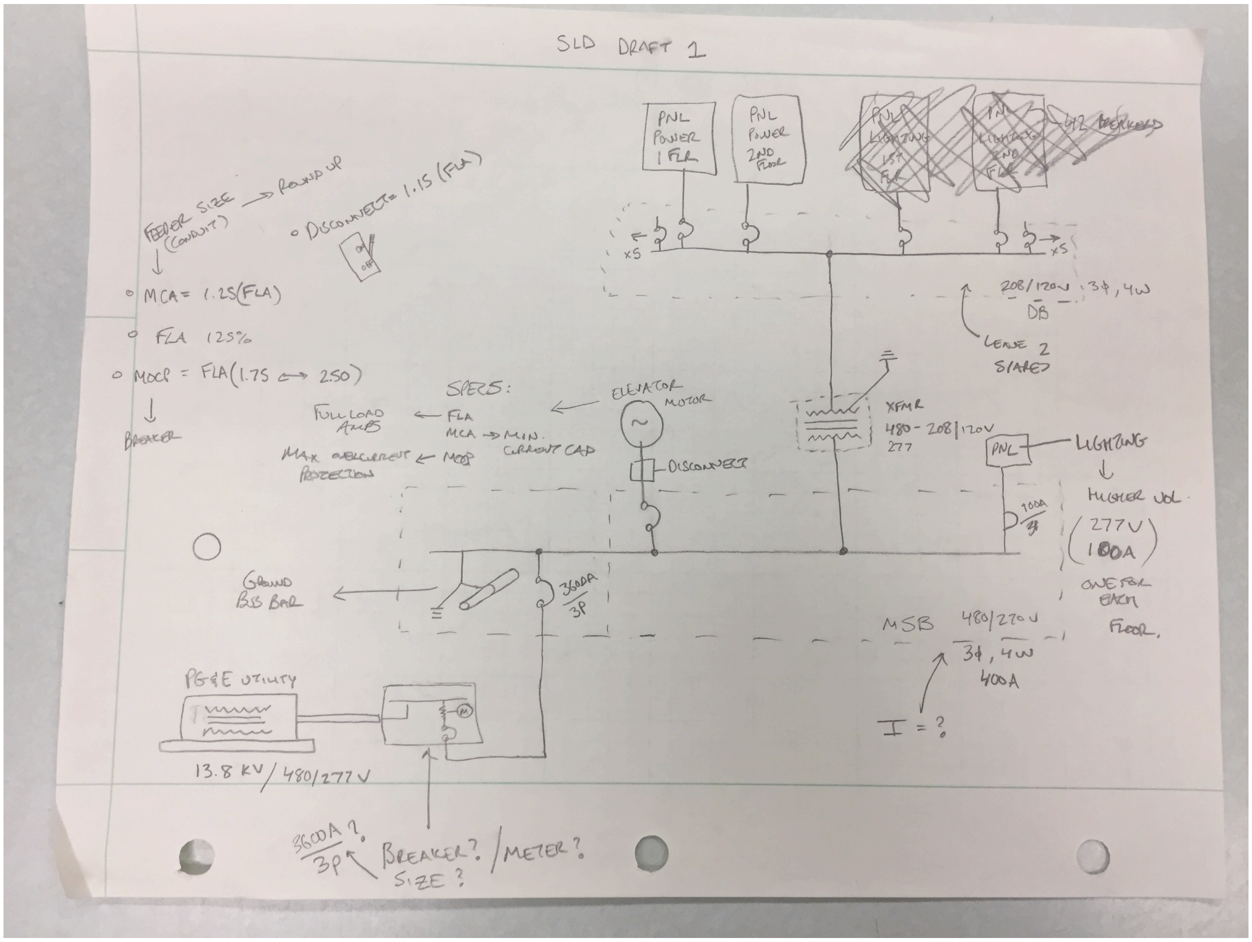


FIGURE 3.8: SINGLE LINE DIAGRAM FIRST DRAFT

One of the main purposes of a SLD is to match voltages. I assumed a utility transformer, with a common rating of 13.8kV to 480V, would be supplied by the local electric company. This transformer is then feed to my main switch board (MSB). Switch boards are the main source of power in a commercial building, and they are typically rated at 480/277V (480 V_{LL} [Volts line-to-line] / 277 V_{LN} [Volts line-to-neutral]). I then designed a 480:208V stepdown transformer to feed my 208/120V distribution board (DB1).

As seen in Figure 3.8, the lower voltage across DB1's bus allows for the loaded circuits within my power panels (like receptacles) to be sourced at the standard 120V. I also decided to power my lighting panels with the MSB bus (277V_{LN} instead of 120V_{LN}). Assuming it takes the same amount of power to light '*x*' amount of fixtures, a higher source voltage results in a relatively lower current. Additionally, this allows for more lighting fixtures on a single circuit, as the subsequent voltage drop per-fixture is smaller. The following maximum load calculations display why a 480/277V panel can source larger lighting fixture loads.

Assume a 20A/1-Pole Breaker in both instances:

Applying the NEC 125% rule: 20A/1.25 = 16A Maximum Current

Maximum Load of 208/120V Panel:

*16A * 120V =* ***1920VA***

Maximum Load of 480/277V Panel with 20A/1-Pole Breaker:

*16A * 277V = 4432VA*

Accounting for "inrush" current, divide by a factor of 1.4 [4]:

4432VA / 1.4 = ***3165VA***

As seen, the 480/277V panel can source a load at almost double the value of a 208/120V panel. Furthermore, LED lighting fixtures require significantly less power than most loads, usually in the 50VA range. This is why engineers prefer powering lighting panels on a 480/277V bus. In fact, all the lighting elements in this project fit on one panelboard with ample room left over. Please see Appendix B for panelboard LGHT1's lighting schedule.

Similarly, the 3-pole panelboard circuit breakers are sized from the "total connected current" specification which is listed near the bottom of each panel schedule. Please see the following example, which was used to size panel PWR1's circuit breaker:

Total Connected Load on Panel PWR1:11540VA

3-Phase Power:
*11540VA / [sqrt(3) * 208*V_{LL}*] = 32.0318A, as listed in "Total Connected Current" of Figure 3.7*

*32.0318A * 1.25 = 40.04A, which barely exceeds a 40A/3-Pole Breaker*

Next available breaker size: ***50A/3-Pole***

Figure 3.9 shows the complete SLD for the power distribution system. The diagram was drafted in a software called *AutoCAD*, then uploaded into *Revit*.

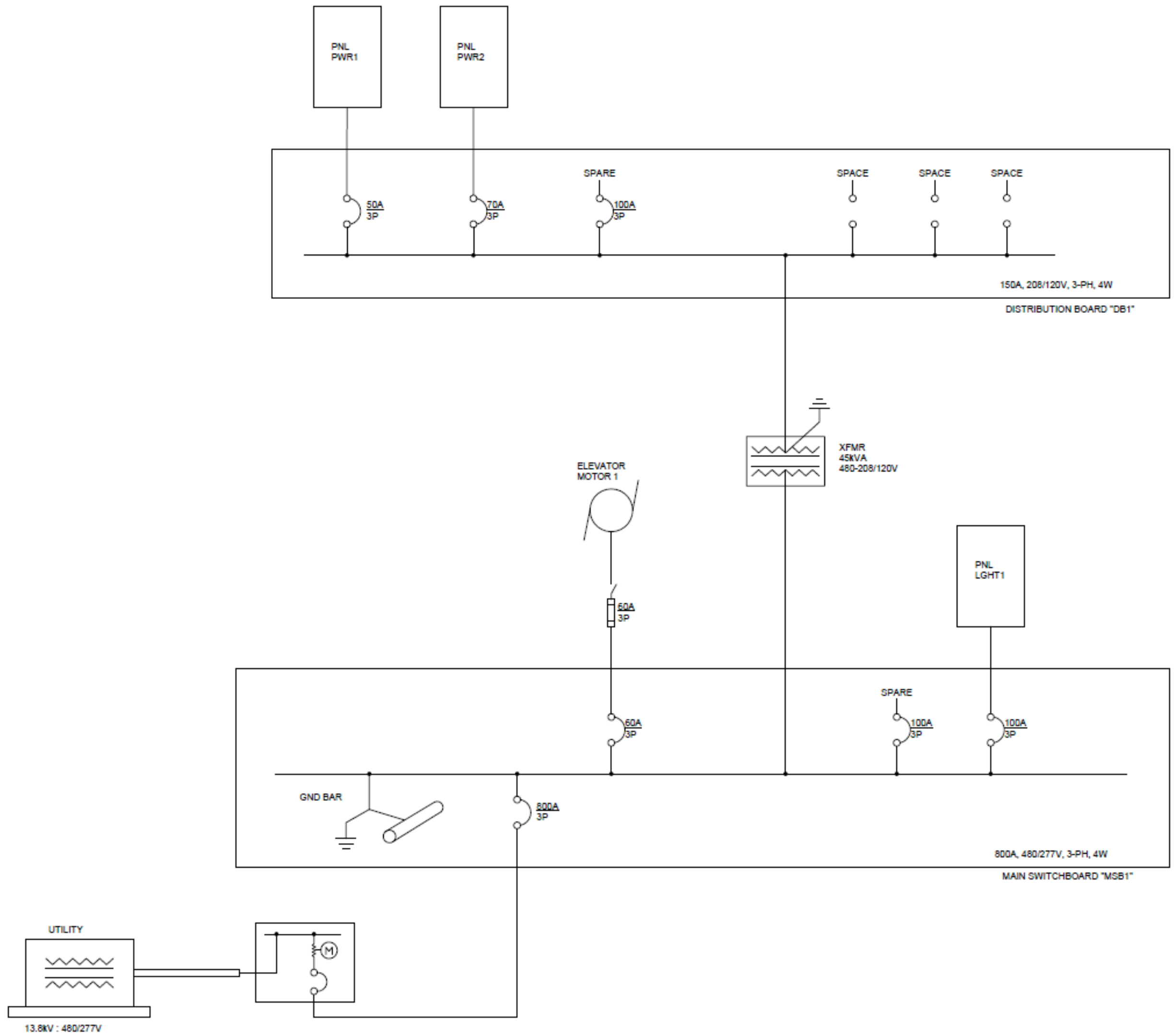


FIGURE 3.9: SINGLE LINE DIAGRAM DRAFTED IN AUTOCAD

The final SLD indicates the major pieces of electrical equipment used in the power distribution system. Note how the elevator motor is fed power from the MSB bus. Both a circuit breaker and disconnect fuse (required by NEC code) offer protection to the MSB in the case of a fault [2]. Moreover, note how the lighting panel is connected to the 480/277V MSB bus, whereas the power panels are connected to the 208/120V DB1 bus.

As seen in Figure 3.9, the XFMR is rated at 45kVA. This is determined by DB1's total load value of 29,280VA, which can be viewed on the panel schedule located in Appendix B. Because DB1's load value is so close to 30kVA, a standard transformer size, the next biggest rated transformer of 45kVA is selected.

Drafting

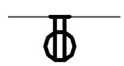
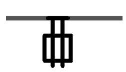
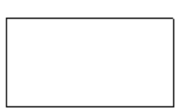
Once the architectural model and SLD were created, I began drafting the lighting and power floor plans. For the project, I assumed that each duplex receptacle consumed 180VA. This is a rule of the NEC which states:

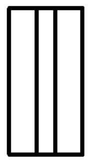
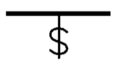
> (1) Where appliances are unlikely to be used simultaneously, each 1.5 m (5 ft) or fraction thereof of each separate and continuous length shall be considered as one outlet of not less than 180 volt-amperes.
> (2) Where appliances are likely to be used simultaneously, each 300 mm (1 ft) or fraction thereof shall be considered as an outlet of not less than 180 volt-amperes. [4]

I learned at my internship that it is good practice to load only six receptacles per circuit. Hence, the multiple 1080VA loads seen on the power panel schedules. In addition, other good practices I applied to this project include: leaving at least 10% of the panelboard's circuits "spare" or unloaded, and ensuring the total loads on phase A, B, and C on every panelboard are balanced within 5%.

Table 3.1 describes the power and lighting symbols I used on my electrical floor plans. Please note, the complete floor plans can be viewed on the electrical sheets, located in Appendix B.

TABLE 3.1
POWER AND LIGHTING DRAFTING SYMBOLS

Symbol	Name	Discipline	Load (Volt-Amperes)
 PWR1-1	Duplex Receptacle	Power	180VA
 PWR1-5	Ground Fault Current Interrupter (GFI) Duplex	Power	180VA
PWR1-11 	Floor Mounted Duplex	Power	180VA
PWR1-6 	Exhaust Fan Junction Box (J-Box)	Power	500VA
MSB-2,4,6 	Elevator Fuse Disconnect	Power	19,800VA

 R1 LGHT1-9a	LED Troffer	Lighting	42VA
 D1 LGHT1-11c	LED Downlight	Lighting	16VA
 S1 LGHT1-5	LED Strip Light	Lighting	51VA
 7 a,b,c	Light Switch	Lighting	N/A
 3a,b,c	Motion (Occupancy) Sensor	Lighting	Small and Unaccounted
	Exit Sign	Lighting	Small and Unaccounted

As previously stated, all the duplex's in this project were rated at their NEC standard of 180VA. The junction boxes that will provide power to restroom exhaust fans are assumed at 500VA. This approximation was provided by my old coworker. Finally, the light switch, motion sensor, and exit sign loads were neglected due to their minimal power consumption.

I researched information regarding the elevator's load and disconnect sizing. A company called Imperial Electric provided a data sheet online. Please see Figure 3.10 for this information.

IMPERIAL ELECTRIC
The Driving Force In Motion

AC VVVF Elevator Hoist Motor 1200 RPM Standard Amp Ratings

Low Slip, Single Speed, Ball Bearings, Elevator End Play, 50ºC Rise, 1200RPM, 60 Minute Duty, Open Construction

HP	5	7.5	10	12.5	15	20	25	30	40	50	60	75
Frame	256T	256T	256T	284T	284T	286T	324T	326T	365T	365T	405T	405T
200 V	**15.4**	**24.5**	**30.8**	34.1	43.8	58.3	70.0	80.4	**113.0**	132.2	**152.0**	**189.0**
208 V	14.8	23.5	29.6	32.7	41.9	55.2	67.0	78.4	108.0	129.3	147.0	**182.0**
220 V	14.2	21.5	26.6	30.9	39.3	52.4	65.8	72.5	104.0	122.0	**139.0**	**172.0**
230 V	13.5	21.6	26.4	29.5	39.0	49.8	61.0	70.4	98.2	116.2	132.2	164.0
240 V	13.6	20.4	26.5	28.9	36.0	47.6	58.6	68.6	95.4	114.2	127.0	156.8
440 V	7.1	10.8	13.3	15.6	19.7	26.2	32.9	36.7	52.0	61.0	**69.3**	86.0
460 V	6.8	10.8	13.2	14.8	19.5	24.9	30.5	35.2	49.1	58.1	66.1	82.0
480 V	6.4	10.2	13.3	14.2	18.0	23.8	29.3	34.3	47.7	57.1	63.5	78.4
575 V	**5.4**	**8.5**	10.5	11.9	15.2	20.1	24.8	28.4	38.6	46.5	**53.0**	**65.5**
Effiency	87.1%	86.9%	88.0%	88.9%	89.0%	89.7%	89.5%	90.8%	90.0%	90.4%	91.4%	91.1%
P/F	79.8%	75.8%	72.4%	88.8%	83.1%	82.6%	85.9%	87.9%	85.1%	88.6%	92.7%	94.2%
BTU/HR	566	864	1,042	1,192	1,416	1,754	2,240	2,322	3,395	4,056	4,312	5,596

Bold Numbers are Calculated

FIGURE 3.10: ELEVATOR MOTOR DATA SHEET INFORMATION

The red box in Figure 3.10 shows the full load amperage (FLA) specification for my selected motor. The elevator motor is also connected to the 480V MSB bus. Using this information, the magnitude of the load could be calculated:

$S_{3PHASE} = sqrt(3) * V_{LL} * I = sqrt(3) * 480V * 23.8A = 19{,}787VA \cong \mathbf{19{,}800VA}$

Next, the fuse disconnect and circuit breaker are sized for the elevator. Please see the following calculation.

3-phase elevator motor has a FLA of 23.8A.

In order to size the disconnect and breaker, the Maximum Overcurrent Protection (MOCP) value needs to be calculated. According to the NEC [4]:

$MOCP = 225\%*FLA = 2.25(23.8A) = 53.55A$

*After rounding-up, a **60A/3-Pole** fuse disconnect and circuit breaker are selected.*

After determining my motor specifications, I researched lighting fixtures. I found troffers, strip lights, and downlights all provided by a commercial lighting company called Lithonia Lighting. I decided to use LED lights, and not florescent, in an attempt to reduce power consumption. Figures 3.11-3.13 show the selected load specifications for all three lighting fixtures. These values are also listed in Table 3.1. Note how the power consumption specifications are given in Watts, as these fixtures only consume real power. All complete data sheets are located in Appendix B.

HE Performance Data			
Lumen Package	Lumens	Input Watts	LPW
48LHE ADP LP830	4655	36	127
48LHE ADP LP835	4775	36	130
48LHE ADP LP840	4880	36	133
48LHE ADP LP850	5121	36	139
60LHE ADP LP830	5473	42	129
60LHE ADP LP835	5614	42	132
60LHE ADP LP840	5738	42	135
60LHE ADP LP850	6020	42	142
72LHE ADP LP830	6805	52	130
72LHE ADP LP835	6981	52	133
72LHE ADP LP840	7135	52	136
72LHE ADP LP850	7486	52	143
85LHE ADP LP830	8189	64	127.
85LHE ADP LP835	8400	64	131
85LHE ADP LP840	8585	64	134
85LHE ADP LP850	9008	64	140

FIGURE 3.11: TROFFER DATA SHEET LOAD SPECIFICATION

Fixture Performance

	3000K				3500K			
	800LMF	1000LMF	1300LMF	1500LMF	800LMF	1000LMF	1300LMF	1500LMF
Lumen Output	3303	4033	4843	5841	3401	4153	4987	6015
Input Watts	25	32	40	51	25	32	40	51
Lumens/Watt	133	125	121	115	137	129	124	119

*AT 80/20 Indirect/Direct Intensity Ratio

FIGURE 3.12: STRIP LIGHT DATA SHEET LOAD SPECIFICATION

LUMEN EQUIVALENCY CHART*						
	RV6 35/06		RV6 35/10		RV6 35/15	
	120V	277V	120V	277V	120V	277V
Delivered lumens (lm)	615	790	900	1200	1475	1580
Nominal wattage (W)	9	10.5	14	16	22.5	23
Comparable fluorescent	18W CFL		26W CFL		32W CFL	
Comparable incandescent	65W BR30		120W BR40		150W A21	
Comparable halogen PAR	50W		75W		90W	

* Data based on LM-79 test reports.

FIGURE 3.13: DOWNLIGHT DATA SHEET LOAD SPECIFICATION

Finally, Figure 3.14 illustrates the layout of the electrical room, including the varying panelboards, distribution board, main switch board, and transformer. When designing the electrical room, the following NEC requirements are met:

(2) Width of Working Space. The width of the working space in front of the electrical equipment shall be the width of the equipment or 762 mm (30 in.), whichever is greater. In all cases, the work space shall permit at least a 90 degree opening of equipment doors or hinged panels.

(3) Height of Working Space. The work space shall be clear and extend from the grade, floor, or platform to a height of 2.0 m (61⁄2 ft) or the height of the equipment, whichever is greater. Within the height requirements of this section, other equipment that is associated with the electrical installation and is located above or below the electrical equipment shall be permitted to extend not more than 150 mm (6 in.) beyond the front of the electrical equipment. [4]

Furthermore, adequate space was left in the electric room to accommodate for any data systems or rack-servers that are used by the office. The complete power and lighting plans can be viewed in Appendix B.

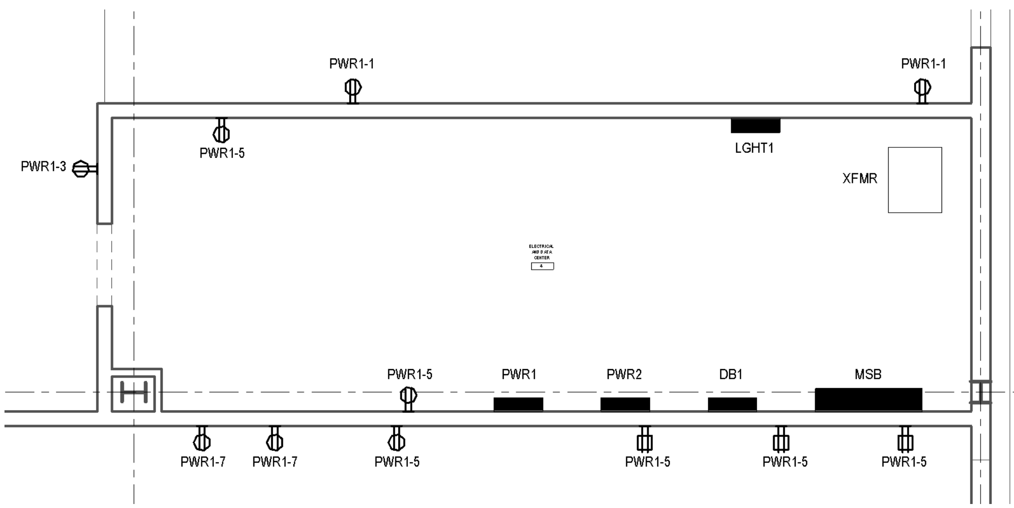


FIGURE 3.14: ELECTRICAL ROOM LAYOUT

Conclusion

The final outcome of this project are the electrical sheets in Appendix B. These sheets contain the final single line diagram, all panel schedules, and the electric floor plans for the power and lighting subsystems. These sheets were transformed into a .pdf file via the *Revit* software.

The project proved successful, but additional items could have been integrated into the assignment if the time or software were available. First, an electrical cover sheet could have been created. This sheet outlines all the legal information associated with the project, as well as listing and describing all the electrical symbols used. Next, annotations for each individual sheet could have been created. These annotations clear-up any uncertainties for the construction workers on site when installing the actual electrical equipment. Finally, an Arc Flash Study could have been completed. The purpose of this study is to isolate any faults within the power distribution system, by coordinating which circuit breakers will trip in the event of failure. Unfortunately, the software to complete this study was not available.

Chapter 4

Cost Estimates

In determining cost estimates, two main expenses are explored: labor and parts. For each cost estimation, the following formula is used:

$$\text{Cost} = (\text{cost}_a + 4\text{cost}_m + \text{cost}_b) / 6$$

Where, ‘cost_a’ is the most optimistic cost estimate, ‘cost_m’ is the most likely cost estimate, and ‘cost_b’ is the most pessimistic estimate [1]. The same model calculates the total hours of labor. This is done by replacing ‘cost’ with ‘time.’

Table 4.1 summarizes the values used in each equation. These time and cost values were determined after consulting my senior project advisor and professor, along with online research.

TABLE 4.1
TIME AND COST EQUATION TOTALS FOR THE POWER DISTRIBUTION SYSTEM

Criteria	**time_a** or **cost_a**	**time_m** or **cost_m**	**time_b** or **cost_b**	**Total Time** or **Cost**
Labor	150 hrs.	180 hrs.	220 hrs.	**181.6 hrs.**
Software	$2000.00	$3800.00	$5400.00	**$3,766.66**
Computer	$500.00	$1000.00	$1500.00	**$1,000.00**
Electrical Installation Equipment	$100,000.00	$130,000.00	$180,000.00	**$133,333.33**
Fees & Shipping	$90,000.000	$120,000.00	$180,000.00	**$125,000.00**

Assuming an hourly wage of $55/hour and three engineers working on the project, the total cost of labor is approximately equal to $30,000.00. Table 4.2 produces a total cost estimate for the entire project.

TABLE 4.2
TOTAL COST ESTIMATES FOR THE POWER DISTRIBUTION SYSTEM

Constraint	**Cost**
Labor	$30,000.00
Software	$3,766.66
Computer	$1,000.00
Electrical Installation Equipment	$133,333.33
Fees and Shipping	$125,000.00
Sub-Total	$293,099.99
Estimated Sales Tax (8%)	$23,448.00
Total	**$316,547.99**

Gantt Chart

Figures 4.1-4.3 use Gantt Charts to outline the expected project plan and presentation dates for my entire senior project. Each figure coincides with a senior project class and quarter; Figure 4.1 represents EE 460 and Winter 2016, Figure 4.2 represents EE 461 and Spring 2016, finally Figure 4.3 represents EE 462 and Fall 2016. Specifically, EE 461 calls for multiple SLD drafts, along with time to build the diagram in *AutoCAD*. EE 462 devotes lots of time towards electrical drafting and panel schedule completion. In addition, ample time is left for any necessary updates and final revisions.

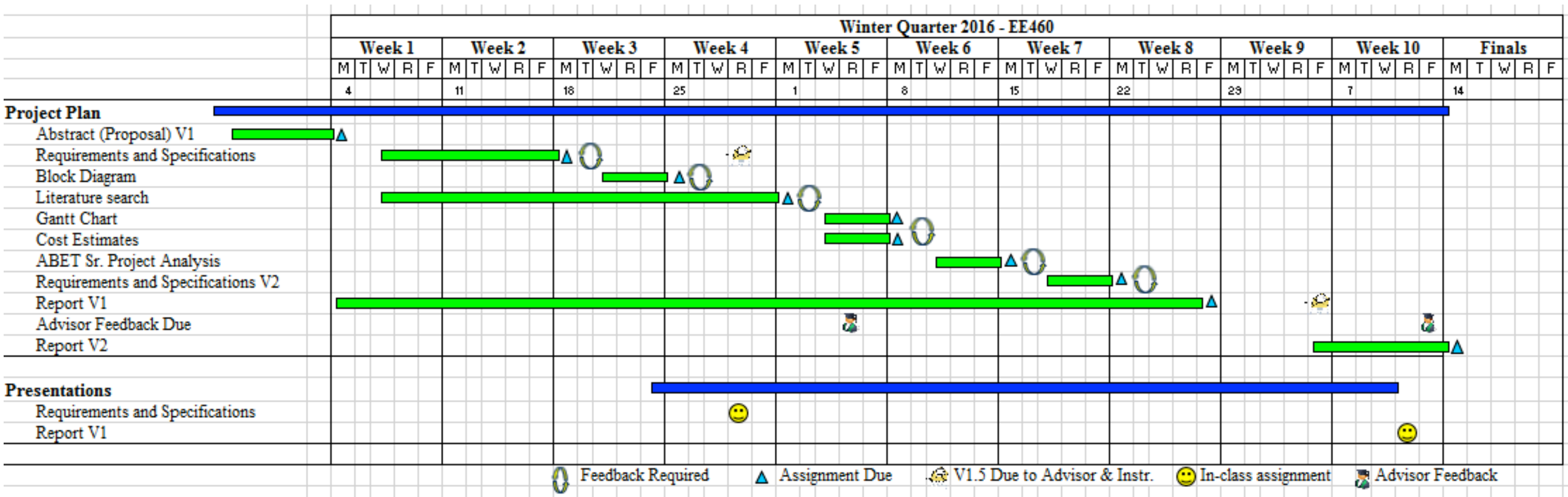


FIGURE 4.1: EE 460 GANTT CHART

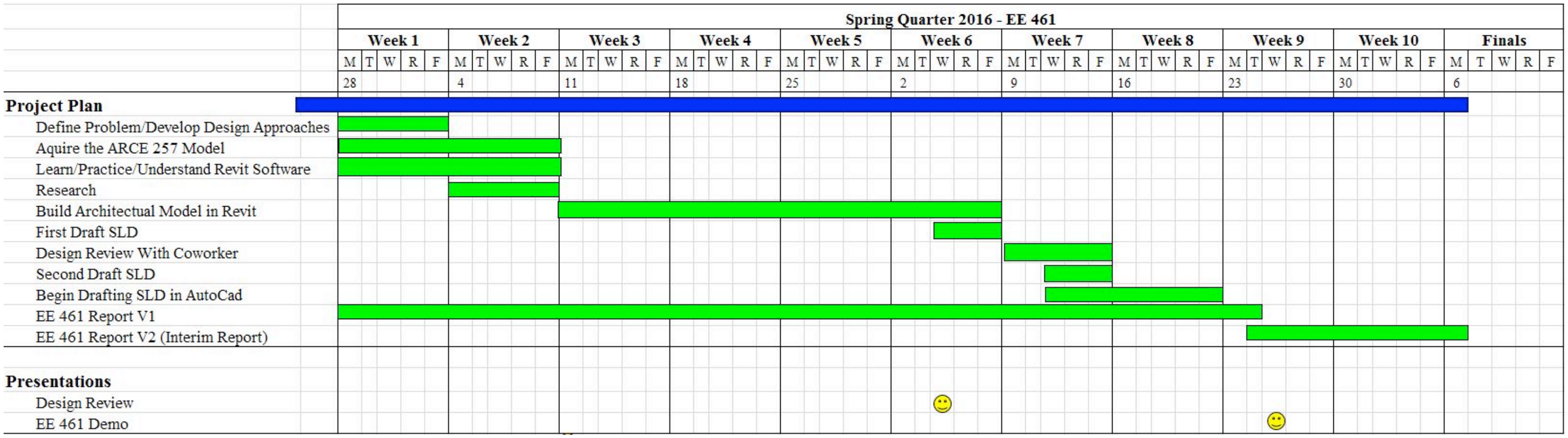


FIGURE 4.2: EE 461 GANTT CHART

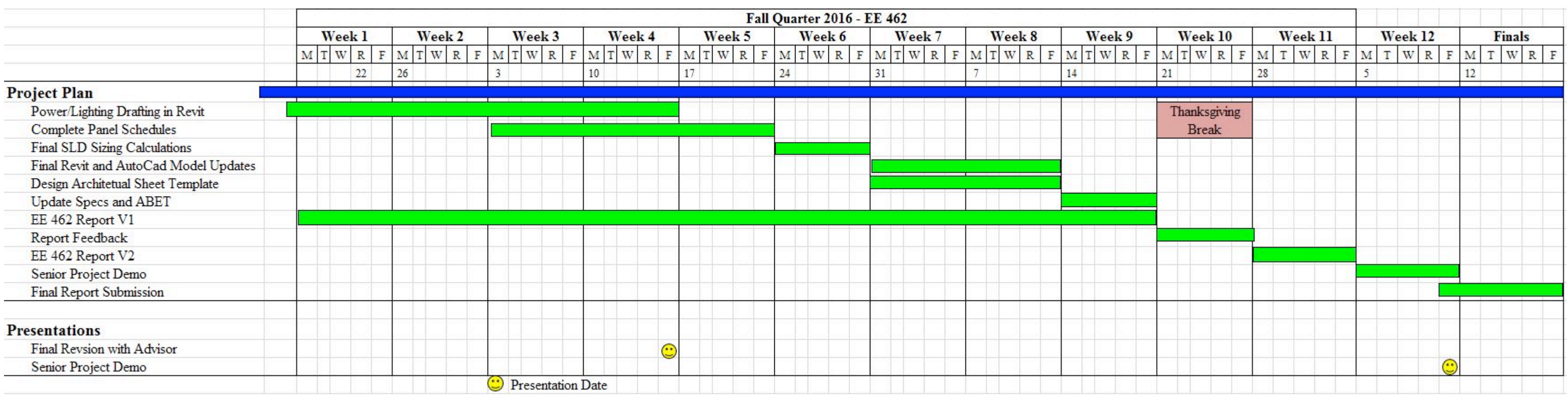


FIGURE 4.3: EE 462 GANTT CHART

References

Literature Search

A literature search was completed for the ABET Development criteria. This provided me with a strong background and knowledge on power distribution systems, the National Electric Code, and potential ideas to incorporate into my design. Sources include books, IEEE articles, and the NEC.

[1] R. Ford and C. Coulston, *Design for Electrical and Computer Eng.* Boston, MA: McGraw-Hill, 2008.

[2] D. W. Heath and H. L. Bradfield, "Short circuit protection of energy efficient motors," in IEEE Industry Applications Magazine, vol. 3, no. 1, pp. 41-44, Jan/Feb 1997.

[3] M. Cobb, N. Justin, A. El-Shahat and R. J. Haddad, "Higher education Building efficient electrical design," SoutheastCon 2016, Norfolk, VA, 2016, pp. 1-7.

[4] DRAFT OF PROPOSED NFPA 70, National Electrical Code, 2014 Edition ed. Quincy, MA: NFPA, 2012. [Online]. Available: https://www.nfpa.org/Assets/files/AboutTheCodes/70/70-A2013-ROPDraft.pdf.

Appendix A

ABET Senior Project Analysis

Project Title: Designing a Power Distribution System for the ARCE 257 Revit Structural Model

Student's Name: Reid Wilhelm

Student's Signature:

Advisor's Name: Tina Smilkstein

Advisor's Initials:

Date:

1. Summary of Functional Requirements

I am designing the power distribution system for a two-story commercial office space. After acquiring the structural plans for the building, I will construct an architectural model and corresponding floor plans in a building information modeling (BIM) software called *Revit*. The architectural model will consist of the walls, doors, windows, ceiling, and rooms that fill the building. The floor plans are used to draft the separate power and lighting systems. Electric panel schedules will define the loads on each circuit used within the system. Finally, a single line diagram will present the overall architecture of the power distribution system by exhibiting the interconnections between the larger pieces of electrical equipment.

2. Primary Constraints

Significant challenges and difficulties are associated with the power distribution system. The first challenge is converting the model from structural to architectural in *Revit*. I will have to teach myself how to create floor plans from a structural model. This includes placing walls, windows, and doorways on top of the columns and beams provided. I will coordinate with my fellow architectural engineering friends at Cal Poly for any help and assistance. The next challenge is learning how to apply the National Electric Code (NEC). There are many rules and regulations regarding the proper sizing, location, and loading of electric machinery. Fortunately, I will have the ability to access the IEEE digital library, along with consulting a former colleague of mine from my previous summer internship. Finally, drafting my single line diagram in the software called *AutoCAD* will be a tedious process, as I will not have access to any electric families or libraries within this software.

3. Economic

Human Capital
The power distribution system has a positive effect on human capital. It enables employees to work in a safe environment with practically unlimited access to power and lighting.

Financial Capital
Creating this power distribution system has a significant effect on financial capital. This job is not cheap, as most construction projects cost hundreds-of-thousands to millions of dollars. One reason for such overheads involves securing the profits necessary to keep a company afloat. Money must be gained to generate future projects. It is also ethical to put aside profits which can be given to charity or a philanthropic cause.

Manufactured or Real Capital
Real capital includes software, labor, and electrical equipment costs. Beginning with software and labor, designing floor plans, architectural models, and distribution systems would not be possible without the brain of an engineer. Both are expensive to fund, as a program like *Revit* costs thousands of dollars to purchase and renew, while engineers do not work for a small price. Money also needs to be spent on purchasing electrical equipment like conduit, panelboards, transformers, circuit breakers, lighting fixture, and receptacles. After production, the electric bills produced by the system should be as affordable. This is achieved in creating the most efficient system possible. Finally, other costs incorporate the companies who sell and ship the project's physical equipment.

Natural Capital
Natural capital used in the manufacturing of this device includes refining elements like silicon, tin, and copper to manufacture electrical components. Other natural capital to consider includes the land used to build the two-story building, any sort of industrial waste produced and how to safely dispose of it, and the CO_2 emissions resulting from all transport or shipping.

When and where do costs and benefits accrue throughout the project's lifecycle?
The following list explains the costs associated over the project's lifecycle:

- Design/Prototype – Costs include money and time. This is during the begging of the project's lifecycle; therefore, it is the easiest to change and least costly.
- Manufacturing – Costs include the money needed to provide efficient machines, parts, and reliable equipment. This starts at the manufacturing stage and is held constant until production is no longer.
- Labor – Costs includes all wages, from the construction workers to the engineering to the CEO. Labor costs are always present, but usually labor costs increase assuming the company is successful.
- Shipping – Costs include receiving equipment from other manufactures. Again, this starts at the manufacturing stage and is held constant until production is no longer.
- Natural Resources Exploited – Elements used to create electrical equipment and distribution systems are not eternally abundant. Also, forestry and other land supporting our ecosystem could potentially be cleared to produce this building. This happens at the manufacturing stage and is held constant until production is no longer.
- Any Pollution or Waste Produced – From transportation CO_2 emissions to potentially hazardous waste, the cost is our environment becoming contaminated. This cost is always present.

The following list explains the benefits associated over the project's lifecycle:

- Power Distribution System – This benefits the employee by providing them with a better quality of life within the workplace. This benefit is seen at the end of the production cycle, when the project is complete.
- Profit – In profiting, future projects are pursued and newer technology can be purchased. This happens about a year or two after production.
- Donation – A part of the profit made on this project could be donated to charity. This happens after profits become stable.

What inputs does the experiment require? How much does the project cost? Who pays?
In the construction industry, the MEP firm makes a bid to the architect or owner in an attempt to win the project. A presentable design, usually in the form of a more general SLD, with total cost estimations is needed in the bid package. If won, a contract is signed, and the engineers are expected to compete the project on a mutually agreed upon date.

The estimated cost of the project is listed in the table below.

Constraint	Cost
Labor	$30,000.00
Software	$3,766.66
Computer	$1,000.00
Electrical Installation Equipment	$133,333.33
Fees and Shipping	$125,000.00
Sub-Total	$293,099.99
Estimated Sales Tax (8%)	$23,448.00
Total	**$316,547.99**

How much does the project earn? Who profits?
This project earns no money. Rather, it benefits other Cal Poly E.E. students who may want to pursue a similar project. In the real world, the employees and engineering firm would profit from this project, as labor costs and certain fees would go directly towards employee salaries and the company.

Timing
Please see the "Gantt Chart" section of my report, particularly Figures 4.1-4.3. These figures outline the quarterly progress needed in order to successfully complete the project. Note, the time for each stage was carefully calculated. Also, multiple project review iterations and updates are present to ensure a quality design. In the industry, completion of this project would take anywhere from 6 months to a year. From the engineer's design, to government approval, to installation, construction is not a quick process.

What happens after the project ends?
When the project ends, my report will be archived into Cal Poly's digital commons and potentially used by future students. If this were a real construction project, an Arc Flash Study would need to be performed to isolate any faults within the power distribution system. These studies coordinate which electric circuit breakers will trip in the event of failure. The power distribution system is also designed to accommodate future electrical needs. Therefore, if more panelboards needed to be installed or the system needed to be updated, the engineering firm could be contracted again. Other additions include adding a cover sheet and keynotes to the floor plans, along with electrical details to help with on-site installation.

4. Commercial Basis:

- Estimated number of distribution systems contracted per year
  - 5 systems
- Estimated cost of each project
  - $750,000
- Estimated purchase price for equipment
  - $200,000
- Estimated profit per year
  - 5*($750,000-$250,000) = $2,500,000 (before labor and other expenses)
- Estimated cost for company to operate power system
  - $18,000/year

5. Environmental

Environmental impacts include using the Earth's elements to fabricate electrical equipment, pollution and potentially harmful waste produced during construction, and all CO_2 emissions released from transportation or shipping processes.

Unfortunately, the elements in the earth's crust are not unlimited. Therefore, the final design of the power distribution system must use as limited amount of natural resources as possible. Additionally, construction tends to produce pollution or harmful waste, which destroys our environment. Therefore, the installation process must be designed to produce the least amount of pollution and solve how to safely eliminate any toxic waste or byproduct. Finally, every piece of equipment either shipped or received via a car, truck, or airplane translates to a further depleted ozone layer. Therefore, shipping must be as efficient as possible, in order to reduce the amount of CO_2 emissions released into our environment.

Ultimately, depleting scarce electrical elements, clearing natural land to build, or improperly disposing of waste has an impact on our ecosystem and the species that live within it. This can directly harm the air we breathe or the water we drink due to pollution. It can also indirectly harm other species; like the food we eat. If a field of corn is cut down to build this two-story structure, or toxic fuels are released near a field of cattle, everyone suffer. The only species this project directly benefits is our own.

6. Manufacturability

Some of the biggest challenges with manufacturability includes coordination between other engineering disciplines. Buildings only have so much space. Therefore, electrical engineers designing these power systems have to work around even bigger HVAC and plumbing systems. In addition, there are many regulations and codes regarding the installation and location of electrical equipment in a commercial building. If violated, people could lose jobs or construction could be jeopardized.

7. Sustainability

When analyzing sustainability, the most important feature of the power distribution system is the ability to accommodate room for future installations. For example, the practice of leaving at least 10% of the circuits "spare," or unloaded, on a panelboard safeguards this need. Furthermore, there are spaces on the distribution board and main switch board for future motors and panelboards to be added if necessary.

Sustainability is dependent on energy efficiency. When drafting lighting system, motion sensors are installed to automatically turn-on and turn-off lights. For the power system, some receptacles are controlled by wall switches. Thus, the power sourcing these circuits can be completely turned-off while not in use.

8. Ethical

When analyzing the IEEE Code of Ethics, the first point of "accept[ing] responsibility in making decisions consistent with the safety, health, and welfare of the public, and to disclose promptly factors that might endanger the public or the environment" is most relevant to my project. Considering this system delivers extremely high current, it is my duty to ensure no harm is done to employees while the system is in use. I should also design the system so that if any alterations were complete, the risk of harm is diminished.

9. Health and Safety

One health and safety concern that should be mentioned is the chance of a complete system failure. If a circuit breaker failed to trip and isolate a fault current, the system could explode and the consequences could be lethal. Other health and safety concerns include risk of fire or water damage. NEC attempts to prevent this, along with fire safety consulting provided by some engineering firms.

10. Social and Political

The only type of political regulation involved with MEP design is government oversight and approval of the final floor plans before construction takes place. This process can take months, as a small violation of the law can result in major design changes.

Direct stakeholders of this system are the employees using the building. Access to power and lighting promotes a better quality of life in the workplace. Other direct stakeholders are the engineers who design the system, as both business and personal credibility are on the line. Indirect stakeholders include third party contributors like construction workers who read the floor plans and install the electrical equipment on site, along with the architect, owner, and general contractor. Obviously, the benefits and pay are unequal, as some jobs require more work or knowledge than others.

11. Development

The main development tool used for this project was my internship experience at **exp**. This provided me with a strong background and knowledge on power system design. Furthermore, I consulted my colleagues at **exp** who offered advice and potential ideas to incorporate into my work. Other development tools include: the literature search, analysis of my project using different ethical frameworks, and using the "SCAMPER" technique to identify more specifications and requirements. Note, the literature search is located in the "References" section of this report.

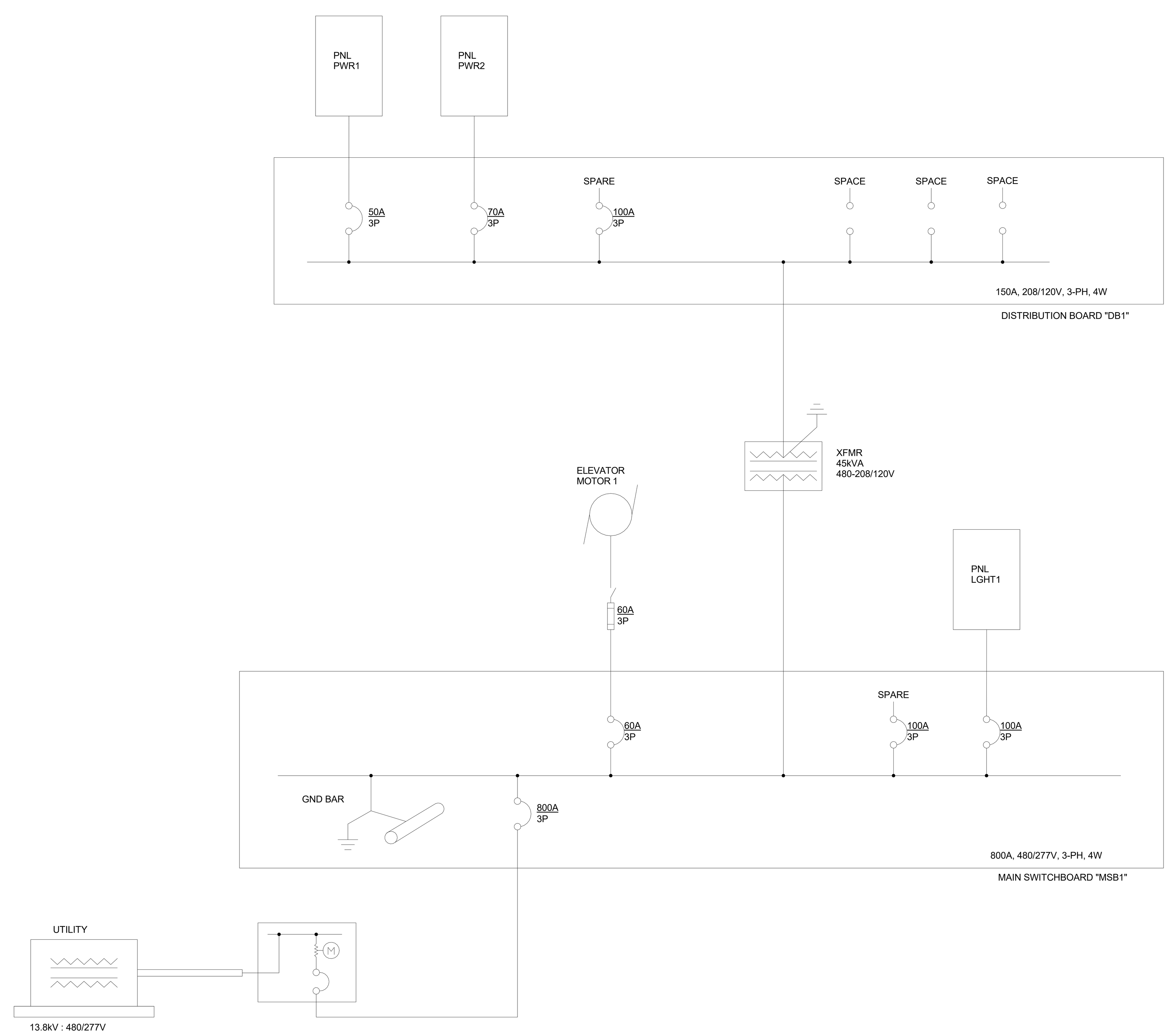
Appendix B

Electrical Plans and Data Sheets

Attached are the final electrical plans. They are listed in the following order:

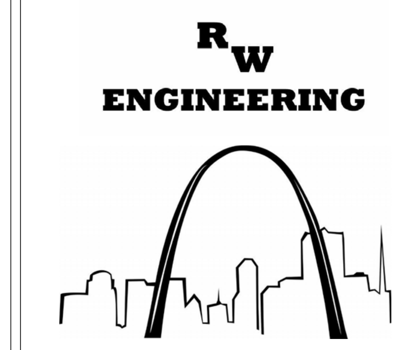
E0.1 – ELECTRICAL SINGLE LINE DIAGRAM
E0.2 – ELECTRICAL PANEL SCHEDULES
EL1.1 – ELECTRICAL LIGHTING LEVEL 1
EL1.2 – ELECTRICAL LIGHTING LEVEL 2
EP1.1 – ELECTRICAL POWER LEVEL 1
EP1.2 – ELECTRICAL POWER LEVEL 2

Additionally, the complete data sheets for the troffers, downlights, strip lights, and elevator motor are listed after the electrical plans.



1 SLD_FINAL
6" = 1'-0"

12/5/2016 3:43:43 PM



OWNER:

DAVID PHAN
5670 OBERLIN DRIVE
SAN DIEGO, CA 92121

ARCHITECT:

H. ROGERS ARCHITECTURE
290 CALIFORNIA BLVD
SAN LUIS OBISPO, CA 93405

MEP:

RW ENGINEERS
1304 E FOOTHILL BLVD
SAN LUIS OBISPO, CA 93405

REID WILHELM

SENIOR PROJECT
ELECTRICAL ENGINEERING DEPARTMENT
CALIFORNIA POLYTECHNIC STATE UNIVERSITY
SAN LUIS OBISPO
2016

No.	Revision	Date

SCHEMATIC DESIGN

Professional Seal(s)

Drawn By:	REID WILHELM
Checked By:	TINA SMILKSTEIN
Approved By:	DENNIS DERICKSON
Date Printed:	12/12/16
File Name:	

Project Title

HOOKS ARCHITECTURE OFFICE
42 Wallaby Way
Oceanside, CA 92051

Dwg. Title

ELECTRICAL SINGLE LINE DIAGRAM

Project No. 101081_6794

Dwg. No. E0.1

Rev. No.

Branch Panel: PWR1

Location: ELECTRICAL AND DATA CENTER 4 **Volts:** 208/120 **A.I.C. Rating:**
Supply From: DB1 **Phases:** 3 **Mains Type:**
Mounting: Surface **Wires:** 4 **Mains Rating:** 150 A
Enclosure: Type 1 **MCB Rating:**

Notes:

CKT	Circuit Description	Trip	Poles	A		B		C		Poles	Trip	Circuit Description	CKT
1	RECEPTACLE, LOBBY	20 A	1	1080 VA	1080 VA					1	20 A	RECEPT, PROJECTOR JBOX, CONF RM.	2
3	RECEPTACLE, LOBBY AND HALLWAY	20 A	1			1080 VA	1080 VA			1	20 A	RECEPTACLE, HALLWAY	4
5	RECEPTACLE, KICTHEN AND ELEC RM.	20 A	1					1080 VA	1720 VA	1	20 A	RECEPTACLE, EXHAUST FAN, RESTRMS.	6
7	REFRIGE MICROWAVE - KITCHEN	20 A	1	1000 VA	720 VA					1	20 A	RECEPTACLE, HALLWAY	8
9	RECEPTACLE, KITCHEN	20 A	1			1080 VA	540 VA			1	20 A	RECEPTACLE, STAIRS AND ELEVATOR	10
11	RECEPTACLE, CONFERENCE RM	20 A	1					1080 VA	0 VA	1	20 A	SPARE	12
13	SPARE	20 A	1	0 VA	0 VA					1	20 A	SPARE	14
15	SPARE	20 A	1			0 VA	0 VA			1	20 A	SPARE	16
17	SPARE	20 A	1					0 VA	0 VA	1	20 A	SPARE	18
19	SPARE	20 A	1	0 VA	0 VA					1	20 A	SPARE	20
21	SPARE	20 A	1			0 VA	0 VA			1	20 A	SPARE	22
23	SPARE	20 A	1					0 VA	0 VA	1	20 A	SPARE	24
25	SPARE	20 A	1	0 VA	0 VA					1	20 A	SPARE	26
27	SPARE	20 A	1			0 VA	0 VA			1	20 A	SPARE	28
29	SPARE	20 A	1					0 VA	0 VA	1	20 A	SPARE	30
31	SPARE	20 A	1	0 VA	0 VA					1	20 A	SPARE	32
33	SPARE	20 A	1			0 VA	0 VA			1	20 A	SPARE	34
35	SPARE	20 A	1					0 VA	0 VA	1	20 A	SPARE	36
37	SPARE	20 A	1	0 VA	0 VA					1	20 A	SPARE	38
39	SPARE	20 A	1			0 VA	0 VA			1	20 A	SPARE	40
41	SPARE	20 A	1					0 VA	0 VA	1	20 A	SPARE	42
			Total Load:	3880 VA		3780 VA		3880 VA					
			Total Amps:	32 A		32 A		32 A					

Legend:

Load Classification	Connected Load	Demand Factor	Estimated Demand	Panel Totals	
Power	1180 VA	100.00%	1180 VA		
				Total Conn. Load:	11540 VA
				Total Est. Demand:	11360 VA
				Total Conn. Current:	32 A
				Total Est. Demand Current:	32 A

Notes:

Branch Panel: PWR2

Location: ELECTRICAL AND DATA CENTER 4 **Volts:** 208/120 **A.I.C. Rating:**
Supply From: DB1 **Phases:** 3 **Mains Type:**
Mounting: Surface **Wires:** 4 **Mains Rating:** 175 A
Enclosure: Type 1 **MCB Rating:**

Notes:

CKT	Circuit Description	Trip	Poles	A		B		C		Poles	Trip	Circuit Description	CKT
1	RECEPTACLE, HALLWAY 2 AND STAIRS 2	20 A	1	1080 VA	1080 VA					1	20 A	RECEPTACLE, LAB	2
3	RECEPTACLE, HALLWAY 2	20 A	1			1080 VA	1080 VA			1	20 A	RECEPTACLE, LAB	4
5	RECEPTACLE, EXHAUST FAN, RESTRMS. 2	20 A	1					1720 VA	720 VA	1	20 A	RECEPTACLE, LAB	6
7	RECEPTACLE, SECRETARY	20 A	1	1080 VA	540 VA					1	20 A	RECEPTACLE, LAB	8
9	RECEPTACLE, SECRETARY	20 A	1			1080 VA	540 VA			1	20 A	RECEPTACLE, LAB	10
11	RECEPTACLE, OFFICE 1	20 A	1					1080 VA	180 VA	1	20 A	RECEPTACLE, LAB	12
13	RECEPTACLE, OFFICE 2	20 A	1	1080 VA	0 VA					1	20 A	SPARE	14
15	RECEPTACLE, OFFICE 3	20 A	1			1080 VA	0 VA			1	20 A	SPARE	16
17	RECEPTACLE, WORKSPACE	20 A	1					1080 VA	0 VA	1	20 A	SPARE	18
19	RECEPTACLE, WORKSPACE	20 A	1	1080 VA	0 VA					1	20 A	SPARE	20
21	RECEPTACLE, WORKSPACE	20 A	1			1080 VA	0 VA			1	20 A	SPARE	22
23	RECEPTACLE, WORKSPACE	20 A	1					1080 VA	0 VA	1	20 A	SPARE	24
25	SPARE	20 A	1	0 VA	0 VA					1	20 A	SPARE	26
27	SPARE	20 A	1			0 VA	0 VA			1	20 A	SPARE	28
29	SPARE	20 A	1					0 VA	0 VA	1	20 A	SPARE	30
31	SPARE	20 A	1	0 VA	0 VA					1	20 A	SPARE	32
33	SPARE	20 A	1			0 VA	0 VA			1	20 A	SPARE	34
35	SPARE	20 A	1					0 VA	0 VA	1	20 A	SPARE	36
37	SPARE	20 A	1	0 VA	0 VA					1	20 A	SPARE	38
39	SPARE	20 A	1			0 VA	0 VA			1	20 A	SPARE	40
41	SPARE	20 A	1					0 VA	0 VA	1	20 A	SPARE	42
			Total Load:	5940 VA		5940 VA		5860 VA					
			Total Amps:	50 A		50 A		49 A					

Legend:

Load Classification	Connected Load	Demand Factor	Estimated Demand	Panel Totals	
Power	1000 VA	100.00%	1000 VA		
				Total Conn. Load:	17740 VA
				Total Est. Demand:	14370 VA
				Total Conn. Current:	49 A
				Total Est. Demand Current:	40 A

Notes:

Branch Panel: DB1

Location: ELECTRICAL AND DATA CENTER 4 **Volts:** 208/120 **A.I.C. Rating:**
Supply From: XFMR **Phases:** 3 **Mains Type:**
Mounting: Surface **Wires:** 4 **Mains Rating:** 150 A
Enclosure: Type 1 **MCB Rating:**

Notes:

CKT	Circuit Description	Trip	Poles	A		B		C		Poles	Trip	Circuit Description	CKT
1	PWR1	50 A	3	3880 VA									2
3	--	--	--			3780 VA							4
5	--	--	--					3880 VA					6
7	PWR2	70 A	3	5940 VA									8
9	--	--	--			5940 VA							10
11	--	--	--					5860 VA					12
13													14
15													16
17													18
19													20
21													22
23													24
25													26
27													28
29													30
31													32
33													34
35													36
37													38
39													40
41													42
			Total Load:	9820 VA		9720 VA		9740 VA					
			Total Amps:	82 A		81 A		81 A					

Legend:

Load Classification	Connected Load	Demand Factor	Estimated Demand	Panel Totals	
Power	2180 VA	100.00%	2180 VA		
				Total Conn. Load:	29280 VA
				Total Est. Demand:	20730 VA
				Total Conn. Current:	81 A
				Total Est. Demand Current:	58 A

Notes:

Branch Panel: LGHT1

Location: ELECTRICAL AND DATA CENTER 4 **Volts:** 480/277 **A.I.C. Rating:**
Supply From: MSB **Phases:** 3 **Mains Type:**
Mounting: Surface **Wires:** 4 **Mains Rating:** 100 A
Enclosure: Type 1 **MCB Rating:**

Notes:

CKT	Circuit Description	Trip	Poles	A		B		C		Poles	Trip	Circuit Description	CKT
1	LIGHTING CONFERENCE	20 A	1	504 VA	336 VA					1	20 A	LIGHTING WOMENS 2/ MENS 2	2
3	LIGHTING LOBBY	20 A	1			448 VA	504 VA			1	20 A	LIGHTING OFFICE 1,2,3	4
5	LIGHTING ELECTRIC RM.	20 A	1					204 VA	726 VA	1	20 A	LIGHTING HALLWAY 2, STAIRS 2, ELEV 2	6
7	LIGHTING HALLWAY 1	20 A	1	546 VA	528 VA					1	20 A	LIGHTING SECRETARY	8
9	LIGHTING MENS 1/WOMENS 1	20 A	1			504 VA	672 VA			1	20 A	LIGHTING WORKSPACE	10
11	LIGHTING KITCHEN	20 A	1					670 VA	894 VA	1	20 A	LIGHTING WORKSPACE	12
13	SPARE	20 A	1	0 VA	297 VA					1	20 A	LIGHTING LAB	14
15	SPARE	20 A	1			0 VA	0 VA			1	20 A	SPARE	16
17	SPARE	20 A	1					0 VA	0 VA	1	20 A	SPARE	18
19	SPARE	20 A	1	0 VA	0 VA					1	20 A	SPARE	20
21	SPARE	20 A	1			0 VA	0 VA			1	20 A	SPARE	22
23	SPARE	20 A	1					0 VA	0 VA	1	20 A	SPARE	24
25	SPARE	20 A	1	0 VA	0 VA					1	20 A	SPARE	26
27	SPARE	20 A	1			0 VA	0 VA			1	20 A	SPARE	28
29	SPARE	20 A	1					0 VA	0 VA	1	20 A	SPARE	30
31	SPARE	20 A	1	0 VA	0 VA					1	20 A	SPARE	32
33	SPARE	20 A	1			0 VA	0 VA			1	20 A	SPARE	34
35	SPARE	20 A	1					0 VA	0 VA	1	20 A	SPARE	36
37	SPARE	20 A	1	0 VA	0 VA					1	20 A	SPARE	38
39	SPARE	20 A	1			0 VA	0 VA			1	20 A	SPARE	40
41	SPARE	20 A	1					0 VA	0 VA	1	20 A	SPARE	42
			Total Load:	2211 VA		2128 VA		2494 VA					
			Total Amps:	8 A		8 A		9 A					

Legend:

Load Classification	Connected Load	Demand Factor	Estimated Demand	Panel Totals	
Lighting	6833 VA	100.00%	6833 VA		
				Total Conn. Load:	6833 VA
				Total Est. Demand:	6833 VA
				Total Conn. Current:	8 A
				Total Est. Demand Current:	8 A

Notes:

Branch Panel: MSB

Location: ELECTRICAL AND DATA CENTER 4 **Volts:** 480/277 **A.I.C. Rating:**
Supply From: **Phases:** 3 **Mains Type:**
Mounting: Surface **Wires:** 4 **Mains Rating:** 1000 A
Enclosure: Type 1 **MCB Rating:**

Notes:

CKT	Circuit Description	Trip	Poles	A		B		C		Poles	Trip	Circuit Description	CKT
1	PNL LGHT1	100 A	3	2211 VA	6600 VA					3	60 A	ELEVATOR MOTOR DISCONNECT	2
3	--	--	--			2128 VA	6600 VA			--	--	--	4
5	--	--	--					2494 VA	6600 VA	--	--	--	6
7	XFMR	50 A	3	9820 VA									8
9	--	--	--			9720 VA							10
11	--	--	--					9740 VA					12
13													14
15													16
17													18
19													20
21													22
23													24
25													26
27													28
29													30
31													32
33													34
35													36
37													38
39													40
41													42
			Total Load:	18631 VA		18448 VA		18834 VA					
			Total Amps:	67 A		67 A		68 A					

Legend:

Load Classification	Connected Load	Demand Factor	Estimated Demand	Panel Totals	
Lighting	6833 VA	100.00%	6833 VA		
Power	21980 VA	100.00%	21980 VA	**Total Conn. Load:**	55913 VA
				Total Est. Demand:	47363 VA
				Total Conn. Current:	67 A
				Total Est. Demand Current:	57 A

Notes:

12/5/2016 3:43:43 PM

R W ENGINEERING

OWNER:

DAVID PHAN
5670 OBERLIN DRIVE
SAN DIEGO, CA 92121

ARCHITECT:

H. ROGERS ARCHITECTURE
290 CALIFORNIA BLVD
SAN LUIS OBISPO, CA 93405

MEP:

RW ENGINEERS
1304 E FOOTHILL BLVD
SAN LUIS OBISPO, CA 93405

CALIFORNIA POLYTECHNIC STATE UNIVERSITY · 1901 · DISCERE FACIENDO

REID WILHELM

SENIOR PROJECT
ELECTRICAL ENGINEERING DEPARTMENT
CALIFORNIA POLYTECHNIC STATE UNIVERSITY
SAN LUIS OBISPO
2016

No.	Revision	Date

SCHEMATIC DESIGN

Professional Seal(s)

Drawn By:	**REID WILHELM**
Checked By:	**TINA SMILKSTEIN**
Approved By:	**DENNIS DERICKSON**
Date Printed:	**12/12/16**
File Name:	

Project Title

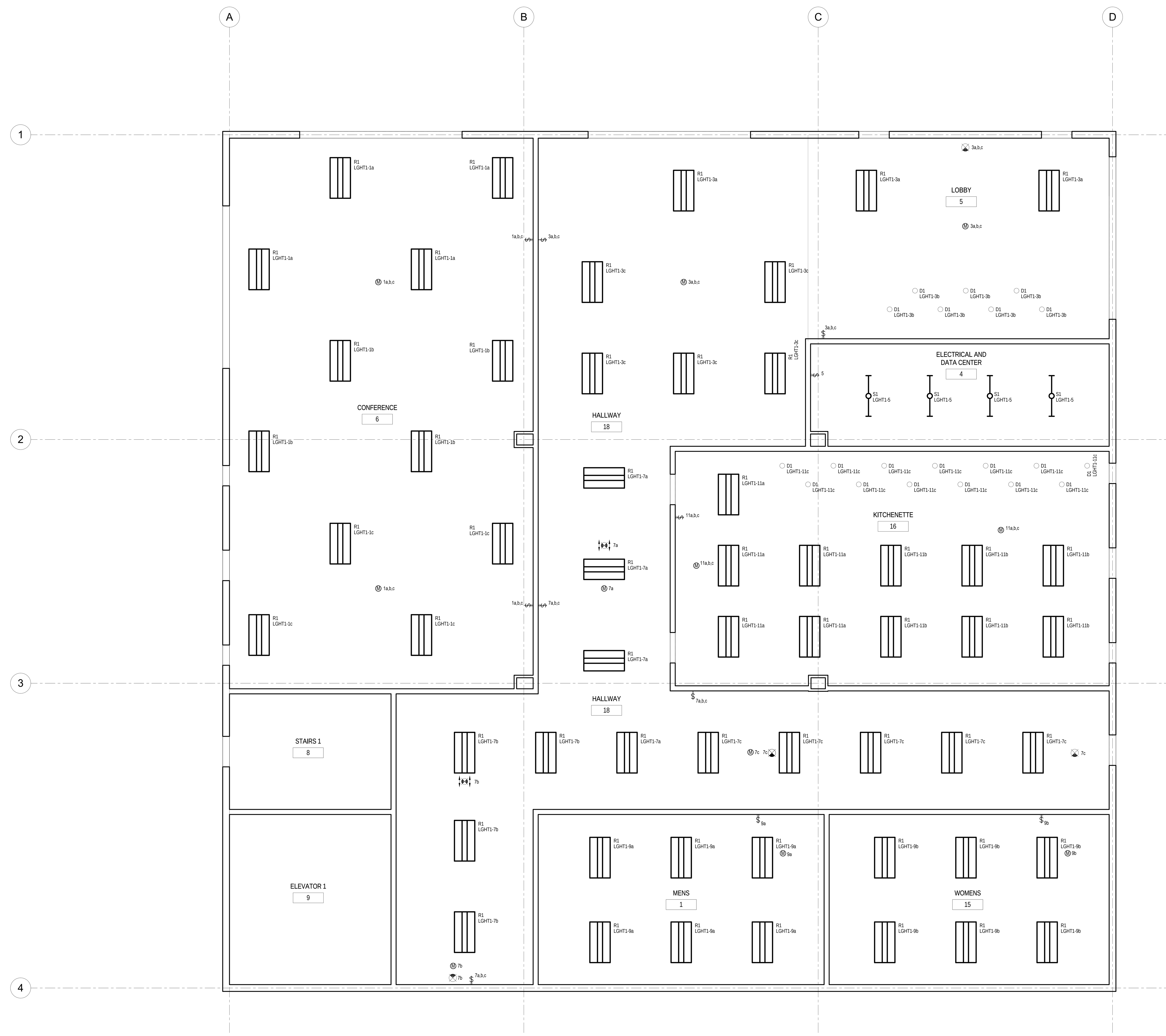
HOOKS ARCHITECTURE OFFICE
42 Wallaby Way
Oceanside, CA 92051

Dwg. Title

ELECTRICAL PANEL SCHEDULES

Project No. 101081_6794

Dwg. No. **E0.2** Rev. No.



1 1ST FLOOR
1/4" = 1'-0"

12/5/2016 3:43:44 PM

R W ENGINEERING

OWNER:

DAVID PHAN
5670 OBERLIN DRIVE
SAN DIEGO, CA 92121

ARCHITECT:

H. ROGERS ARCHITECTURE
290 CALIFORNIA BLVD
SAN LUIS OBISPO, CA 93405

MEP:

RW ENGINEERS
1304 E FOOTHILL BLVD
SAN LUIS OBISPO, CA 93405

REID WILHELM

SENIOR PROJECT
ELECTRICAL ENGINEERING DEPARTMENT
CALIFORNIA POLYTECHNIC STATE UNIVERSITY
SAN LUIS OBISPO
2016

No.	Revision	Date

SCHEMATIC DESIGN

Professional Seal(s)

Drawn By:	REID WILHELM
Checked By:	TINA SMILKSTEIN
Approved By:	DENNIS DERICKSON
Date Printed:	12/12/16
File Name:	

Project Title

HOOKS ARCHITECTURE OFFICE
42 Wallaby Way
Oceanside, CA 92051

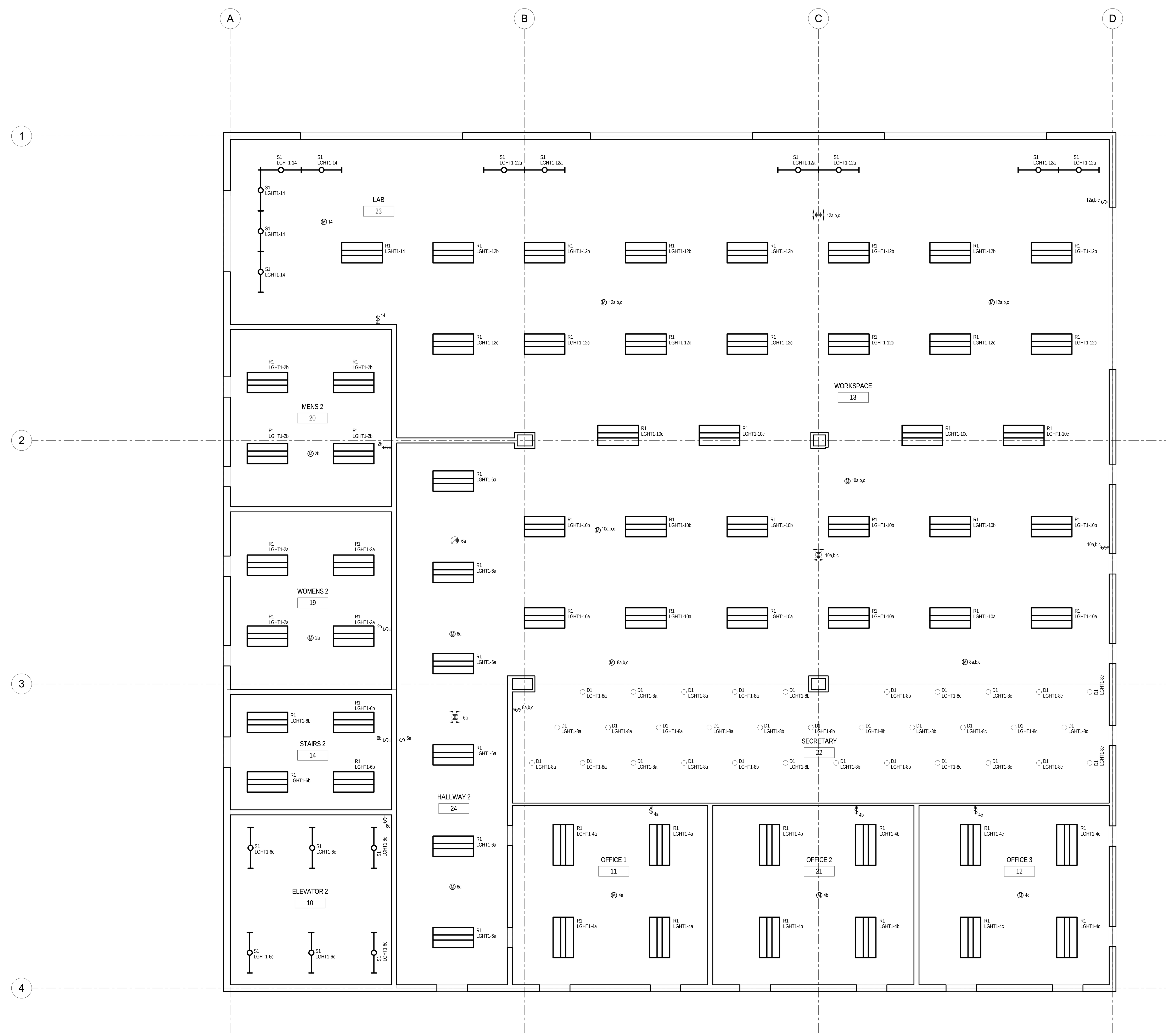
Dwg. Title

ELECTRICAL LIGHTING LEVEL 1

Project No.
101081_6794

Dwg. No.
EL1.1

Rev. No.



1 2ND FLOOR
1/4" = 1'-0"

12/5/2016 3:43:45 PM

R W ENGINEERING

OWNER:
DAVID PHAN
5670 OBERLIN DRIVE
SAN DIEGO, CA 92121

ARCHITECT:
H. ROGERS ARCHITECTURE
290 CALIFORNIA BLVD
SAN LUIS OBISPO, CA 93405

MEP:
RW ENGINEERS
1304 E FOOTHILL BLVD
SAN LUIS OBISPO, CA 93405

REID WILHELM

SENIOR PROJECT
ELECTRICAL ENGINEERING DEPARTMENT
CALIFORNIA POLYTECHNIC STATE UNIVERSITY
SAN LUIS OBISPO
2016

No.	Revision	Date

SCHEMATIC DESIGN

Professional Seal(s)

Drawn By:	REID WILHELM
Checked By:	TINA SMILKSTEIN
Approved By:	DENNIS DERICKSON
Date Printed:	12/12/16
File Name:	

Project Title

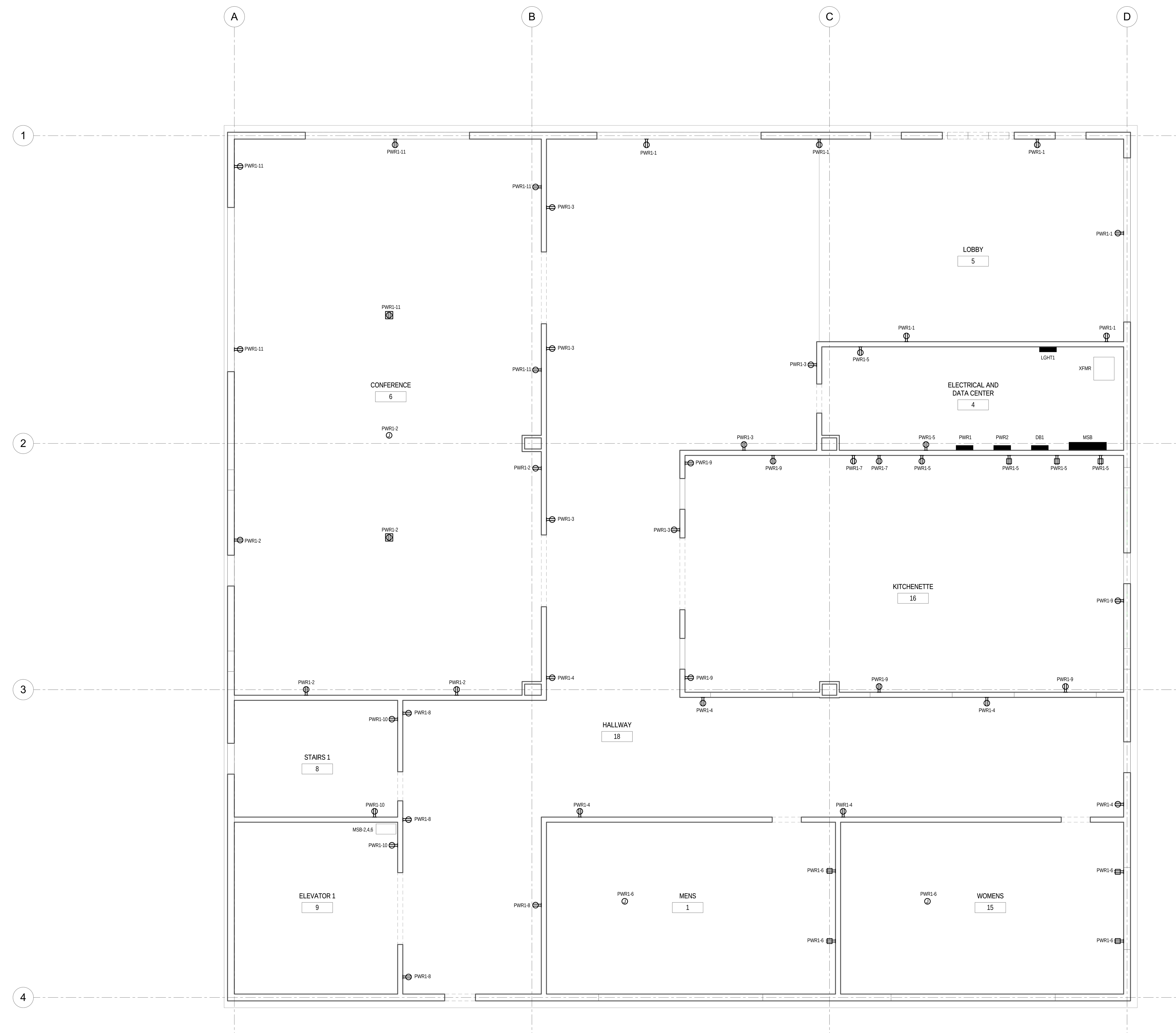
HOOKS ARCHITECTURE OFFICE
42 Wallaby Way
Oceanside, CA 92051

Dwg. Title

ELECTRICAL LIGHTING LEVEL 2

Project No. 101081_6794

Dwg. No. **EL1.2** Rev. No.



1 1ST FLOOR_POWER
1/4" = 1'-0"

12/5/2016 3:43:45 PM

RW ENGINEERING

OWNER:
DAVID PHAN
5670 OBERLIN DRIVE
SAN DIEGO, CA 92121

ARCHITECT:
H. ROGERS ARCHITECTURE
290 CALIFORNIA BLVD
SAN LUIS OBISPO, CA 93405

MEP:
RW ENGINEERS
1304 E FOOTHILL BLVD
SAN LUIS OBISPO, CA 93405

REID WILHELM

SENIOR PROJECT
ELECTRICAL ENGINEERING DEPARTMENT
CALIFORNIA POLYTECHNIC STATE UNIVERSITY
SAN LUIS OBISPO
2016

No.	Revision	Date

SCHEMATIC DESIGN

Professional Seal(s)

Drawn By:	REID WILHELM
Checked By:	TINA SMILKSTEIN
Approved By:	DENNIS DERICKSON
Date Printed:	12/12/16
File Name:	

Project Title

HOOKS ARCHITECTURE OFFICE
42 Wallaby Way
Oceanside, CA 92051

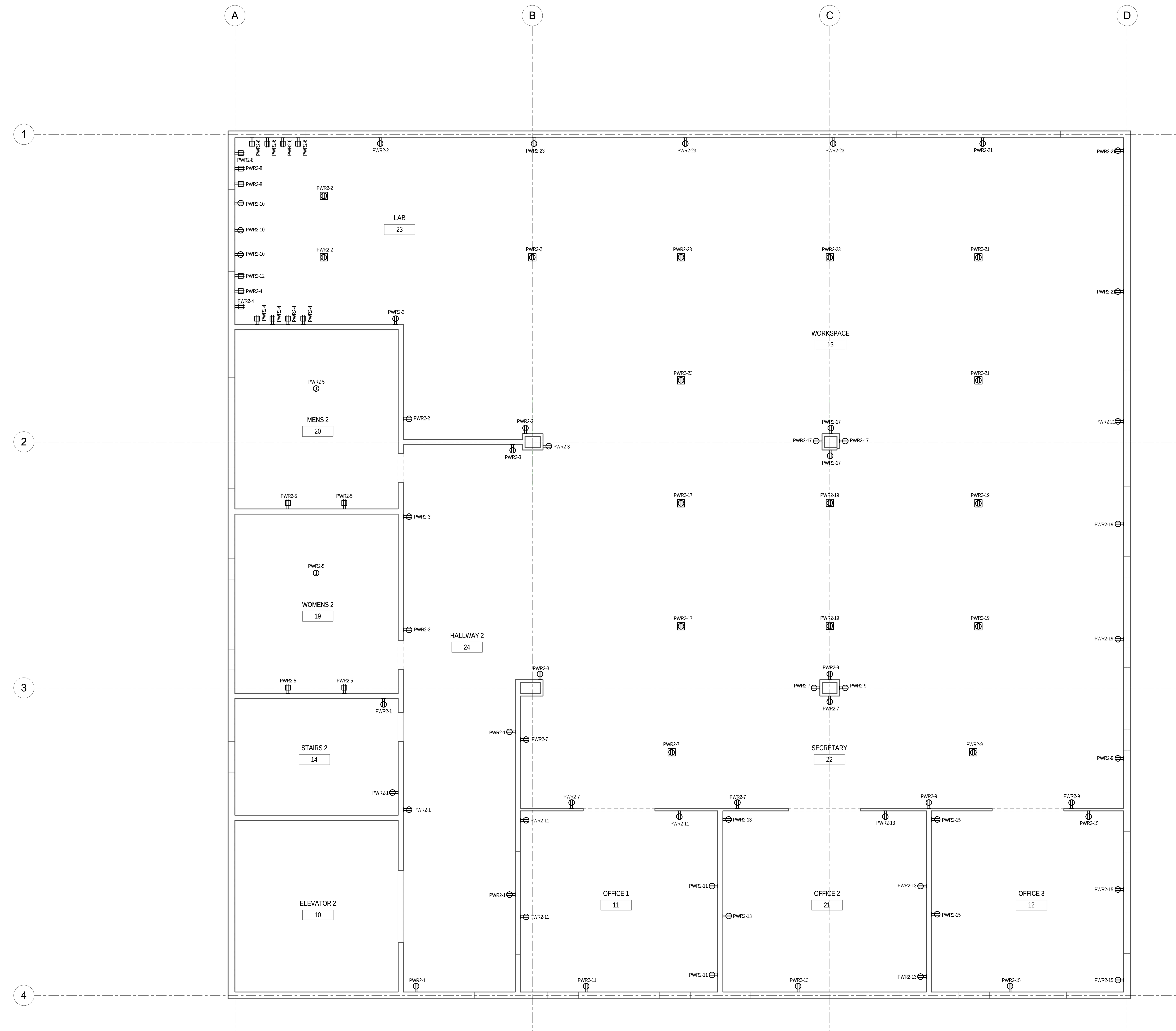
Dwg. Title

ELECTRICAL POWER
LEVEL 1

Project No. 101081_6794

Dwg. No. **EP1.1**

Rev. No.



1 2ND FLOOR_POWER
1/4" = 1'-0"

12/5/2016 3:43:45 PM

RW ENGINEERING

OWNER:

DAVID PHAN
5670 OBERLIN DRIVE
SAN DIEGO, CA 92121

ARCHITECT:

H. ROGERS ARCHITECTURE
290 CALIFORNIA BLVD
SAN LUIS OBISPO, CA 93405

MEP:

RW ENGINEERS
1304 E FOOTHILL BLVD
SAN LUIS OBISPO, CA 93405

REID WILHELM

SENIOR PROJECT
ELECTRICAL ENGINEERING DEPARTMENT
CALIFORNIA POLYTECHNIC STATE UNIVERSITY
SAN LUIS OBISPO
2016

No.	Revision	Date

SCHEMATIC DESIGN

Professional Seal(s)

Drawn By:	**REID WILHELM**
Checked By:	**TINA SMILKSTEIN**
Approved By:	**DENNIS DERICKSON**
Date Printed:	**12/12/16**
File Name:	

Project Title

HOOKS ARCHITECTURE
OFFICE
42 Wallaby Way
Oceanside, CA 92051

Dwg. Title

ELECTRICAL POWER
LEVEL 2

Project No. 101081_6794

Dwg. No. **EP1.2**

Rev. No.

LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	

FEATURES & SPECIFICATIONS

INTENDED USE —The BLT Best-in-Value Low Profile LED luminaire features a popular center basket design that offers a clean, versatile style and volumetric distribution. High efficacy LED light engines deliver energy savings and low maintenance compared to traditional sources. An extensive selection of configurations and options make the BLT the perfect choice for many lighting applications including schools, offices and other commercial spaces, retail, hospitals and healthcare facilities. The low profile BLT design (2-3/8") also makes it an excellent choice for renovation projects.

CONSTRUCTION — BLT enclosure components are die-formed for dimensional consistency and painted after fabrication with a polyester powder paint for improved performance and protection.

The reflector is finished with a high reflective matte white powder paint for improved aesthetics and increased light diffusion.

End plates contain easy-to-position integral T-bar clips for securely attaching the luminaire to the T-grid. For additional T-grid security, optional screw on T-bar clips are available.

Diffusers are extruded from impact modified acrylic for increased durability.

LED boards are accessible from below; driver is accessible from the plenum.

OPTICS — Volumetric illumination is achieved by creating an optimal mix of light to walls, partitions and vertical and horizontal work surfaces – rendering the interior space, objects and occupants in a more balanced, complimentary luminous environment. High performance extruded acrylic diffusers conceal LEDs and efficiently deliver light in a volumetric distribution. Four diffuser choices available - curved and square designs with linear prisms or a smooth frosted finish.

ELECTRICAL — Long-life LEDs, coupled with high-efficiency drivers, provide superior quantity and quality of illumination for extended service life. 80% LED lumen maintenance at 60,000 hours (L80/60,000).

Non-Configurable BLT: Generic 0-10 volt dimming driver. Dims to 10%

Configurable BLT: available in High Efficiency (HE) versions for applications where a lower wattage (over the standard product) is required. The High Efficiency versions deliver >130 LPW and can be specified via the Lumen Package designations in the Ordering Information below.

eldoLED driver options deliver choice of dimming range, and choices for control, while assuring flicker-free, low-current inrush, 89% efficiency and low EMI.

Optional integrated nLight® controls make each luminaire addressable - allowing it to digitally communicate with other nLight enabled controls such as dimmers, switches, occupancy sensors and photocontrols. Connection to nLight is simple. It can be accomplished with integrated nLight AIR wireless or through standard Cat-5 cabling. nLight offers unique plug-and-play convenience as devices and luminaires automatically discover each other and self-commission, while nLight AIR is commissioned easily through an intutitive mobile app.

Lumen Management: Unique lumen management system (option N80) provides on board intelligence that actively manages the LED light source so that constant lumen output is maintained over the system life, preventing the energy waste created by the traditional practice of over-lighting.

Step-level dimming option allows system to be switched to 50% power for compliance with common energy codes while maintaining fixture appearance.

Driver disconnect provided where required to comply with US and Canadian codes.

SENSOR— Integrated sensor (individual control): Sensor Switch MSD7ADCX ((Passive infrared (PIR)) or MSDPDT7ADCX ((PIR/Microphonics Dual Tech (PDT)) integrated occupancy sensor/automatic dimming photocell allows the luminaire to power off when the space is unoccupied or enough ambient light is entering the space. See page 4 for more details on the integrated sensor.

Integrated Sensor (nLight Wired Networking): This sensor is nLight-enabled, meaning it has the ability to communicate over an nLight network. When wired, using CAT-5 cabling, with other nLight-enabled sensors, power packs, or WallPods, an nLight control zone is created. Once linked to a Gateway, directly or via a Bridge, the zone becomes capable of remote status monitoring and control via SensorView software. See page 4 for the nLight sensor options.

Integrated Smart Sensor (nLight Air Wireless Platform): The rES7 sensor is nLight AIR enabled, meaning it has the ability to communicate over the wireless nLight control platform. It is both a digital PIR occupancy sensor/automatic dimming photocell. It pairs to other luminairs and wall switches through our mobile app, CL*AIR*ITY, which allows for simple sensor adjustment. See page 4 for more details on the Integrated Smart Sensor.

INSTALLATION — The BLT's low profile design of only 2-3/8" provides increased installation flexibility especially in restrictive plenum applications. The BLT fits into standard 15/16" and narrow 9/16" T-grid ceiling systems.

Suitable for damp location.

For recessed mounting in hard ceiling applications, Drywall Grid Adapters (DGA) are available as an accessory. See Accessories section.

LISTINGS — CSA Certified to meet U.S. and Canadian standards. IC rated.
DesignLights Consortium® (DLC) Premium qualified product. Not all versions of this product may be DLC Premium qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.

WARRANTY — 5-year limited warranty. Complete warranty terms located at
www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

NOTE: Actual performance may differ as a result of end-user environment and application.
All values are design or typical values, measured under laboratory conditions at 25 °C.
Specifications subject to change without notice.

BLT Series LED

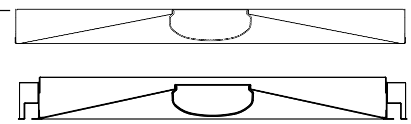
2BLT

2' x 4'
LED

eldoLED nLIGHT

Specifications

Length: 47-3/4 (121.2)
Width: 23-3/4 (60.3)
Depth: 2-3/8 (6.0)
Depth with Air supply/return: 2-3/4 (6.9)



All dimensions are inches (centimeters) unless otherwise specified.

Multiple Diffuser Options

ADP
Curved Ribbed

ADSM
Curved Smooth

SDP
Square Ribbed

SDSM
Square Smooth

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® control networks when ordered with drivers marked by a shaded background*
- This luminaire is part of an A+ Certified solution for nLight control networks, providing advanced control functionality at the luminaire level, when selection includes driver and control options marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

A+ Capable options indicated by this color background.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: 2BLT4 40L ADP EZ1 LP840

2BLT4						
Series	**Air function**	**Lumens**[2]	**Diffuser**	**Voltage**	**Driver**	**Color temperature**
2BLT4 2x4 BLT	(blank) Static A Air supply/ return[1]	**Standard efficiency (>100 LPW)** 30L 3000 40L 4000 48L 4800 60L 6000 72L 7200 **High efficiency**[3,4] **(>130 LPW)** 40LHE 4000 48LHE 4800 60LHE 6000 72LHE 7200 85LHE 8500	ADP Curved, linear prisms ADSM Curved, smooth SDP Square, linear prisms SDSM Square, smooth **Includes trim rings to match sensored version** ADPT Curved, linear prisms ADSMT Curved, smooth SDPT Square, linear prisms SDSMT Square, smooth	(blank) MVOLT 120 120V 277 277V 347 347V[5]	EZ1 eldoLED dims to 1% (0-10 volt dimming) SLD Step-level dimming[6] LE1 Lutron Ecosystem driver dims to 1%[6,7]	LP830 82CRI, 3000 K LP835 82CRI, 3500 K LP840 82CRI, 4000 K LP850 82CRI, 5000 K LP930 90CRI, 3000K LP935 90CRI, 3500K LP940 90CRI, 4000K LP950 90CRI, 5000K

Controls		**Occupancy control**[10]				**Options**	
(blank)	No nLight®	(blank)	No sensor control	**Individual Control**		EL7L	700 lumen battery pack[13]
N80	nLight® with 80% lumen management	**nLight Wired Networking**		MSD7ADCX	PIR integral occupancy sensor with automatic dimming control photocell[6,12]	EL14L	1400 lumen battery pack[13]
N80EMG	nLight® with 80% lumen management For use with generator supply EM power[8]	NES7	nLight™ nES 7 PIR integral occupancy sensor[11]	MSDPDT7ADCX	PDT integral occupancy sensor with automatic dimming control photocell[6,12]	CP	Chicago plenum[14]
N100	nLight® without lumen management	NESPDT7	nLight™ nES PDT 7 dual technology integral occupancy control[11]	**nLight Wireless Zone**		BGTD	Bodine Generator Transfer Device[15]
N100EMG	nLight® without lumen management For use with generator supply EM power[8]	NES7ADCX	nLight™ nES 7 ADCX PIR integral occupancy sensor with automatic dimming photocell[11]	RES7Z	nLight Air PIR integral occupancy sensor with automatic dimming photocell for zone control	PWS1836	6' pre-wire, 3/8" diameter, 18 gauge, 1 circuit
NLTAIR	nLight AIR enabled[9]	NESPDT7ADCX	nLight™ nES PDT 7 dual technology integral occupancy sensor with automatic dimming photocell[11]			PWS1846	6' pre-wire, 3/8" diameter, 18 gauge, 2 circuit
		nLight Wireless Networking				PWS1846 PWSLV	Two cables: one 6' pre-wire, 3/8" diameter, 18 gauge, 2 circuits; one 6' pre-wire, 3/8" diameter, 18 gauge, purple and gray[16]
		RES7N	nLight AIR PIR integral occupancy sensor with automatic dimming photocell for Networking Capabilities			PWS1856LV	6' pre-wire, 3/8" diameter, 18 gauge, 1 circuit w/low voltage purple and grey wires[16]
						GLR	Fast-blowing fuse[17]
						GMF	Slow-blowing fuse[17]
						NPLT	Narrow pallet
						RRL_	RELOC®-ready luminaire[18]
						LATC	Earthquake clip
						DWAM	Anti-Microbial paint
						JP16	Job packaging

Accessories next page

Notes

1. Air supply/return option only available with ADPT, ADSMT, SDPT, and SDSMT diffuser options.
2. Approximate lumen output.
3. All versions may not achieve 130+ LPW. Refer to photometry on www.acuitybrands.com.
4. Air supply/return option, 90 CRI, and versions with integral sensor trim rings may not achieve 130 LPW.
5. Not available with SLD EL7L, or EL14L options.
6. Not available with N80, N80EMG, N100, N100EMG, NLTAIR, or occupancy control.
7. Not available with controls, occupancy controls, or PWS options. Consult factory for Hi-Lume dimming.
8. nLight EMG option requires a connection to existing nLight network. Power is provided from a separate N80 or N100 enabled fixture.
9. Must order with RES7N or RES7Z sensor. Only available with EZ1 driver.
10. Must specify diffuser with trim rings. See sensor options on page 4.
11. Requires N80, N80EMG, N100, or N100EMG.
12. Only available with EZ1 driver option. 0-10v dimming wires not accessible via access plate.
13. When using pre-wire option, use PWS1846 or PWS1846 PWSLV.
14. Not available with N80, N80EMG, N100, or N100EMG.
15. Must specify voltage. Requires BSE labeling, voltage specific. Consult factory for options.
16. Not available with nLight wired/wireless network or individual controls.
17. Must specify voltage, 120 or 277, with GLR and GFM fusing.
18. For ordering logic consult RRL_2013.

2BLT Volumetric Recessed Lighting 2'x4'

Non-Configurable BLT								
Stock/MTO	**Catalog Description ***	**UPC**	**Lumens**	**Wattage**	**LPW**	**Color Temperature**	**Voltage**	**Pallet Qty**
Stock	2BLT4 40L ADP LP835	00190887470789	3945	34	116	3500K/82 CRI	120-277	26
	2BLT4 40L ADP LP840	00190887470765	4032	34	118	4000K/82CRI	120-277	26
	2BLT4 46L ADP LP835	00190887468656	4520	38.34	118	3500K/82 CRI	120-277	26
	2BLT4 46L ADP LP840	00190887468649	4620	38.34	120	4000K/82CRI	120-277	26
	2BLT4 40L ADP EL14L LP835	00190887470925	3945	34	116	3500K/82 CRI	120-277	26
	2BLT4 40L ADP EL14L LP840	00190887470918	4032	34	118	4000K/82 CRI	120-277	26
	2BLT4 46L ADP EL14L LP835	00190887468670	4520	38.34	118	3500K/82 CRI	120-277	26
	2BLT4 46L ADP EL14L LP840	00190887468663	4620	38.34	120	4000K/82 CRI	120-277	26
MTO	2BLT4 40L ADP 347 LP835		3945	34	116	3500K/82 CRI	347	26
	2BLT4 40L ADP 347 LP840		4032	34	118	4000K/82CRI	347	26
	2BLT4 46L ADP 347 LP835		4520	38.34	118	3500K/82 CRI	347	26
	2BLT4 46L ADP 347 LP840		4620	38.34	120	4000K/82CRI	347	26

*Generic 0-10V Dimming to 10%.

Accessories: *Order as separate catalog number.*

DGA24	Drywall grid adapter for 2x4 recessed fixture

nLight® Wired Control Accessories:
Order as separate catalog number. Visit www.acuitybrands.com/products/controls/nlight.

WallPod stations	**Model number**	**Occupancy sensors**	**Model number**
On/Off	nPODM [color]	Small motion 360°, ceiling (PIR / dual tech)	nCM 9 RJB / nCM PDT 9 RJB
On/Off & raise/lower	nPODM DX [color]	Large motion 360°, ceiling (PIR / dual tech)	nCM10 RJB / nCM PDT 10 RJB
Graphic touchscreen	nPOD GFX [color]	Wall switch with raise/lower	nWSX PDT LV DX [color]
Photocell controls	**Model number**	**Cat-5 cable (plenum rated)**	**Model number**
Full range dimming	nCM ADCX RJB	10' cable	CAT5 10FT J1
		30' cable	CAT5 30FT J1

nLight® AIR Control Accessories:
Order as separate catalog number. Visit www.acuitybrands.com/products/controls/nlightair.

Wall switches	**Model number**
On/Off single pole	rPODB [color]
On/Off two pole	rPODB 2P [color]
On/Off & raise/lower single pole	rPODB DX [color]
On/Off & raise/lower two pole	rPODB 2P DX [color]
On/Off & raise/lower single pole	rPODBZ DX WH[1]

Notes

1 Can only be ordered with the RES7Z zone control sensor version.

Replacement Parts: *Order as separate catalog number.*

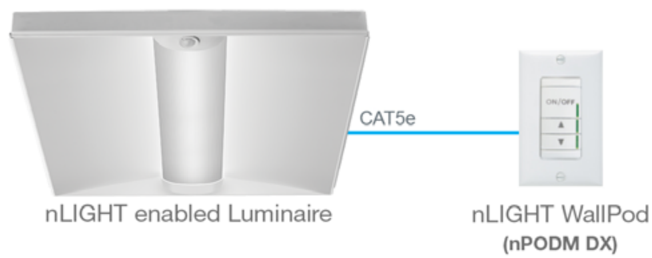
2DBLT48 ADP LENS ASSEMBLY	4 ft. replacement lens
2DBLT48 SDP LENS ASSEMBLY	4 ft. replacement lens
2DBLT48 ADSM LENS ASSEMBLY	4 ft. replacement lens
2DBLT48 SDSM LENS ASSEMBLY	4 ft. replacement lens
2DBLT48 ADPT LENS ASSEMBLY	4 ft. replacement lens
2DBLT48 SDPT LENS ASSEMBLY	4 ft. replacement lens
2DBLT48 ADSMT LENS ASSEMBLY	4 ft. replacement lens
2DBLT48 SDSMT LENS ASSEMBLY	4 ft. replacement lens
2DBLT48 ADPT SENSOR LENS ASSEMBLY	4 ft. replacement lens
2DBLT48 SDPT SENSOR LENS ASSEMBLY	4 ft. replacement lens
2DBLT48 ADSMT SENSOR LENS ASSEMBLY	4 ft. replacement lens
2DBLT48 SDSMT SENSOR LENS ASSEMBLY	4 ft. replacement lens

LITHONIA LIGHTING®
An Acuity Brands Company

LED: One Lithonia Way Conyers, GA 30012 Phone: 800-858-7763 www.lithonia.com

Sensor Options						
Option	Automatic Dimming Photocell	Occupancy Sensing PIR	Occupancy Sensing PDT	nLight Wired Networking	nLight AIR Networking	nLight AIR Zone
MSD7ADCX	X	X				
MSDPDT7ADCX	X		X			
NES7		X		X		
NES7ADCX	X	X		X		
NESPDT7			X	X		
NESPDT7ADCX	X		X	X		
RES7N	X	X			X	
RES7Z	X	X				X

Basic nLight Zone

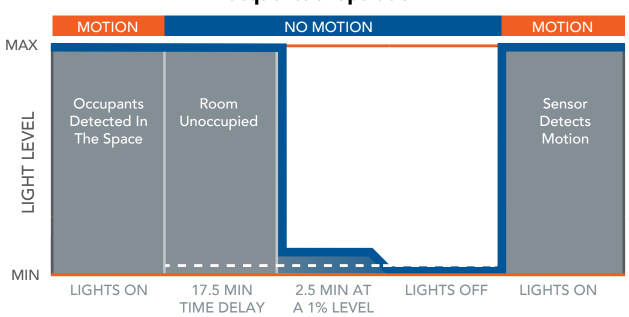


Integrated Sensor with Individual Control

The MSD7ADCX PIR occupancy sensor/automatic dimming photocell is ideal for areas without obstructions and where daylight harvesting may be desired. Suggested applications include, but not limited to, hallways, corridors, storage rooms, and breakrooms or other areas where people are typically moving.

The MSDPDT7ADCX PIR/Microphonics Dual Tech occupancy sensor/automatic dimming photocell is ideal for areas with obstructions and where daylight harvesting is desired. Suggested applications include, but not limited to, open offices, private offices, classrooms, public restrooms, and conference rooms.

Sequence of Operation



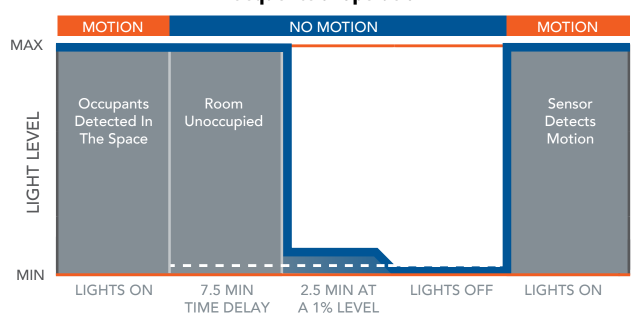
*The presetting on the automatic dimming photocell is 5fc.

nLight Wired Networking

The nES 7 is ideal for small rooms without obstructions or areas with primarily walking motion. Ideal areas include hallways, corridors, storage rooms, and breakrooms. Additionally, the NES7ADCX includes an integrated photocell, which enables daylight harvesting controls.

For areas like restrooms, private offices, open offices, conference rooms or any space with obstructions, the nES PDT 7 dual technology sensor is recommended. The nES PDT 7 utilizes both PIR (passive infrared) and Microphonics technologies to detect occupancy. Additionally, the NESPDT7ADCX includes an integrated photocell, which enables daylight harvesting controls which is ideal for areas where windows are present.

Sequence of Operation

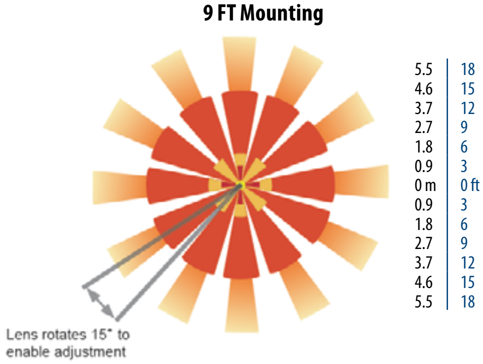


*The presetting on the automatic dimming photocell is 5fc.

Sensor Coverage Pattern
Mini 360° Lens

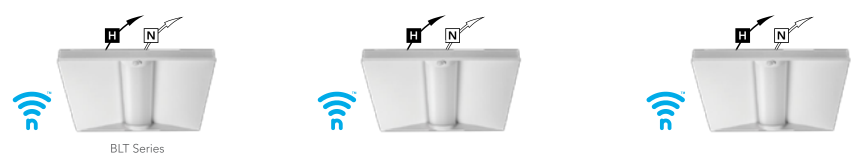
- Recommended for walking motion detection from mounting heights between 8 ft (2.44 m) and 20 ft (6.10 m)
- Initial detection of walking motion along sensor axes at distances of 2x the mounting height up to 15 ft (4.57 m) and
- 1.75x up to 20 ft (6.10 m).
- Provides 12 ft (3.66 m) radial detection of small motion when mounted at 9 ft (2.74 m)
- Initial detection will occur earlier when walking across sensor's field of view than when walking directly at sensor

9 FT Mounting



nLight AIR Wireless

nLight AIR is the ideal solution for retrofit or new construction spaces where adding additional wiring can be labor intensive and costly. The integrated rES 7 smart sensor is part of each luminaire in the nLight AIR network, which can be grouped to control multiple luminaires. The granularity of control with the digital PIR occupancy detection and daylight sensing makes a great solution for any application.

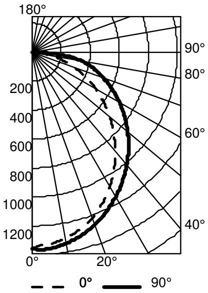


Simple as 1,2,3

1. Install the nLight® AIR fixtures with embedded smart sensor
2. Install the wireless battery-powered wall switch
3. With CLAIRITY app, pair the fixtures with the wall switch and if desired, customize the sensor settings for the desired outcome

PHOTOMETRICS

2BLT4 40L ADP LP835, 3945 delivered lumens, test no. LTL28918P37, tested in accordance to IESNA LM-79



CP Summary

	0°	90
0°	1356	1356
5°	1330	1361
15°	1269	1309
25°	1147	1212
35°	984	1085
45°	795	938
55°	599	777
65°	407	609
75°	216	437
85°	54	179
90	6	2

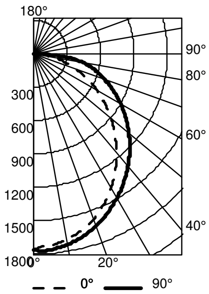
Coefficients of Utilization

pf	20%								
pc	80%			70%			50%		
pw	70%	50%	30%	50%	30%	10%	50%	30%	10%
RCR 0	119	119	119	116	116	116	111	111	111
1	108	103	98	100	96	92	96	92	89
2	98	89	82	87	80	75	83	78	73
3	89	78	69	76	68	62	73	66	61
4	81	69	60	67	59	52	65	57	52
5	75	61	52	60	52	45	58	50	44
6	69	55	46	54	46	39	52	45	39
7	64	50	41	49	41	35	48	40	34
8	59	46	37	45	37	31	44	36	31
9	56	42	34	41	33	28	40	33	28
10	52	39	31	38	30	25	37	30	25

Zonal Lumen Summary

Zone	Lumens	% Lamp	% Fixture
0° - 30°	1037	26.3	26.3
0° - 40°	1686	42.7	42.7
0° - 60°	2970	75.3	75.3
0° - 90°	3947	100.0	100.0
90° - 180°	0	0.0	0.0
0° - 180°	3947	100.0	100.0

2BLT4 48L ADP LP835, 5121 delivered lumens, test no. LTL28918P41, tested in accordance to IESNA LM-79



CP Summary

	0°	90
0°	1760	1760
5°	1726	1767
15°	1647	1699
25°	1490	1574
35°	1277	1409
45°	1033	1217
55°	778	1008
65°	528	791
75°	280	567
85°	70	232
90	8	3

Coefficients of Utilization

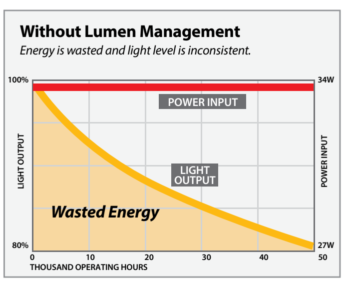
pf	20%								
pc	80%			70%			50%		
pw	70%	50%	30%	50%	30%	10%	50%	30%	10%
RCR 0	119	119	119	116	116	116	111	111	111
1	108	103	98	100	96	92	96	92	89
2	98	89	82	87	80	75	83	78	73
3	89	78	69	76	68	62	73	66	61
4	81	69	60	67	59	52	65	57	52
5	75	61	52	60	52	45	58	50	44
6	69	55	46	54	46	39	52	45	39
7	64	50	41	49	41	35	48	40	34
8	59	46	37	45	37	31	44	36	31
9	56	42	34	41	33	28	40	33	28
10	52	39	31	38	30	25	37	30	25

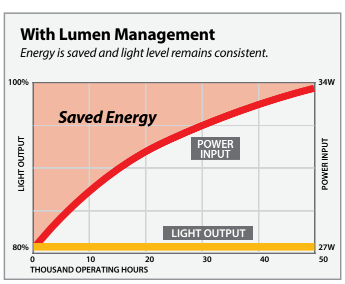
Zonal Lumen Summary

Zone	Lumens	% Lamp	% Fixture
0° - 30°	1346	26.3	26.3
0° - 40°	2188	42.7	42.7
0° - 60°	3856	75.3	75.3
0° - 90°	5123	100.0	100.0
90° - 180°	0	0.0	0.0
0° - 180°	5123	100.0	100.0

Constant Lumen Management

Enabled by the embedded nLight control, the BLT actively tracks its run-time and manages its light source such that constant lumen output is maintained over the system life. Referred to as lumen management, this feature eliminates the energy waste created by the traditional practice of over-lighting.





Performance Data

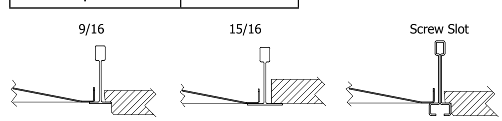
Lumen Package	Lumens	Input Watts	LPW
30L ADP LP830	3286	30	110
30L ADP LP835	3371	30	113
30L ADP LP840	3445	30	115
30L ADP LP850	3614	30	121
40L ADP LP830	3846	34	113
40L ADP LP835	3945	34	116
40L ADP LP840	4032	34	118
40L ADP LP850	4230	34	124
48L ADP LP830	4993	45	111
48L ADP LP835	5121	45	114
48L ADP LP840	5234	45	116
48L ADP LP850	5492	45	122
60L ADP LP830	6014	53	114
60L ADP LP835	6169	53	117
60L ADP LP840	6305	53	119
60L ADP LP850	6615	53	125
72L ADP LP830	7388	67	110
72L ADP LP835	7579	67	113
72L ADP LP840	7746	67	115
72L ADP LP850	8127	67	121
AIR 30L ADP LP830	3075	30	103
AIR 30L ADP LP835	3138	30	105
AIR 30L ADP LP840	3223	30	108
AIR 30L ADP LP850	3250	30	108
AIR 40L ADP LP830	3599	34	105
AIR 40L ADP LP835	3673	34	108
AIR 40L ADP LP840	3772	34	110
AIR 40L ADP LP850	3804	34	111
AIR 48L ADP LP830	4672	45	104
AIR 48L ADP LP835	4897	45	109
AIR 48L ADP LP840	4897	45	109
AIR 48L ADP LP850	4939	45	110
AIR 60L ADP LP830	5628	53	106
AIR 60L ADP LP835	5743	53	108
AIR 60L ADP LP840	5899	53	111
AIR 60L ADP LP850	5949	53	112
AIR 72L ADP LP830	6914	67	103
AIR 72L ADP LP835	7055	67	105
AIR 72L ADP LP840	7247	67	108
AIR 72L ADP LP850	7309	67	109

HE Performance Data

Lumen Package	Lumens	Input Watts	LPW
48LHE ADP LP830	4655	36	127
48LHE ADP LP835	4775	36	130
48LHE ADP LP840	4880	36	133
48LHE ADP LP850	5121	36	139
60LHE ADP LP830	5473	42	129
60LHE ADP LP835	5614	42	132
60LHE ADP LP840	5738	42	135
60LHE ADP LP850	6020	42	142
72LHE ADP LP830	6805	52	130
72LHE ADP LP835	6981	52	133
72LHE ADP LP840	7135	52	136
72LHE ADP LP850	7486	52	143
85LHE ADP LP830	8189	64	127.
85LHE ADP LP835	8400	64	131
85LHE ADP LP840	8585	64	134
85LHE ADP LP850	9008	64	140

MOUNTING DATA

Ceiling Type	Appropriate Trim Type
Exposed grid tee (1' and 9/16")	G
Concealed grid tee	G
Plaster or plasterboard	G*



*DGA accessory available to provide ceiling trim flange and fixture support for plaster or plasterboard ceiling. Recommended rough-in dimensions for DGA installation is 24-3/4" x 48-3/4" (Tolerance is +1/8", -0").

LITHONIA LIGHTING®
An AcuityBrands Company

LED: One Lithonia Way Conyers, GA 30012 Phone: 800-858-7763 www.lithonia.com

Rev. 11/15/16

Catalog Number

Notes

Type

RV6 LED

6" OPEN LED
Non-IC
Retrofit Downlight

WET LOCATION
DIMMABLE LED

FEATURES & SPECIFICATIONS

INTENDED USE — LED downlight for retrofit of installed 6" nominal commercial "pan-style" housings with incandescent, compact fluorescent (CFL), or high intensity discharge (HID) sources. Compatible range is 5 3/4" to 6 7/8". All installation can be performed from the room side without removing the existing fixture. Multiple lumen packages to replace the installed base of CFL or HID sources with energy savings up to 50%. See Lumen Equivalency Chart.

CONSTRUCTION — Innovative housing design that simultaneously retaining and centers the fixture in the existing mounting pan.

OPTICS — LED light source with diffuse lens recessed in a reflector with a 55-degree cutoff. Aluminum full reflectors are optically designed to maximize lumen output and to provide superior glare control.

Anodized trim colors for open reflectors are clear diffuse, pewter or wheat. White polyester powder coat also available.

Minimum CRI of 80.

ELECTRICAL — Propriety electrical design allows for excellent line voltage dimming down to 10% light output on 120V product. The zero in rush design enables maximum loading of incandescent dimmers. This enables customers to add dimming of a low cost without pulling additional wires. For compatible dimmers and dimming range, refer to Dimmer Compatibility Chart.

The system maintains 70% lumen output at more than 50,000 hours.

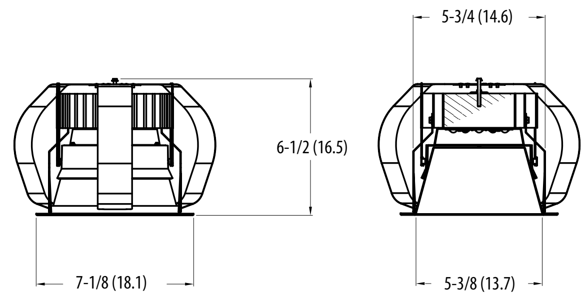
LISTINGS — CSA certified to US and Canadian safety standards. Wet location listed.

WARRANTY — 5-year limited warranty. Complete warranty terms located at www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

Note: Actual performance may differ as a result of end-user environment and application.

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.



Specifications

Aperture:	5-5/16 (13.5)	Max. ceiling opening:	6-7/8 (17.5)
Overlap trim:	7-1/8 (18.1)	Min. ceiling opening:	5-3/4 (14.6)
Height:	6-1/2 (16.5)	Max. ceiling thickness:	2 (5.1)
Length:	7 (17.8)		

All dimensions are inches (centimeters) unless otherwise indicated.

LUMEN EQUIVALENCY CHART*

	RV6 35/06		RV6 35/10		RV6 35/15	
	120V	277V	120V	277V	120V	277V
Delivered lumens (lm)	615	790	900	1200	1475	1580
Nominal wattage (W)	9	10.5	14	16	22.5	23
Comparable fluorescent	18W CFL		26W CFL		32W CFL	
Comparable incandescent	65W BR30		120W BR40		150W A21	
Comparable halogen PAR	50W		75W		90W	

* Data based on LM-79 test reports.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: RV6 35/15 R06AR 120

RV6							
Series	**Color temperature**	**Lumens**	**Reflector**	**Trim color**	**Finish**	**Voltage**	**Options**
RV6	27/ 2700 K 30/ 3000 K 35/ 3500 K 40/ 4000 K	06 600 lumens [1] 10 1000 lumens [1] 15 1500 lumens [1]	R06 Downlight RW6 Wallwash	AR Clear PR Pewter WTR Wheat WR White [2]	(blank) Semi-specular LD Matte-diffuse LS Specular	120 277	TRW White painted flange TRBL Black painted flange

Accessories: *Order as separate catalog number.*

EAC ISSM 375	Compact interruptible emergency AC power system
EAC ISSM 125	Compact interruptible emergency AC power system
RK2 SDT 347277120 395VA AD JZ	347V step down transformer mounted in box installed by others
GRA68 JZ	Oversized trim ring with 8" outside diameter. Refer to TECH-GOOF RINGS for more options.
RV6RGIN	6" rough-in frame. Refer to RV ROUGH-IN FRAMES.
RV6RGIN IFB	6" install from below, rough-in frame. Refer to RV ROUGH-IN FRAMES.

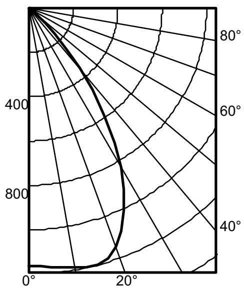
Notes

1 Approximate lumen output.
2 Not available with finishes.

PHOTOMETRICS

Distribution Curve	Distribution Data	Output Data	Coefficient of Utilization	Illuminance Data at 30" Above Floor for a Single Luminaire

RV6 35/15 R06AR 120, input watts: 21, delivered lumens: 1433, LM/W = 68, test no. LTL25291.



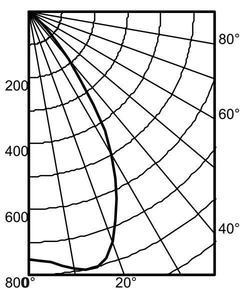
	Ave	Lumens
0	1162	
5	1172	112
15	1196	335
25	1008	458
35	592	365
45	168	138
55	13	19
65	3	3
75	1	1
85	0	0
90	0	

Zone	Lumens	% Lamp
0° - 30°	906.3	63.2
0° - 40°	1271.4	88.7
0° - 60°	1428.5	99.7
0° - 90°	1433.1	100.0
90° - 180°	0.0	0.0
0° - 180°	1433.1	*100.0

*Efficiency

pf	20%								
pc	80%			70%			50%		
pw	50%	30%	10%	50%	30%	10%	50%	30%	10%
0	119	119	119	116	116	116	111	111	111
1	110	108	105	108	106	104	104	102	101
2	102	98	94	100	97	93	97	94	91
3	95	89	85	93	88	84	91	86	83
4	88	82	78	87	81	77	84	80	76
5	82	75	71	81	75	71	79	74	70
6	76	70	65	75	69	65	74	68	65
7	71	65	60	70	64	60	69	64	60
8	66	60	56	66	60	56	65	59	55
9	62	56	52	62	56	52	61	55	52
10	59	52	48	58	52	48	57	52	48

RV6 35/10 R06AR 120, input watts: 14, delivered lumens: 889, LM/W = 64, test no. LTL25276.



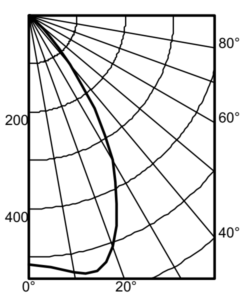
	Ave	Lumens
0	753	
5	763	74
15	803	223
25	628	286
35	342	211
45	86	72
55	7	10
65	2	2
75	0	1
85	0	0
90	0	

Zone	Lumens	% Lamp
0° - 30°	583.3	66.4
0° - 40°	794.6	90.4
0° - 60°	876.2	99.7
0° - 90°	878.8	100.0
90° - 180°	0.0	0.0
0° - 180°	878.8	*100.0

*Efficiency

pf	20%								
pc	80%			70%			50%		
pw	50%	30%	10%	50%	30%	10%	50%	30%	10%
0	119	119	119	116	116	116	111	111	111
1	111	108	106	108	106	104	104	102	101
2	102	98	95	101	97	94	98	94	92
3	95	90	86	94	89	85	91	87	84
4	89	83	78	87	82	78	85	81	77
5	83	77	72	82	76	72	80	75	71
6	77	71	66	76	70	66	75	70	66
7	72	66	62	72	66	61	70	65	61
8	68	61	57	67	61	57	66	61	57
9	64	57	53	63	57	53	62	57	53
10	60	54	50	59	54	50	59	53	50

RV6 35/06 R06AR 120, input watts: 8 , delivered lumens: 604, LM/W = 76, test no. LTL25277.



	Ave	Lumens
0	515	
5	522	50
15	548	152
25	430	196
35	236	146
45	60	50
55	5	7
65	1	1
75	0	0
85	0	0
90	0	

Zone	Lumens	% Lamp
0° - 30°	398.7	66.0
0° - 40°	544.9	90.2
0° - 60°	602.2	99.7
0° - 90°	604.0	100.0
90° - 180°	0.0	0.0
0° - 180°	604.0	*100.0

*Efficiency

pf	20%								
pc	80%			70%			50%		
pw	50%	30%	10%	50%	30%	10%	50%	30%	10%
0	119	119	119	116	116	116	111	111	111
1	110	108	106	108	106	104	104	102	101
2	102	98	95	101	97	94	97	94	92
3	95	90	86	94	89	85	91	87	84
4	88	83	78	87	82	78	85	81	77
5	82	76	72	82	76	72	80	75	71
6	77	71	66	76	70	66	75	70	66
7	72	66	61	71	65	61	70	65	61
8	68	61	57	67	61	57	66	61	57
9	63	57	53	63	57	53	62	57	53
10	60	54	50	59	54	50	58	53	50

Notes

- Tested in accordance with IESNA LM-79-08.
- Tested to current IES and NEMA standards under stabilized laboratory conditions.

DOWNLIGHTING: One Lithonia Way, Conyers, GA 30012 Phone: 800-315-4935 Fax: 770-860-3129 www.lithonia.com

ADDITIONAL DATA

Color temperature	Lumen multiplier
27K	0.83
30K	0.94
35K	1.00 (baseline)
40K	1.03

Trim color	Lumen multiplier
Clear (AR)	1.01
Pewter (PR)	0.97
Wheat (WTR)	0.98
White (WR)	1.00

ENERGY DATA*	
Min. starting temp	-18°C (0°F)
Min. power factor	0.80
Input frequency	50/60 Hz
*Values at non-dimming line voltage.	

ELECTRICAL DATA*		
Lumen package	Input current	
	120V	277V
600 lm	0.07 A	0.04 A
1000 lm	0.12 A	0.06 A
1500 lm	0.18 A	0.09 A
* Values at non-dimming line voltage.		

DIMMER COMPATIBILITY CHART			
Manufacturer	Model/Series	Part numbers	Comments
Sensor Switch	nlight	nSP5 PCD 2W	
Lutron	Diva C-L	DVCL-153P	
	Diva	DVELV-300P	
	Diva	DVELV-600P	
	Skylark Contour	CT-603P	
	Skylark Contour C-L	CTCL-153P	
Leviton	Decora	6674-P	
	Decora	6633P	
	IllumaTech™	IPX06-70Z (for 277V)	Dims to 40%
	TRIMATRON	6681++	
	TRIMATRON	6684++	
++ Must have at least 40W on dimmer circuit.			

DOWNLIGHTING: One Lithonia Way, Conyers, GA 30012 Phone: 800-315-4935 Fax: 770-860-3129 www.lithonia.com

Catalog Number	
Notes	
Type	

LITHONIA LIGHTING®

FEATURES & SPECIFICATIONS

INTENDED USE —The GRAD is a linear suspended product for commercial indoor, education and healthcare applications.

CONSTRUCTION — Nominal 8-1/4" x 1-3/4" rectangular housing is formed from cold-rolled steel.

End caps are mechanically attached with no exposed fasteners.

Color for housing and end caps is white or painted aluminum. Consult factory for custom colors.

OPTICS — Four LED lumen packages and three available color temperature options (3000K, 3500K and 4000K) — all within 2.5 MacAdam ellipses.

ELECTRICAL — LED light engine — consisting of modular LED boards and dimming driver — is rated for >60,000 hours (L80) at 25° C ambient temperature. Specify 120V or 277V. Pre-wired with 16AWG fixture wire. For special circuiting or wire gauge, consult factory. Plug-in electrical connectors included.

CONTROLS — For constant lumen output at 80% of initial light output, choose lumen management CL80.

MIN1 option provides "natural dimming" with smooth, continuous and flicker-free dimming. Syncing for controls: 2mA max. THD: < 20%. Insignificant inrush current at 120 and 277VAC. FCC Class A and B tested for EMI and RFI. Controls and system networking options. For wired networking via Cat-5e, choose an integrated nLight® module. For daylight dimming and/or dual technology occupancy detection, see Page 3 for integrated sensor options. One control module per 4' section or 40' maximum row.

INSTALLATION — 4' and 8' lengths in a single section for exact suspension spacing of 4' and 8'. For total luminaire length, add 1/16" for each flat end cap. Using internal joiners, 4' and 8' sections can be joined to form longer rows.

Ambient operating temperature between 0° C and 25° C.

LISTINGS — CSA/CUS listed. LM-79 tested. Individual sections meet FCC Part 15 requirements. Lighting Facts partner.

DesignLights Consortium® (DLC) Premium qualified product and DLC qualified product. Not all versions of this product may be DLC Premium qualified or DLC qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.

GRAD LINEAR

I/D, Direct

eldoLED nLIGHT

WARRANTY — 5-year limited warranty. Complete warranty terms located at www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

Note: Actual performance may differ as a result of end-user environment and application. All values are design or typical values, measured under laboratory conditions at 25 °C. Specifications subject to change without notice.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: GRD LLP 16FT MSL4 80CRI 30K ID1000LMF 80/20 MIN1 ZT 120 SCT CL80 F1/24A C110

Luminaire	Linear length plan	Total run length	Maximum section length	LED color rendering	LED color temperature	Indirect/direct LED output	Indirect/direct intensity ratio
GRD	LLP Linear longest possible LSL Linear same length	__FT Indicate luminaire row length in 4' increments. Ex: 12FT	MSL4 4' section(s) MSL8 8' section(s)	80CRI 80+ CRI	30K 3000K 35K 3500K 40K 4000K	ID800LMF 800 nominal lumens per foot ID1000LMF 1000 nominal lumens per foot ID1300LMF 1300 nominal lumens per foot ID1500LMF 1500 nominal lumens per foot	80/20 Std. 80% up/ 20% down 20/80 20% up/ 80% down 0/100 0% up/ 100% down

Minimum dimming level	Control input	Voltage	Wiring option	Emergency options
MIN1 Constant current, dimming to 1% MIN10 Constant current, dimming to 10%	ZT 0-10V NLIGHT nLight enabled ECO Lutron Ecosystem[1]	120 120V 277 277V	SCT Single circuit	(blank) None 1EC (1) Emergency circuit module 2EC (2) Emergency circuit modules __EC __ Emergency circuit modules[2] __E7W __ 7-watt emergency battery pack (575 lumens)[2,3]

Control option[4]	Lumen management[5]	Mounting type /	Overall suspension		Color
(blank) No sensor ADC Daylight dimming sensor PDT Occupancy sensor; occupancy/ daylight sensor	(blank) None CL80 Constant lumen ouput, 80%	F1/ T-bar ceiling (universal mounting bracket) F1A/ T-bar ceiling (UMB with integrated J-box) F2/ Hard ceiling (horizontal J-box)	12F 12" fixed 18F 18" fixed 24F 24" fixed 24A 24" adjustable 36A 36" adjustable 48A 48" adjustable	72A 72" adjustable 96A 96" adjustable 144A 144" adjustable 192A 192" adjustable 240A 240" adjustable	C110 Painted aluminum (low gloss) C210 White white (fine textured) C099 Custom color

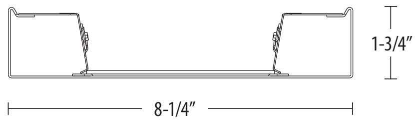
Fusing	Territory compliance	Cover	Canopy	Junction box	Slope
(blank) None GLR Fast blow GMF Slow blow	(blank) None CSA Manufactured to Canadian standards	(blank) None DU Dust cover	(blank) None MCS Matching canopy at support for aesthetics MCSJ Matching canopy for J-box mounting at non-power feed support locations	(blank) None OJB Offset J-box at feed	(blank) None SLP Sloped ceiling

Notes

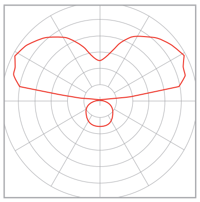
1 Only available with MIN1.
2 Must specify quantity.
3 Only 20/80 and 0/100 ratios meet the 1fc test at a max fixture mounting height of 12.9 feet above floor.
4 Only available with ZT or NLIGHT.
5 Only available with NLIGHT.

DIMENSIONS

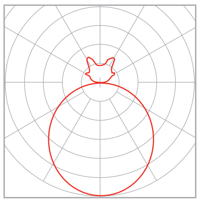
All dimensions are inches (centimeters) unless otherwise specified.



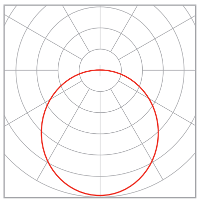
PHOTOMETRICS



ID800LMF 80/20 80CRI 35K
137 lm/W
3401 delivered lumens per 4' section



ID800LMF 20/80 80CRI 35K
105 lm/W
2621 delivered lumens per 4' section



ID800LMF 0/100 80CRI 35K
94 lm/W
2335 delivered lumens per 4' section

Fixture Performance

	3000K				3500K				4000K			
	800LMF	1000LMF	1300LMF	1500LMF	800LMF	1000LMF	1300LMF	1500LMF	800LMF	1000LMF	1300LMF	1500LMF
Lumen Output	3303	4033	4843	5841	3401	4153	4987	6015	3456	4220	5067	6111
Input Watts	25	32	40	51	25	32	40	51	25	32	40	51
Lumens/Watt	133	125	121	115	137	129	124	119	139	131	126	121

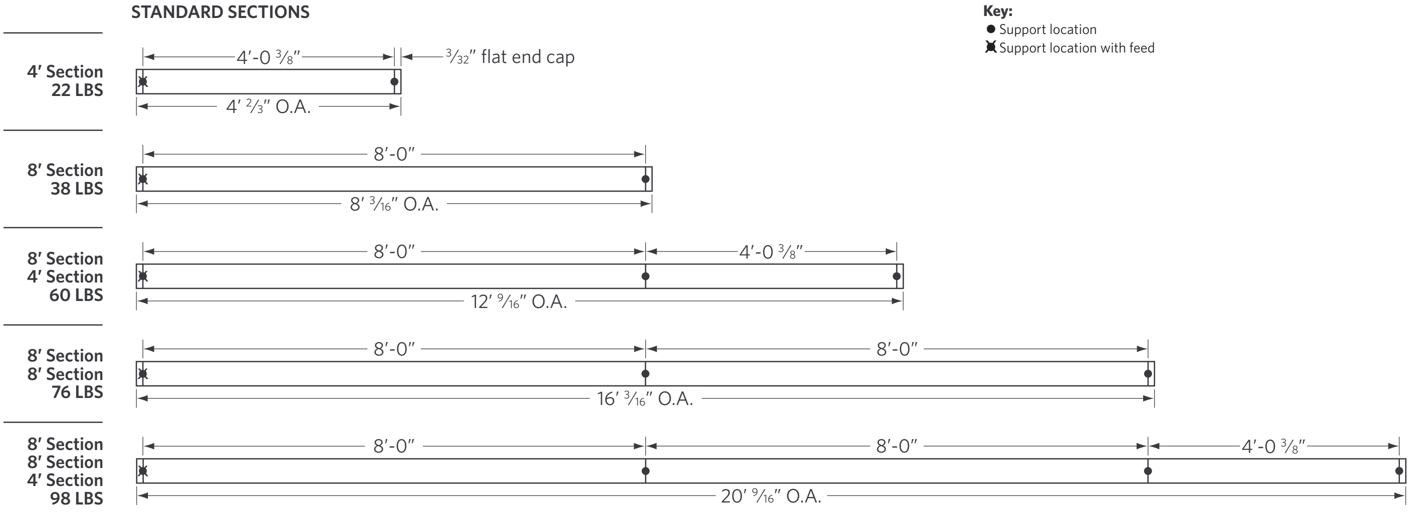
*AT 80/20 Indirect/Direct Intensity Ratio

LITHONIA LIGHTING®
An Acuity Brands Company

LED: One Lithonia Way, Conyers, GA 30012 Phone: 800-858-7763 Fax: 770-929-8789 www.lithonia.com

Weights and Support Spacing

Suspension spacing equals section length. Default location shown. Consult factory for stem mounting suspension spacing and alternate locations.



PLAN VIEW

Linear Plan:

Lithonia Lighting offers the ability to provide a continuous run plan to suit your requirements by optionally offering three different methods of configuration.

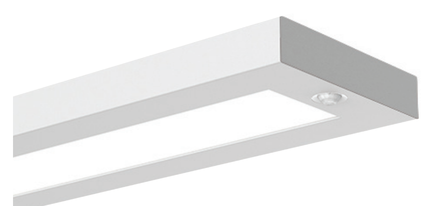
LSL- Linear Same Length:
In this configuration, each segment is the same length and is standardized based on the longest length available and is the only option provided. Because it is dependent on one segment length there are mathematical limitations on what overall row lengths can be achieved. Example: 20 FT row would be achieved with 5, 4 FT long segments equaling 20 FT (nominal).

LCB- Linear Center Balanced:
This configuration incorporates the longest center segment(s) along with any additional lengths required to fill the run length, added to the run ends. Example: 20 FT run would have 2, 4 FT segments (one at each end) and 1, 8 FT segment in the center.

LLP- Linear Longest Possible
In this configuration, the longest length available is optimized, resulting in the fewest segments and mounting locations. Caution, should be used where balanced appearance is a concern. Example: 20 FT run would have 2, 8 FT segment and 1, 4 FT segment at the end of the run.

INTEGRATED SENSOR OPTIONS

Dimming Driver	Integrated Sensor	Daylight Dimming	Daylight Dimming and/or Occupancy Detection	nLight Wired Networking	Link to Spec Sheet
NLIGHT	ADC	X		X	PeerlessLighting.com/nES-ADCX
NLIGHT	PDT		X	X	PeerlessLighting.com/nES-PDT7
ZT	ADC	X			PeerlessLighting.com/MSD-EZ-ADC
ZT	PDT		X		PeerlessLighting.com/MSD-EZ-PDT



Daylight harvesting deactivated by default and field programmed per sequence of operations for PDT sensor options.

Luminaires specified with nLight system networking ship with one RJ-45 connector integrated into the luminaire, 10' of Cat-5e cable and a splitter to control the entire luminaire row (depending on wattage/voltage limitations). For multiple zones, please contact TechSupport@PeerlessLighting.com.

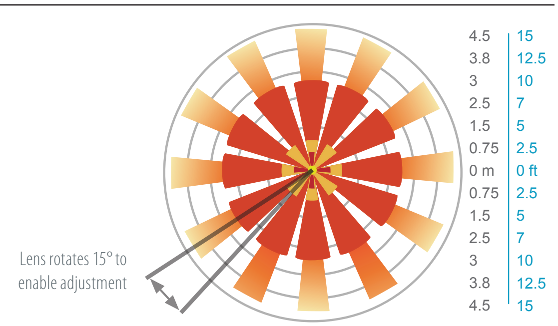
OCCUPANCY DETECTION COVERAGE

At the 7.5 ft (2.9 m) hanging height of a typical pendant mount fixture the sensor provides 10 ft (3.05 m) radial detection of small motion. At a 9 ft (2.74 m) hanging height the radius is 12 ft (3.66 m) for small motion.

Adequate for walking motion detection from mounting heights between 7.5 ft (2.29 m) and 20 ft (6.10 m).

Initial detection will occur earlier when walking across sensor's field of view than when walking directly at sensor.

Initial detection of walking motion into long coverage segment will occur at distances of 2x the mounting height up to 15 ft (4.57 m) and 1.75x up to 20 ft (6.10 m). Lens assembly rotates 15° to enable adjustment in order to line up long segments.



LITHONIA LIGHTING®
An AcuityBrands Company

LED: One Lithonia Way, Conyers, GA 30012 Phone: 800-858-7763 Fax: 770-929-8789 www.lithonia.com

Most Common Mounting Types and Options

Options available for this specific luminaire are checked in the boxes below.

Mounting Type

F1/ For use with most T-Bar and screw slot grid ceilings. Designed for on-grid and off-grid applications.

F2/ For use with recessed or surface mount horizontal J-box applications.

F1A/ For use with most T-Bar and screw slot grid ceilings. Designed for on-grid and off-grid applications. Comes complete with vertical J-box with built-in wire way. See also CP.

Mounting Options

MCS Matching canopy at support for aesthetics.

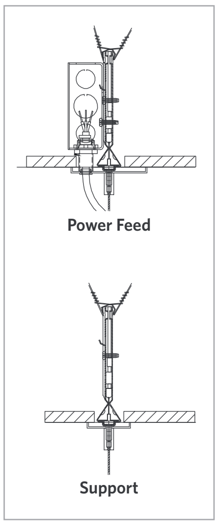
MCSJ Matching canopy for J-box mounting at non-power feed support locations.

OJB Offset J-box at feed.

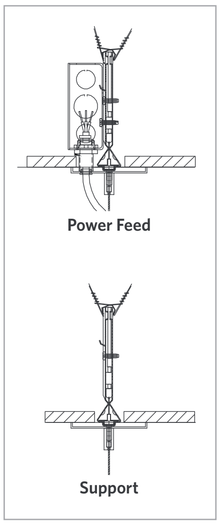
SLP OJB Sloped ceiling couplers and offset J-box option at feed.

For more detailed mounting drawings and information, see PeerlessLighting.com/MountingOptions

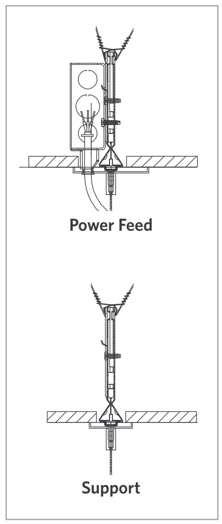
☑ **F1/**



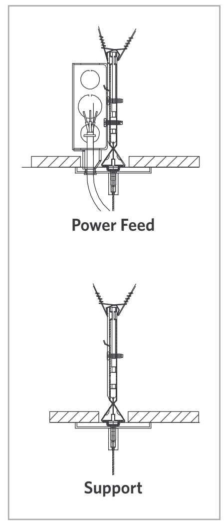
☑ **F1/MCS**



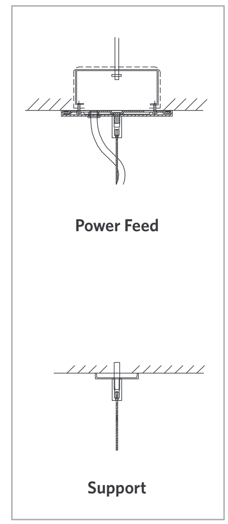
☑ **F1A/**



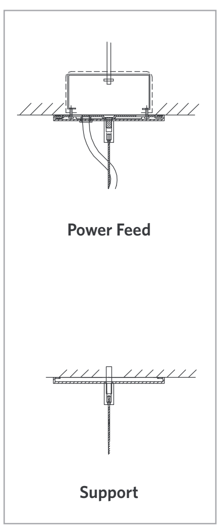
☑ **F1A/MCS**



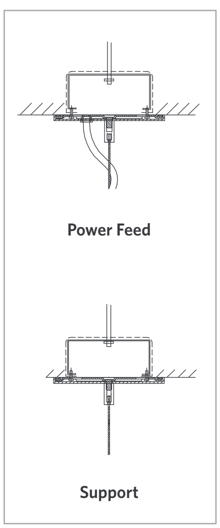
☑ **F2/**



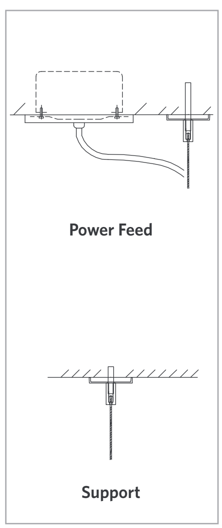
☑ **F2/MCS**



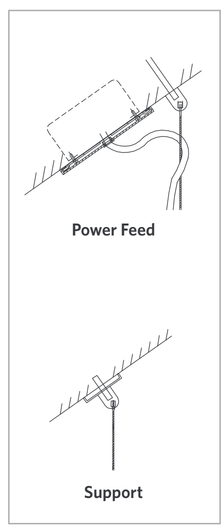
☑ **F2/MCSJ**



☑ **F2/OJB**



☑ **F2/SLP OJB**



LED: One Lithonia Way, Conyers, GA 30012 Phone: 800-858-7763 Fax: 770-929-8789 www.lithonia.com

AC Traction Elevator Hoist Motor

Polyphase squirrel cage induction motor designed for use with VVVF drives, low slip (2% Nominal) with high breakdown torque (250% Minimum), or high slip (10% Nominal) with high starting torque (275% Minimum).

Mechanical construction with cast iron frame & brackets, hot rolled steel shaft, regreaseable ball bearings, open drip-proof, totally enclosed fan cooled, or totally enclosed non-ventilated enclosures.

If required, motor shall be supplied with motor mounted shaft driven optical encoder rated at 1,024 pulses per revolution.

Insulation system shall be standard class B or optional class F with stator winding of copper insulated magnet wire. Insulation processing shall include minimum of 2 dips and bakes of polyester varnish.

Duty for VVVF applications shall be 60 minute for low slip and 30 minute for high slip designs at name plate rating. Motor temperature rise in a 40ºC maximum room ambient at nameplate rating shall be:

Open Drip-Proof	60ºC by resistance
Totally Enclosed Fan Cooled	60ºC by resistance
Totally Enclosed Non-Ventilated	65ºC by resistance

Laminations to be fully processed core plated electrical grade steel of suitable gage.

Rotor shall be of die cast aluminum construction.

Motors shall comply with all applicable NEMA standards per publication MG-1 latest edition and revisions. Motors shall be CSA listed and have appropriate CSA marking on the motor nameplate.

For other mechanical and electrical configurations, consult factory.

Imperial Electric
1503 Exeter Road
Akron, OH 44306
Phone: (330) 734-3600
Fax: (330) 734-3601
www.ImperialElectric.com

Contact: Dennis Rhodes
Elevator Sales Engineer
Rhodesd@ImperialElectric.com
Ext. 206

10/17/2002 REV A

AC VVVF Elevator Hoist Motor 1200 RPM Standard Amp Ratings

IMPERIAL ELECTRIC
The Driving Force In Motion

Low Slip, Single Speed, Ball Bearings, Elevator End Play, 50ºC Rise, 1200RPM, 60 Minute Duty, Open Construction

HP	5	7.5	10	12.5	15	20	25	30	40	50	60	75
Frame	256T	256T	256T	284T	284T	286T	324T	326T	365T	365T	405T	405T
200 V	**15.4**	**24.5**	**30.8**	34.1	43.8	58.3	70.0	80.4	**113.0**	132.2	**152.0**	**189.0**
208 V	14.8	23.5	29.6	32.7	41.9	55.2	67.0	78.4	108.0	129.3	147.0	**182.0**
220 V	14.2	21.5	26.6	30.9	39.3	52.4	65.8	72.5	104.0	122.0	**139.0**	**172.0**
230 V	13.5	21.6	26.4	29.5	39.0	49.8	61.0	70.4	98.2	116.2	132.2	164.0
240 V	13.6	20.4	26.5	28.9	36.0	47.6	58.6	68.6	95.4	114.2	127.0	156.8
440 V	7.1	10.8	13.3	15.6	19.7	26.2	32.9	36.7	52.0	61.0	**69.3**	86.0
460 V	6.8	10.8	13.2	14.8	19.5	24.9	30.5	35.2	49.1	58.1	66.1	82.0
480 V	6.4	10.2	13.3	14.2	18.0	23.8	29.3	34.3	47.7	57.1	63.5	78.4
575 V	**5.4**	**8.5**	10.5	11.9	15.2	20.1	24.8	28.4	38.6	46.5	**53.0**	**65.5**
Effiency	87.1%	86.9%	88.0%	88.9%	89.0%	89.7%	89.5%	90.8%	90.0%	90.4%	91.4%	91.1%
P/F	79.8%	75.8%	72.4%	88.8%	83.1%	82.6%	85.9%	87.9%	85.1%	88.6%	92.7%	94.2%
BTU/HR	566	864	1,042	1,192	1,416	1,754	2,240	2,322	3,395	4,056	4,312	5,596

Bold Numbers are Calculated

For other mechanical and electrical configurations, consult factory.

Imperial Electric
1503 Exeter Road
Akron, OH 44306
Phone: (330) 734-3600
Fax: (330) 734-3601

Contact: Dennis Rhodes
Elevator Sales Engineer
Rhodesd@ImperialElectric.com
Ext. 206
www.ImperialElectric.com

03/09/2005

IMPERIAL
ELECTRIC
The Driving Force In Motion

AC VVVF Elevator Hoist Motor 900 RPM Standard Amp Ratings

Low Slip, Single Speed, Ball Bearings, Elevator End Play, 50ºC Rise, 1200RPM, 60 Minute Duty, Open Construction

HP	5	7.5	10	12.5	15	20	25	30	40	50	60	75
Frame	256T	256T	284T	286T	286T	324T	326T	365T	365T	405T	405T	405T
200 V	**18.2**	**31.0**	**32.0**	**45.0**	48.4	**67.0**	**82.0**	**97.0**	**126.0**	**142.0**	**166.0**	**210.0**
208 V	17.4	28.6	31.0	40.3	48.5	62.0	79.4	91.3	122.3	**136.0**	**160.0**	**202.0**
220 V	**16.8**	**29.2**	31.6	**39.6**	45.0	57.7	72.7	85.6	111.2	**130.0**	**152.0**	**192.0**
230 V	**4.0**	28.0	29.2	36.7	43.2	55.0	67.6	80.4	111.0	120.4	**141.0**	**184.0**
240 V	16.2	27.3	26.5	37.4	40.0	55.2	68.0	80.6	105.0	118.0	138.0	**175.0**
440 V	**8.4**	**14.6**	15.8	**19.8**	22.5	28.9	36.3	42.8	55.6	**65.0**	**76.0**	**96.0**
460 V	**8.0**	14.0	14.6	18.9	21.6	27.5	33.8	40.2	55.3	60.2	70.2	**92.0**
480 V	7.6	13.7	13.3	18.7	20.0	27.6	34.0	40.3	52.4	59.0	69.0	87.4
575 V	**6.4**	**11.4**	**11.8**	**15.6**	17.7	**23.0**	**28.5**	**33.8**	**44.0**	**50.0**	**58.0**	**73.0**
Effiency	84.9%	85.0%	87.5%	87.2%	88.1%	89.0%	89.5%	89.1%	89.6%	90.5%	91.2%	91.2%
P/F	69.6%	62.2%	76.1%	73.3%	72.5%	76.3%	73.8%	76.4%	79.3%	85.8%	85.9%	84.5%
BTU/HR	679	1,011	1,091	1,401	1,548	1,888	2,240	2,803	3,546	4,009	4,422	5,527

Bold Numbers are Calculated

For other mechanical and electrical configurations, consult factory.

Imperial Electric
1503 Exeter Road
Akron, OH 44306
Phone: (330) 734-3600
Fax: (330) 734-3601

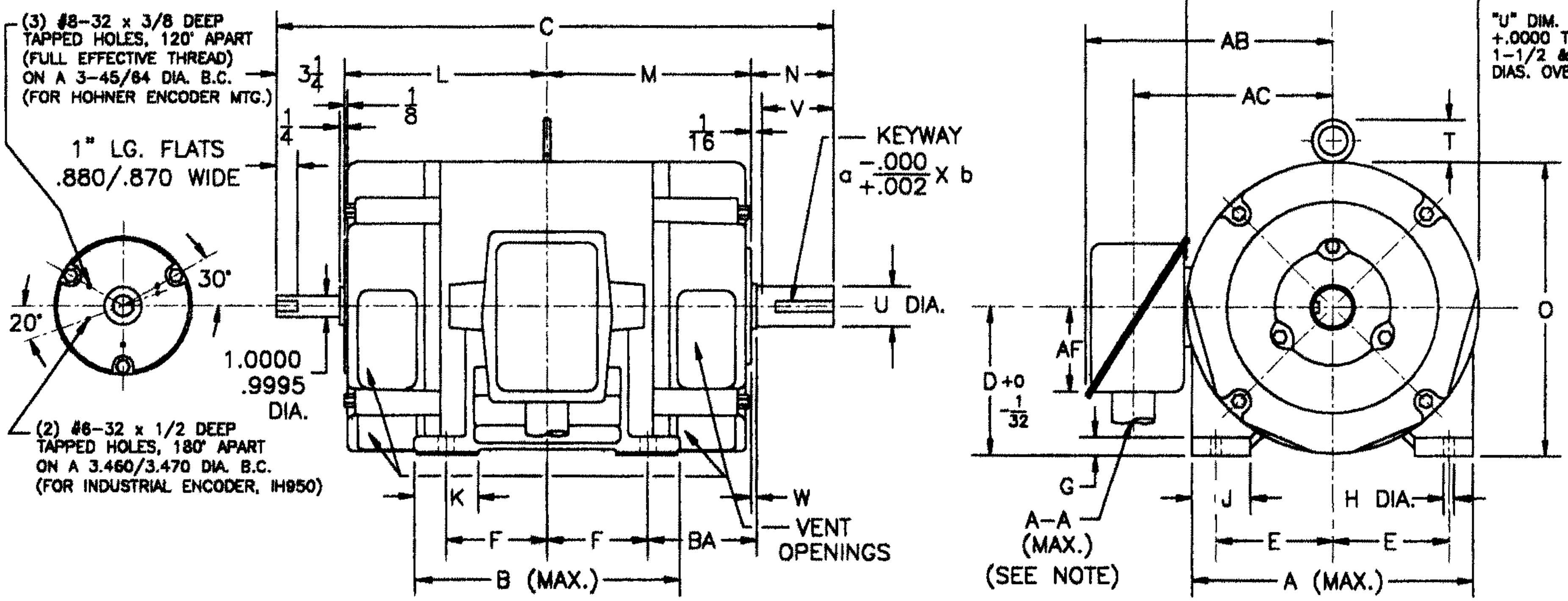
Contact: Dennis Rhodes
Elevator Sales Engineer
Rhodesd@ImperialElectric.com
Ext. 206
www.ImperialElectric.com

03/09/2005

END VIEW FOR CUST. MTG OF HOHNER ENCODER MODEL NO. 88-1382A-1024 AFTER MTG. MOTOR TO GEARED MACHINE, OR WHEN INDUSTRIAL ENCODER (IH950 SERIES) IS MTD. BY CUST. OR IMPERIAL ELEC. FACTORY MTD. (SEE AUX. DIM. DWG. 1-1900-0082.

STANDARD TLBX MTG. @ F-1 (F-2 & TOP MTG. AVAILABLE). TLBX IS MTD. SO CONDUIT CAN BE LOCATED IN 90° INCREMENTS.

"U" DIM. ON SHAFT VARIES FROM +.0000 TO -.0005 FOR DIAS. TO 1-1/2 & +.000 TO -.001 FOR DIAS. OVER 1-1/2.



FRAME	A	B	BA	C	D	E	F	G	H	J	K	L	M	N	O	P	T	U	V	W	a	b	AA	AB	AC	AF				WT
215T	10 1/2	9	3 1/2	20 9/16	5 1/4	4 1/4	3 1/2	5/8	13/32	1 3/4	2	6 15/16	6 7/8	3 1/2	10 5/16	10 1/8	—	1 3/8	3 1/8	1/8	5/16	5/32	1	8 9/16	6 15/16	2 3/4				125
254T	12 1/2	10 3/4	4 1/4	23 7/8	6 1/4	5	4 1/8	3/4	17/32	2 1/4	2 1/2	8 3/8	8 1/4	4 1/8	12 5/16	12 1/8	2 3/8	1 5/8	3 3/4	1/8	3/8	3/16	1 1/2	11	8 3/4	4				200
256T	12 1/2	12 1/2	4 1/4	25 5/8	6 1/4	5	5	3/4	17/32	2 1/4	2 1/2	9 1/4	9 1/8	4 1/8	12 5/16	12 1/8	2 3/8	1 5/8	3 3/4	1/8	3/8	3/16	1 1/2	11	8 3/4	4				225
284T	14	12 1/2	4 3/4	26 7/8	7	5 1/2	4 3/4	7/8	17/32	2 3/4	3	9 1/2	9 3/8	4 3/4	13 13/16	13 3/4	2 3/8	1 7/8	4 3/8	1/8	1/2	1/4	1 1/2	11 3/4	9 1/2	4				300
284TS	14	12 1/2	4 3/4	25 1/2	7	5 1/2	4 3/4	7/8	17/32	2 3/4	3	9 1/2	9 3/8	3 3/8	13 13/16	13 3/4	2 3/8	1 5/8	3	1/8	3/8	3/16	1 1/2	11 3/4	9 1/2	4				300
286T	14	14	4 3/4	28 3/8	7	5 1/2	5 1/2	7/8	17/32	2 3/4	3	10 1/4	10 1/8	4 3/4	13 13/16	13 3/4	2 3/8	1 7/8	4 3/8	1/8	1/2	1/4	1 1/2	11 3/4	9 1/2	4				325
286TS	14	14	4 3/4	27	7	5 1/2	5 1/2	7/8	17/32	2 3/4	3	10 1/4	10 1/8	3 3/8	13 13/16	13 3/4	2 3/8	1 5/8	3	1/8	3/8	3/16	1 1/2	11 3/4	9 1/2	4				325
324T	16	14	5 1/4	29 1/2	8	6 1/4	5 1/4	1	21/32	3 1/4	3 1/2	10 1/2	10 3/8	5 3/8	15 13/16	15 5/8	2 3/8	2 1/8	5	1/8	1/2	1/4	2	12 3/4	10 1/2	4				400
324TS	16	14	5 1/4	28	8	6 1/4	5 1/4	1	21/32	3 1/4	3 1/2	10 1/2	10 3/8	3 7/8	15 13/16	15 5/8	2 3/8	1 7/8	3 1/2	1/8	1/2	1/4	2	12 3/4	10 1/2	4				400
326T	16	15 1/2	5 1/4	31	8	6 1/4	6	1	21/32	3 1/4	3 1/2	11 1/4	11 1/8	5 3/8	15 13/16	15 5/8	2 3/8	2 1/8	5	1/8	1/2	1/4	2	12 3/4	10 1/2	4				450
326TS	16	15 1/2	5 1/4	29 1/2	8	6 1/4	6	1	21/32	3 1/4	3 1/2	11 1/4	11 1/8	3 7/8	15 13/16	15 5/8	2 3/8	1 7/8	3 1/2	1/8	1/2	1/4	2	12 3/4	10 1/2	4				450

CUSTOMER NAME ______________________ BY __________
CUSTOMER ORDER NO. ______________________ DATE __________
IMPERIAL ELEC. ORDER NO. ______________________ VOLTS __________
FRAME HP RPM PH HZ

SCALE 1/4=1, 284
DESIGN REF. 5-2000-1097
DRAWN R.FOX 4/6/99
DATE
CHK'D.
DATE
INSP.
DATE

CUSTOMER DIMENSION DRAWING

TITLE A.C. MOTOR DRIPPROOF, "T,TS" EXT. BALL BRG., W/FEET SPL. ENCODER MTG.-FE

FRAME NO. 210-320
M- NO.

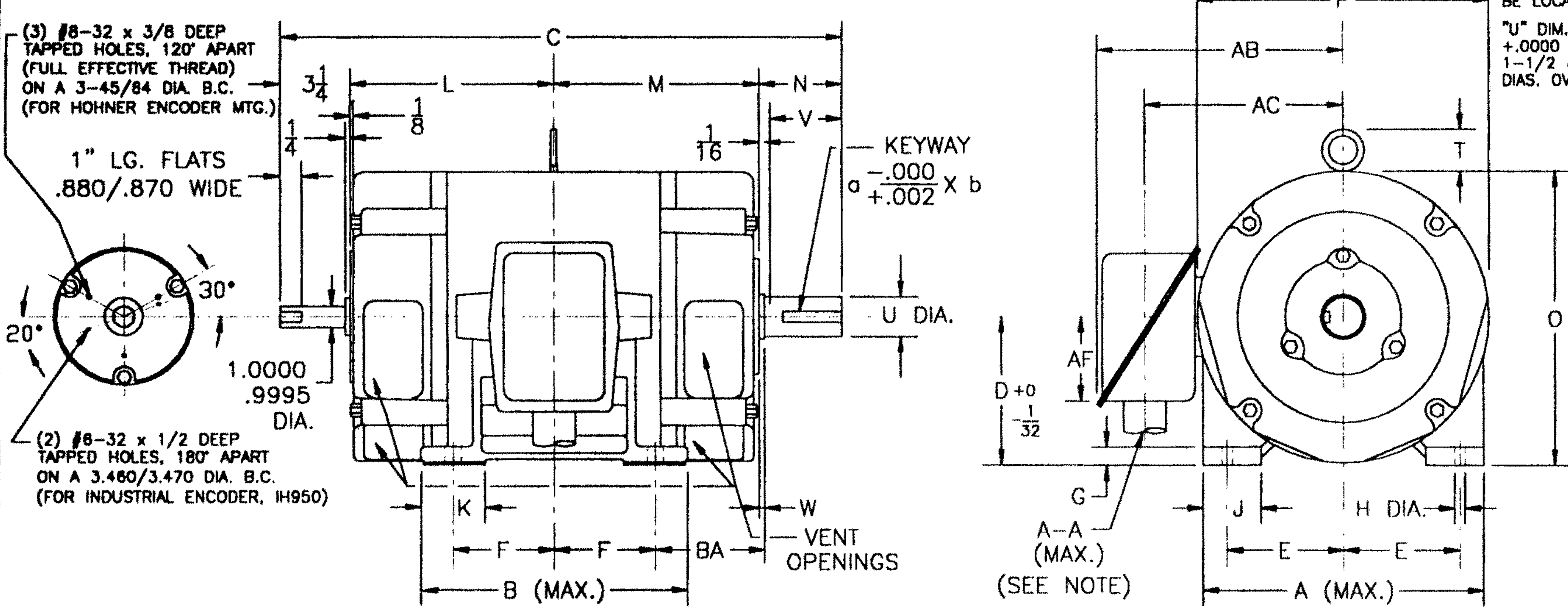
IMPERIAL ELECTRIC CO.

DWG. NO. 5-2000-1109-1

END VIEW FOR CUST. MTG OF HOHNER ENCODER MODEL NO. 88-1362A-1024 AFTER MTG. MOTOR TO GEARED MACHINE, OR WHEN INDUSTRIAL ENCODER (IH950 SERIES) IS MTD. BY CUST. OR IMPERIAL ELEC. FACTORY MTD. (SEE AUX. DIM. DWG. 1-1900-0082.

STANDARD TLBX MTG. @ F-1 (F-2 & TOP MTG. AVAILABLE). TLBX IS MTD. SO CONDUIT CAN BE LOCATED IN 90° INCREMENTS.

"U" DIM. ON SHAFT VARIES FROM +.0000 TO -.0005 FOR DIAS. TO 1-1/2 & +.000 TO -.001 FOR DIAS. OVER 1-1/2.



FRAME	A	B	BA	C	D	E	F	G	H	J	K	L	M	N	O	P	T	U	V	W	a	b	AA	AB	AC	AF				WT
364T	18	15 1/4	5 7/8	32	9	7	5 5/8	1	21/32	2 1/2	3	11 3/8	11 3/8	6	17 13/16	18 5/8	2 3/4	2 3/8	5 5/8	1/8	5/8	5/16	3	15 7/8	12 13/16	4 1/2				550
364TS	18	15 1/4	5 7/8	29 7/8	9	7	5 5/8	1	21/32	2 1/2	3	11 3/8	11 3/8	3 7/8	17 13/16	18 5/8	2 3/4	1 7/8	3 1/2	1/8	1/2	1/4	3	15 7/8	12 13/16	4 1/2				550
365T	18	16 1/4	5 7/8	33	9	7	6 1/8	1	21/32	2 1/2	3	11 7/8	11 7/8	6	17 13/16	18 5/8	2 3/4	2 3/8	5 5/8	1/8	5/8	5/16	3	15 7/8	12 13/16	4 1/2				610
365TS	18	16 1/4	5 7/8	30 7/8	9	7	6 1/8	1	21/32	2 1/2	3	11 7/8	11 7/8	3 7/8	17 13/16	18 5/8	2 3/4	1 7/8	3 1/2	1/8	1/2	1/4	3	15 7/8	12 13/16	4 1/2				610
404T	20	16 1/4	6 5/8	36	10	8	6 1/8	1	13/16	3	3 1/2	12 3/4	12 5/8	7 3/8	19 13/16	19 5/8	2 3/4	2 7/8	7	1/8	3/4	3/8	3	15 7/8	12 7/8	4 1/2				780
404TS	20	16 1/4	6 5/8	33	10	8	6 1/8	1	13/16	3	3 1/2	12 3/4	12 5/8	4 3/8	19 13/16	19 5/8	2 3/4	2 1/8	4	1/8	1/2	1/4	3	15 7/8	12 7/8	4 1/2				780
405T	20	17 3/4	6 5/8	37 1/2	10	8	6 7/8	1	13/16	3	3 1/2	13 1/2	13 3/8	7 3/8	19 13/16	19 5/8	2 3/4	2 7/8	7	1/8	3/4	3/8	3	15 7/8	12 7/8	4 1/2				865
405TS	20	17 3/4	6 5/8	34 1/2	10	8	6 7/8	1	13/16	3	3 1/2	13 1/2	13 3/8	4 3/8	19 13/16	19 5/8	2 3/4	2 1/8	4	1/8	1/2	1/4	3	15 7/8	12 7/8	4 1/2				865
445T	22	20 1/2	7 1/2	43 1/4	11	9	8 1/4	1	13/16	3	4 1/8	15 3/4	15 5/8	8 5/8	22 11/16	23 3/8	3 1/4	3 3/8	8 1/4	1/8	7/8	7/16	3	18 5/8	15 5/8	4 1/2				1205
445TS	22	20 1/2	7 1/2	39 1/2	11	9	8 1/4	1	13/16	3	4 1/8	15 3/4	15 5/8	4 7/8	22 11/16	23 3/8	3 1/4	2 3/8	4 1/2	1/8	5/8	5/16	3	18 5/8	15 5/8	4 1/2				1205

CUSTOMER NAME ______________________ BY ________
CUSTOMER ORDER NO. ______________________ DATE ________
IMPERIAL ELEC. ORDER NO. ______________________ VOLTS ________
FRAME HP RPM PH HZ

SCALE 1/4=1, 284
DESIGN REF. 5-2000-1097
DRAWN R.FOX DATE 4/5/99
CHK'D. DATE
INS'P. DATE

CUSTOMER DIMENSION DRAWING
TITLE A.C. MOTOR DRIPPROOF, "T,TS" EXT. BALL BRG., W/FEET SPL. ENCODER MTG.-FE
FRAME NO. 360-440
M-NO.
IMPERIAL ELECTRIC CO. AKRON-MIDDLEPORT, OHIO
DWG. NO. 5-2000-1109-2